BLOOMING
Inclusion and Diversity in STEAM

A2.1: Report on the state of diversity and inclusion in STEM in each partner country

Desk research:

One report from each country on the state of diversity and inclusion in STEAM. The report may involve, literature review of analysis of the educational curricula, the reviewing of existing initiatives, interviews with experts.

Goals & Objectives

The Desk research (A2.1) will allow us to collect consistent data about inclusion and diversity in STEM in the different countries and get an understanding about general trends in each country, that is essential to map the current situation with respect to engagement of young women in STEM for ages 14 and above.

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Executive Summary

The A2.1 Desk Research report provides a comprehensive overview of the state of diversity and inclusion in STEM (Science, Technology, Engineering, and Mathematics) education across several countries, with a specific focus on the engagement of young women aged 14 and above. By examining the STEM landscapes in Greece, Italy, Ireland, and Romania, this report highlights key trends, challenges, and initiatives that impact young women's participation in these fields. Each national report includes a review of educational curricula, expert interviews, and analysis of existing initiatives, creating a holistic view of the current status of diversity and inclusion in STEM education across these countries

1. Greece National Report

1.1 A scoping review of gender balance in STE(A)M education in Greece

1.1.1 The STE(A)M landscape in Greek employment and education

Greek women have been students at higher education at increasing numbers especially after the 1980s but the female candidates to STEM-related higher education were confronted with social criticism for their choices and it was harder for them to handle such studies compared to the male candidates since high schools did not prepare adequately enough girls in STEM (especially in Math) as there was the underlying concept that girls are lacking in mathematical skills (Boltsi, n.d.).

Nowadays, in Greece, as in other Mediterranean and Balkan states, the presence of females in the STEM area especially in the employment sector is limited. Discrimination against women is visible in the STEM sector in both education and the workplace. More specifically, regarding education, the landscape in schools and universities is similar. According to research, girls during their primary and secondary school years are less likely to be actively engaged in the STEM courses and be successful at them. This is due to various reasons. First of all, there is not enough encouragement from the family environment. The girls' parents tend to sustain the stereotype of boys being good in STEM courses like math, physics and computer science while girls are considered better in theoretical courses such as literature and history. As a result, they are pushing them to succeed primarily in these areas. Additionally, there are social reasons. More particularly, there is a strong stereotype regarding students that are talented in STEM courses, the

stereotype of being a 'nerd'. The students who are considered as 'nerds' are facing bullying, discrimination and are stigmatized throughout their school years. This stigma, according to research, is more impactful on girls' social life. As a result, there are many cases of girls sacrificing their interest in STEM courses and they are discouraged from excelling in STEM courses even though they might be talented (Berdousis and Kordaki, 2018).

As far as Greek universities are concerned, the presence of female students in STEM faculties is strong, however their percentage is still lower than that of male students. It seems that female students are the ones that interact the most with their professors and a reason for this is that they tend to seek more support than males. It was also reported that they prefer mostly female professors to cooperate with because for them they act as role models, and they are likely to enhance their confidence. However, as the relevant study has shown, there is inadequate presence of female faculty in Academia especially in the field of computing while in sectors such as Biology or even physics and math the gender gap is smaller (Berdousis and Kordaki, 2018).

Still to this date though, it is attested that although the gender gap in education in general in Greece has closed, a gender gap persists and is consolidated in the fields of studies with female students dominating the areas of humanities, social sciences and health-related studies (Secretary General for Demography and Family Policy and Gender Equality, 2022).

As already mentioned, the STEM workplace is also an area where Greek women are still discriminated against. The situation shows some improvement in the last few years. First, it is worth mentioning that in Greece, there is a high number of STEM students in graduate and postgraduate programs. All these students are candidates for a place in the STEM job market which presents the highest demand out of all the sectors in the country. In this competitive system, it is even more difficult for

females to gain the professional recognition they deserve as STEM experts. More specifically, according to a research that took place in 2019, only 4% of Greek women work in the field of STEM, while the counterpart percentage of men is 20% (European Institute for Gender Equality, 2019). As far as the field of STEM research is concerned, the percentage of women STEM researchers is only 37% out of the total (Perifanou and Economides, 2020a).

1.1.2 Initiatives to overcome gender disparity in STEM Education and workplace in Greece

There are some initiatives in order to improve the situation and enhance the participation of women in STEM. A great example is **Greek Women in STEM** whose scope is to empower women that aspire to work in STEM. It offers mentoring programs, interviews with female scientists that can act as role models for girls as well as the organization of related events (Greek Women In STEM, n.d.).

Many of these initiatives come from civil society and the business sectors and are quite recent especially focusing on technology and computer science. One such initiative is the one called **Greek Girls Code**. This is a 'social initiative and campaign dedicated to advancing Greek women in the fields of science, research, and technology'. As they aim to bridge the gender gap in STEM in Greece they provide mentoring, workshops, hackathons and bootcamps for women to enhance their interest and skills in pursuing STEM careers and studies. In their efforts, they work along with schools and academics and encourage girls to 'explore STEM subjects and careers' (Greek Girls Code, n.d.).

Technology companies are also promoting initiatives such as the **#codelikeagirl** which is one of the largest events of code development addressing adolescent girls between 14 and 18 years old. In the same vein,

Code it Like a Girl is the 'first social enterprise in Greece offering coding workshops to girls and women in order for them to obtain the hard skills to lead innovation and close the gender gap in the IT industry' (StartUs network website, n.d).

Some technology companies initiatives include the following:

- Microsoft has been involved in various initiatives to promote STEM education and gender diversity in Greece. They have partnered with local organizations and schools to provide coding workshops, technology training, and mentorship opportunities for girls.
- IBM has been known to collaborate with educational institutions and organizations in Greece to promote STEM education and diversity. They have offered workshops, coding events, and training programs for girls to enhance their skills in technology and innovation.
- Cisco has supported programs and events that encourage girls to pursue careers in technology. They have partnered with educational institutions and non-profit organizations to provide networking and learning opportunities in the field of STEM.
- Vodafone has been active in supporting initiatives related to digital skills and technology education for girls. They have organized workshops and events to empower girls with coding and digital literacy skills.
- Greek Research and Technology Network (GRNET) has collaborated with educational institutions to organize events and workshops promoting STEM fields among girls. They have worked to bridge the gender gap in technology and research.

Another example is the Womentors initiative of Lambrakis Foundation. The initiative focuses also on STEM disciplines and aims at the multifaceted empowerment of young women through education and capacity building for greater participation, decision-making, power and action, in order to

take full control of their lives in relation to their economic activity, the public/political space at their disposal, the harmonization of work with personal time, the safeguarding of their rights at work and in all areas of their life and health (Womentors webpage).

1.1.3 STEM and the Arts in Education

The introduction of the Arts in STEM education in Greece is still at an embryonic state of affairs. In a rather recent study among early age educators in Greece the STEAM approach was presented and although most of the educators consider it a very useful and creative approach in early childhood education, more than half of them were not quite knowledgeable or trained in using it. So the study concludes that the need to introduce training programmes in STEAM among educators is imperative (Karapanou and Tzirou, 2018).

There are limited initiatives to incorporate the arts in the science and technology sectors and almost exclusively in the civil society sector, and focusing mainly in robotics. An example is the STEAM GREECE, a non-profit organization which claims to specialize in designing and materializing innovative projects on STEAM and robotics in cooperation with Greek schools. (STEAM GREECE, 2017).

Some notable efforts to engage the public to STEAM activities through periodic displays or educational events, have been made by foundations. Some examples include the following:

- Onassis STEGI: Onassis STEGI is an innovative cultural space in Athens that hosts a variety of artistic and educational events. It often features

interdisciplinary projects that bridge art and technology. Their programs include workshops, exhibitions, and performances that explore the intersections of various disciplines.

- Eugenides Foundation: The Eugenides Foundation in Athens has been known for its educational initiatives, including the New Digital Planetarium. This facility combines astronomy with technology and multimedia art to create immersive educational experiences.
- Stavros Niarchos Foundation Cultural Center (SNFCC): The SNFCC in Athens is a multifunctional complex that hosts various cultural and educational events. While it emphasizes sustainability and the environment, it has also incorporated artistic and technological elements into its programming.

1.2 Objectives

To monitor progress in terms of achieving the goals of Greece's STEM education policy and further promoting the Arts (or STEAM) in general but also in terms of closing the gender gap in this area, a data-driven approach is needed. This involves gathering information about relevant practices and interventions at all levels of education together with evidence about their effectiveness. Despite the role of universities as an important stakeholder in the ecosystem of STEM education, limited information is available about initiatives and actions implemented to close the gender gap in this context. This study is driven by the need to explore the state of gender balance in STEAM education in Greece. It provides a review of evolving literature to map relevant practices in Greek education and training with a focus on tertiary since most of our sources relate to this level of formal education). A scoping review process is used, drawing upon the literature from the last decade (2013-2023) to address the following research questions:

- What is known about gender equality in STE(A)M in Greek educational establishments?

- How is gender equality in STE(A)M education and training promoted in the contexts under examination?
- What enablers and barriers have been reported related to closing the gender balance gap in STEAM education and training?

The review explores relevant practices, interventions, critical enablers, challenges and barriers to gender balance in STEAM education (formal, informal and non formal) in Greece. Enablers are understood as initiatives that facilitate the promotion of gender balance in STEAM education, and barriers refer to challenges and obstacles that hinder this. A clear understanding of the state of gender (im)balance in STEAM education in Greece can help to identify areas for improvement, inform future actions, and open up paths to further research.

1.3 Methods

A scoping review approach was employed for this study, following the guidelines of the 2018 PRISMA framework for scoping reviews (Tricco et al., 2018), as this is deemed appropriate for exploring emerging areas to clarify understanding and to identify where there are gaps in knowledge.

1.3.1 Eligibility criteria

To be eligible for inclusion sources had to be peer reviewed academic Journal articles in order to ensure that only high-quality scholarly sources that meet academic integrity principles were examined. Only sources published in English were included. The inclusion criteria also required sources to be published in the last decade (2013-2023), in order to capture the most recent developments in the state of gender balance in STE(A)M education. For the needs of the present study and to provide a more

accurate image of the field, the term 'education' has been extended here to include informal and non-formal education such as training opportunities and digital skills for professional opportunities. Articles that focused on university education as well as those related to training initiatives, research and further employment opportunities were included.
To qualify for inclusion in the database of this scoping review, studies had to include at least one STEM domain (i.e. science, technology, engineering, mathematics and arts). The exclusion criteria included the following:

- The study is not peer reviewed.
- The study is not written in English.
- The study is a (systematic) literature review.
- The study is not relevant to the topic of gender balance in STEAM in Greece.

1.3.2 Information sources

Searches were conducted across the databases of Scopus, Web of Science, ERIC (ProQuest) and JSTOR. Peer reviewed sources published in English in the period from 2013-2023 were considered. Keywords included STEM, STEAM, education, gender and Greece. These were intentionally broad in order to capture as many results as possible.

1.3.3 Search and selection of resources

After using the specific search strategies mentioned above with different databases, as well as the criteria that the studies required in order to be included, the following studies were selected. What is going to be discussed is 5 studies referring to the topic, with an explanation of how the study was conducted and what the results were.

1.4 Results

For each of the 5 articles, these particular characteristics are included: 1) authors and year of publication 2) title 3) aims 4) findings and recommendations. The analysis is presented in the following table:

Table 1. Table of sources on gender balance in STE(A)M in Greece.

Authors & year of publication	Title	Aims	Findings & Recommendations
Papadakis, S., Tousia, C., & Polychronaki, K. (2018)	Women in computer science. The case study of the Computer Science Department of the University of Crete, Greece.	The researchers aimed to study whether the presence of women in Computer science In Greece has decreased between the years 1985-1986 and 2016-2017.	- After 2000 the participation of women in the computer science sector academically has decreased by almost 6%. -The females that continued their studies with a postgraduate program and ended up getting it are significantly less than males. - The biggest difference between males and females is in the PhD possession where only ten percent of women have a PhD, in a computer science related area. The percentages vary greatly and are almost 10% for females and 90% for males. -This difference in the percentages for participation in computer science academically in all levels of studies, has been more intense the last years.

Maria Perifanou & Anastasios A. Economides (2020a)	Gender Equality Policies and Initiatives for STEM Skills in Greece	The researchers aimed to find out what kind of policies and initiatives are implemented in Greece so that the participation of women in an academic and vocational level is to be promoted.	-In educational levels such as high schools in Greece, the grades in STEM related courses are not significantly different among females and males. -Females in Greece are more likely to be unemployed in STEM sectors than males in the same positions. Tertiary educated women in Greece have the highest rate of unemployment among the similarly educated women in the whole EU. -Women do not occupy positions in jobs with growth potential, or high committees or even as university professors. That's because they face difficulties such as fighting stereotypes in STEM, having a challenging time balancing family roles and career, or not being as well informed as males for STEM job positions. -There are some policies that aim to fix the aforementioned situation, such as the General Secretariat for Gender Equality that is responsible for protecting gender equality in the country. -Apart from that there are also many initiatives that aim specifically, to combat the inequalities in the STEM workplaces and digital skills. Examples of those are "Innovation Hub for Women in Technology", "National Action plan for Digital

			Skills and Jobs in Greece" or "Innovation and Employability for Women".
Ioannis Berdousis & Maria Kordaki, (2018).	Computing and STEM in Greek tertiary education: gender representation of faculty members during the decade 2003–2013	The purpose of the research was to study the participation of women in academia as professors or lecturers, in the sector of STEM and computing in Greece, during the period 2003-2013.	-.The female working members in the Greek Universities in STEM-related faculties, are significantly lower in number than males, consisting only of 27-29 percent. -Throughout the years, despite that there were some changes in the university's teaching staff numbers such as an increase up until 2010 and then a decrease, female staff number remained generally stable, with a slight decrease. -Out of the total number of faculty members in STEM departments at universities, women have the lowest representation in professors, and the highest in lecturers throughout the years. -The physics departments seem to have the largest female representation among all STEM departments on average throughout these years and the lowest representation can be found in computer science disciplines.

Pappas, M. A., Drigas, A. S., Papagerasimou, Y., Dimitriou, H., Katsanou, N., Papakonstantinou, S., & Karabatzaki, Z. (2018).	Female entrepreneurship and employability in the digital era: The case of Greece.	The aim of this paper was to find out whether and how skills in Information and communication Technology (ICT) influence women's job prospects in Greece.	-Women in Greece report that they will not welcome jobs linked with information technology due to negative comments on their skills by co-workers, or to the fact that the people hiring are afraid to hire women because they think they will be disproportionately occupied by family responsibilities. -Half of women asked believe that it is difficult for women to have leading positions in IT related jobs, mostly because of stereotypes against them as well as of the behavior of men towards them. -Despite the fact that nearly all the women in the research agreed that ICT skills are the most vital in entrepreneurship, 70 percent of them believe that the ICT skills of women are not enough in this sector.
Perifanou, M., & Economides, A. A. (2020b)	Gender gap in digital skills in Greece.	The paper aims to explore any policy or initiative that aims to make the digital skills of women stronger in Greece, so that they can be empowered in the workplace but also in the field of education.	-There are efforts made in Greece for women to be further included in the digital world both academically and professionally especially in the public sector. Some of them are going to be referred as examples here: -One of them is the "Women and Girls Go Digital" initiative that is based on knowledge. It provides training and workshops about technology for women and both Greek and European stakeholders are involved.

			-There are also projects that aim to practically put women in the ICT job market more smoothly. For example the "women4it" initiative is responsible for empowering women's employment using the tools the internet and the digital era provide. - The "National Action plan for Digital Skills and Jobs in Greece" is also a good initiative that aims to build a bridge between the ICT companies in Greece and women of the sector so that trust can be built and more participation of women to be achieved.

From everything mentioned in Table 1, it is now clear that in Greece, there is a lot of work to be done in order to achieve equality in STE(A)M. There is a gender gap in the participation in these sectors, and what is more worrying is the fact that this gap is obvious both in education as well in the job market.

In particular, women's participation in the study of computer science is way lower than that of males in all the phases of academic education, going from undergraduate students to PhD students (Papadakis et al., 2018). Even for these women that ultimately get their degree in STEM-related fields, unemployment is a usual phenomenon for them, and way more usual than it is for males (Perifanou and Economides 2020a). Even when they find a job there are obstacles, since, in Greece, the stereotypes, the pressure to choose between career and family and the mistrust against them, it is hard for them and poses obstacles to finding a job and especially be in a managerial position (Pappas et al., 2018).

There is still some hope, since in Greece there are a number of initiatives and projects, engaging both the public sector as well as European institutions to fight the gender gap in STEM. These initiatives, either aim for better educational support for women, providing training to improve women's digital skills, or aim to provide women a better future in the job market or both of them (Perifanou and Economides 2020a).

Finally, after reviewing some of the literature available, it is clear that there is definitely the need for more initiatives and actions aiming to decrease the gender gap in STE(A)M as the efforts so far are limited. A well-rounded take on the issue, with more studies would better help to understand the phenomenon and find ways to better combat it. The integration of the Arts into the STEM approach needs to be consolidated in the Greek context and the educators need to be better informed and trained on this subject.

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2 Italy National Report

2.1 A Scoping Review of gender balance in STE(A)M education in Italy

2.1.1 The need for gender balance in STEM education and careers

In the United States, women make up less than one-third of the workforce in STEM (Science, Technology, Engineering, and Mathematics) sectors, and men still vastly outnumber women when majoring in these fields (Bureau of Census, 2019). In Europe in 2017, 41% of scientists and engineers in Europe were women (Eurostat, 2019). Despite significant recent progress, enhanced by diversity and inclusion policies targeting women in various sectors, gender stereotypes still seem to be deeply ingrained in perceptions and practices across all spectrums of society. Increasing participation rates in science, technology, engineering, and mathematics (STEM) education and employment, whilst ensuring inclusion and diversity, has become a global imperative. STEM are transforming society and the labor market, creating, therefore, the need to invest in STEM education to nurture, develop, and deploy STEM talent. In the European Union, employment of STEM skilled labor is increasing but recruitment difficulties have been reported in the majority of Member States (Caprile et al., 2015: 6). Concerns have also been raised about the fact that the number of students choosing STEM fields is not increasing at a European level and women continue to be underrepresented (*ibid.*). Despite important initiatives in many countries aimed at reducing these gender patterns (OECD, 2019), together with the changing nature of collective beliefs, gender differences in attitudes and roles in STEM are still persistent.

To revert this situation, different policies related to encouraging STEM studies and careers in Europe have been pursued with a strong focus on promoting gender equality. For example, the European Commission and the Helsinki Group on Gender in Research and Innovation, in consultation with the European research area stakeholders' platform, has developed a guide to promote gender equality in research and innovation[1] and has published its Gender Equality Strategy 2020–2025[2], which includes policy objectives and actions towards a gender-equal Europe; UNESCO's (2017) report analyzes the causes of the STEM gender gap and presents evidence and possible lines of action; the European Institute for Gender Equality has developed a model to estimate the macroeconomic benefits of gender equality at the European level (Morais Maceira, 2017).

Gender equality is one of the 17 UN Sustainable Development Goals (SDGs):

> "Gender bias is undermining our social fabric and devalues all of us. It is not just a human rights issue; it is a tremendous waste of the world's human potential. By denying women equal rights, we deny half the population a chance to live life at its fullest. Political, economic and social equality for women will benefit all the world's citizens. Together we can eradicate prejudice and work for equal rights and respect for all."

The need to address the current under-representation of women in STEM areas is emphasized through SDG4: '*To ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*' and SDG5: '*To achieve gender equality and empower all women and girls*'.

[1] Directorate-General for Research and Innovation (European Commission); Helsinki Group on Gender in Research and Innovation. Guidance to Facilitate the Implementation of Targets to Promote Gender Equality in Research and Innovation (2018). Available online: https://op.europa.eu/en/publication-detail/-/publication/2aa2585b-1d03-11e8-ac73-01aa75ed71a1
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2.1.2 STEM and the Arts in Education

Learning science begins in the elementary grades, which is a critical timeframe for students as they are introduced to foundational and crosscutting concepts necessary for later success in science achievement. Disparities in science achievement emerge early, and programs that address these issues need to target the early elementary and preschool years. The incorporation of arts into the inquiry-based approach, could improve learning and that it is a major challenge in STEM education to support teachers enacting inquiry-based instruction and integrating the arts into classroom curriculum. Proponents of the arts suggest that integrating arts with STEM efforts (STEAM) may play a supportive role in science learning. Defining the arts will include the areas of performing arts (i.e., dance, music, and theatre), the presenting arts (i.e., visual arts), and the producing arts (i.e., media arts).

Arts integration in science can offer the support for learning across domains of both externally focused social processing and internally focused cognitive processes. A recent literature review conducted by Wahyuningsih et al. (2020), identified STEAM learning as a popular pedagogical methodology with evidence that supports early childhood education specifically to improve students' learning behaviors, such as creativity, problem-solving, scientific inquiry, critical thinking, and cognitive development. Considering the social processing of working in groups, students learning science might use an arts-integrated approach. Using arts strategies engages students in the creative process, helping them take greater risks and decreasing anxiety (Morgan and Stengel-Mohri, 2014). Arts-integration in science inherently invites students to engage in science in ways that transcend typical

boundaries between what is considered “academic” or “appropriate” in a science classroom and instead invites more creative ways to express ideas. By opening up science to student creativity in these ways, art can increase students’ engagement with science in ways that lower their affective filter and reduce anxiety around communicating their science ideas. Arts may provide a rich and previously untapped classroom resource for both embodied cognition and social ways of processing science learning. Taking the perspective of science learning as a process in which students should be positioned as knowers and doers of science, who are capable of engaging in authentic science practices (NGSS Lead States, 2013; NRC, 2012), we argue that there is a need to encourage and foster the creative side of science learning (Hadzigeorgiou, 2016), as a way to increase equitable learning opportunities for EB students. Traditional pedagogical approaches in science curricula have given attention to the necessary teaching tools for communicating and investigating scientific results, but have done less to provide support for the aesthetic tools, or students’ imaginative engagement and transformative experiences required to conduct science (Hadzigeorgiou, 2016). Imaginative engagement in science education extends beyond the traditional teaching and learning context, fostering creativity, critical thinking, and problem-solving (Hadzigeorgiou et al., 2012). Like a scientist navigating from a list of observational data, to experimental design, and the interpretation of results—this complex process requires intuition, ingenuity, and imagination driving the scientific sensemaking (Kind and Kind, 2007). Both visual arts (i.e., painting, drawing, sculpturing) and performing arts (music, dance, drama) techniques offer pedagogical affordances that extend beyond traditional approaches toward learning science. Integrating the arts in science may provide students with a way to internalize concepts, process information, visualize and develop the ability to think metaphorically, and such “metaphor creates a space in human cognition, where individuals are free to rehearse new ideas of expression and form” (Efland, 2004, p. 757).

2.1.3 The STE(A)M landscape in Italy employment and education

According to the 2019 edition of the International Organization for Economic Cooperation and Development's "Education at a Glance" report, Italy continues to reduce investments in preparing the workforce of the future; on the contrary, our competitors continue to raise the investment bar.

However, the demand for STEM jobs will triple in comparison to traditional jobs in less than ten years. A particularly low peak is the data referring to students in the ICT field: in Italy they represent only 1.7% of tertiary-educated 25-64 year-olds, in 2021, while the OECD average on ICT field of study is 4.8% (OECD, 2022). There are some paths that, despite the far from favorable scenario, guarantee better opportunities in terms of job placement: graduates in STEM disciplines represent real treasures for companies because they have the cross-sector abilities necessary to compete in the digital age. According to the OECD, in Italy students who are attending STEM subjects have the prospect of a much easier entry into the job world, with an employability rate of over 85%. Within these fields, people who studied ICT have the highest employment rates: on average, 87% of adults with postsecondary ICT degrees are employed in Italy. Similarly, 85% are employed in engineering, manufacturing and construction.

The Italian Deloitte Foundation calls on key agents of change (institutions, communities, universities, enterprises and the third sector) to work together on potential reforms, policies and measures that provide youth and workers with the hybrid skills required to tackle today's challenges. Key enablers play a pivotal role in influencing the debate on education and have the potential to make a difference in shaping new learning models in view of the STEAM approach. STEAM (science, technology, engineering, arts, and

mathematics) is an innovative approach to learning that promotes creativity and increases student engagement by integrating arts into scientific subjects.

Therefore, generating awareness of STEM, via initiatives that provide a non-biased view of STEM is key to leveraging young people's interest in these subjects. Unlocking equal opportunities is a priority for achieving social and environmental sustainability. Tackling gender, cultural and socio-economic barriers embedded within our societies via initiatives and measures that foster STEM inclusiveness and equality is essential for guaranteeing social progress. Finally, rethinking the skills needed to thrive and breaking down structural socio-economic and cultural barriers is vital for opening up equal opportunities, whilst ensuring academic and professional development for everyone, regardless of people's socio-economic status. In this context, reskilling and upskilling comprise a fundamental process for keeping up with fast-changing environmental needs. Skills hybridization and transferable skills can help steer the workers of the future toward a more sustainable social, digital and climate transformation. A combination of arts and humanities and STEM skills can provide an innovative way to tackle social and environmental challenges. In this report, Deloitte identifies three main actions of change that key enablers should engage with, in order to actively generate a positive impact on social progress: broadening STEM knowledge, eradicating barriers, rethinking talent.

Gender imbalance is also present in STEM employment and education in Italy. A minority of respondents, from the targets considered by the Deloitte mapping analysis, believe that STEM disciplines are not suitable for women, due to **deeply rooted gender stereotypes**. Men are more likely than women to study STEM subjects, which are associated with higher earnings, while a larger proportion of women pursue fields linked with relatively lower earnings, such as education, arts and humanities. From 2015 to 2020, reported Tortuga on "il Sole 24 ore", the number of male students choosing

a STEM pathway increased more (7,8%) than their female counterparts (6,9%).

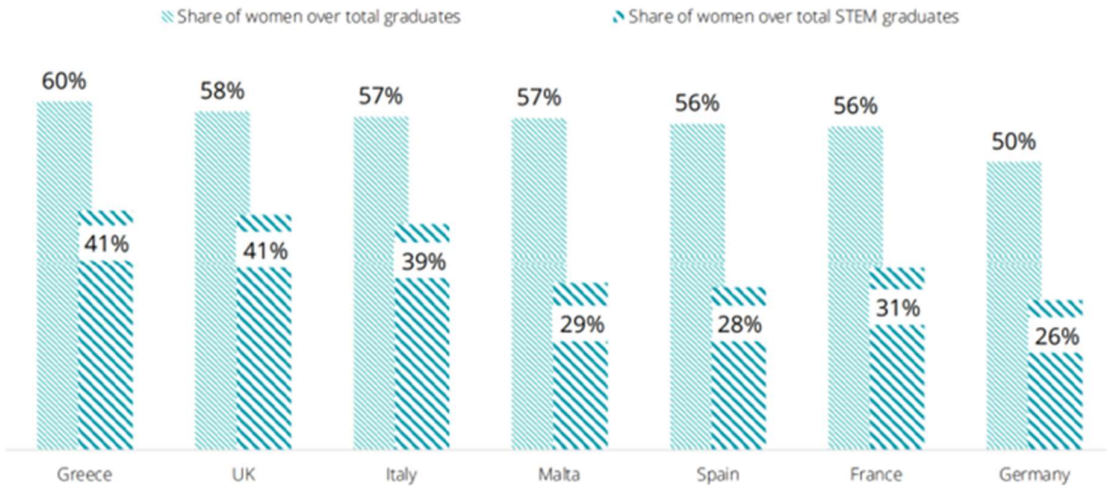

Figure: Presence of women among STEM and non-STEM graduates Source: data from Eurostat, 2019; retrieved in the Deloitte report: Rethink.

2.1.4 STE(A)M education, 2022

In Italy, women graduates among STEM graduates were 39%. This may be linked to **discrimination they may face in the workplace**. Deloitte, in 2022, detected at 50,5% the international average about the percentage of workers who perceive women discrimination at work, while in Italy the percentage was higher 60%.

The under-representation of women in STEM-related tertiary education and careers could be partially explained by the significant gender imbalances in STEM subject selection at post-primary level, as revealed by a recent literature review on effective interventions for addressing gender balance in STEM at all levels of Italy education. There has been some progress in diversity and inclusion in STEM in Italy in recent years but more work is needed to encourage more women and marginalized cohorts to enter

STEM courses and careers. When politicians discuss Italy's position in terms of achieving equality between men and women, the school environment is rarely called into question or mentioned. This is despite the fact that gender inequality remains a prominent feature of the Italian education system. The reason for this failure to perceive the problem, and the consequent lack of investment in policies for gender equality in education, derives from a massive misunderstanding: school is perceived by the public and the political class as one of the few environments within the highly sexist Italian social fabric in which equality has been achieved. On closer examination, however, it is clear that the Italian school is merely the image of a sexist society which in turn acts as the driving force for a traditional and stereotypical view of male and female roles. Three areas of education are problematic in gender terms: gendered educational choices; sexist stereotypes transmitted through textbooks; and the lack of adequate training for teachers.

Despite improving education and better performance, women in Italy remain largely under-represented in the technical-scientific tracks. This form of segregation, due to both enduring gender stereotypes and the peculiar structure of the Italian education system, tends to exclude women from the more requested professions. The lack of further education policies and targeted interventions in support of a transition from school to work for young people, makes for endemic school-work mismatch affecting the entire students supply chain by creating a dual male-female labour market in the economy 4.0.

2.1.5 Italy's STEM Education Policy 2017-2026

Similar to STEM Education policies in other countries, Italy's policy identifies actions for the improvement of the STEM education experience for all learners from early years to post-primary level.

Equally importantly, it is recognized that STEM education should not be confined to formal education (early childhood, primary, post-primary and higher education); STEM learning experiences can be offered in informal settings by a variety of stakeholders and programmes, with support from third-level institutions, business and industry, professional associations, science centres, and community organizations. All stakeholders will need to collaborate in order to 'sustain a supportive STEM education eco-system'.

In order to promote STEM Education among female students, since 2016, from the 8th of March to the 8th of April, the Italian Ministery of Education has been celebrating STEM month by organizing the national competition "STEM femminile plurale" about women's presence in STEM subjects and other public events. In 2023 the Minister of Education Valditara announced that 600 mln of PNRR resources will be used to fill the gender gap. Moreover in 2023, the CUG (Comitato Unico di Garanzia) for equal opportunities has been restored in order to promote the female presence in the Ministery of Education against all the forms of discrimination. The chief of CUG will be a woman. Finally, the Ministery of Education has been on the front line to fight violence against women and guarantee equal opportunities at work for anybody.

2.1.6 Initiatives to overcome gender disparity in STEM Education and workplace in Italy

Video Games, Education and Inclusion: MINECRAFT EDUCATION for girls

Currently, video games are not only popular, but they are an integral part of our lives. They do not have a well-defined and delineated age, nor even a gender. Several studies demonstrate their usefulness and relevance both in development and education. They can be used for entertainment, to reduce stress, to socialize, but if they were used to teach STEAM subjects and educate against gender diversity?

According to the research "Video games in Italy in 2022" carried out by IIDEA (Italian Interactive Digital Entertainment Association) video game consumption in our country shows stability. In the year 2022 there was a turnover amounting to 2.2 billion euros, with a number of players equal to 14.2 million (32% of the population between 6 and 64 years), of which 42% are represented by women. The female audience has an average age of 30 years and spends around 8 hours per week on the various gaming platforms.

The research, conducted by IPSOS Germany for the Vodafone Foundation ("School, skills digital increasingly central: the research of the Vodafone Foundation - Economy and Finance - Repubblica.it"), has involved 10,000 European parents and according to the data, in Italy, almost three quarters of parents (73%) he said he would be in favor of European standards for teaching digital skills and 85% also said that digital literacy should be a key objective of learning at school. But the data also shows that in our country only 2 in 5 students have access to online education provided by their schools.

The MIUR encourages the use of gaming among school desks, an example of this is the *Piano Nazionale Scuola Digitale*, which supports the use of new technologies, and the *Premio Scuola Digitale* which aims to promote innovative projects in the field of teaching. Minecraft is a sandbox video game by Microsoft, to date the best-selling video game ever. Minecraft Education Edition offers children the opportunity to develop their soft skills such as: ideate, persevere, think creatively, work collaboratively, solve problems through design and create solely by exploring the map. Students also learn independently to use programming languages such as Java and Python. The MineClass research, carried out by Andrea Nardi and M. Elisabetta Cigognini between 2018 and 2021 investigated the immersive teaching experience through Minecraft. Two surveys were developed: in the first (year 2019) 1634 students participated, 51% females and 49% males respectively; in the second (year 2021), 1416 students were involved, divided between males (55%) and females (45%). From the final questionnaires it emerged that at least 79% of students appreciate this method of approach to school and half of them from both editions declare that it was easier to work in a group, mainly the female gender (94%) compared to the male gender (91%). This study found that there are important links between the development of students' autonomy and social skills with education through play, and this is observed both in the context of individual student differences and in relation to gender. The teachers involved also point to Minecraft as a strong element of cohesion for socialization and reduction of social distancing (37%) beyond the obvious benefits of experimentation in terms of added value for the development of transversal skills, the increase in motivation, involvement and autonomy of students (Cigognini et al., 2022).

The Coding Girls project

Coding Girls is an educational enrichment program aimed at encouraging young students to become more familiar with programming and at inspiring young female students to consider pursuing technological and

scientific fields of study. The program was launched in 2014 under the auspices of the US Diplomatic Mission in Italy in conjunction with the Italian Ministry of Education, the Italian Ministry of Higher Education and Research, and Microsoft.

The Starry Night: a STEAM Project

In many schools, the need to teach Maths through an interdisciplinary approach led to the development of STEAM projects. Maria Luisa Spreafico, assistant professor at the Turin Politecnico, proposed in 2019 some STEAM lessons in a few primary and secondary schools in the Northern Italy, in which some famous paintings were covered in origami. The realization of each origami was preceded by a Maths lesson where the mathematical properties and the engineering applications of each origami were shown. In 2021, during the COVID pandemic, this project was replicated in the Scientific Liceo "B. Croce" in Palermo and 15 students of which the most (9) were female, were involved. The girls were extremely active and interested in these STEAM activities. This is an example of good practices that show how female students can be successfully interested in STEAM subjects.

Initiatives at the Universities

Furthermore, even in Italy, University Courses dedicated to the gender gap are being created. A couple of examples: the 'Gender and Equal Opportunity Education' course at the University of Florence, in the Academic Administration and Clinical Education master's degree program; the 'Theories and Educational Models of Gender Differences' course at the University of Bologna-Rimini Center, in the 'Social and Cultural Educators' degree program.

2.2 Objectives

To monitor progress in terms of achieving the goals of Italy's STEM education policy and further promoting the Arts (or STEAM) in general but also in terms of closing the gender gap in this area, a data-driven approach is needed. This involves gathering information about relevant practices and interventions at all levels of education together with evidence about their effectiveness. Some information has become recently available about effective interventions for addressing gender balance in STEM in early years, primary and post-primary education, identifying some of the challenges and barriers to success. Also, despite the role of universities as an important stakeholder in the ecosystem of STEM education, limited information is available about initiatives and actions implemented to close the gender gap in this context.

This study is driven by the need to explore the state of gender balance in STEAM education in Italy. It provides a review of evolving literature to map relevant practices at all levels of Italy education (primary, post-primary and tertiary). A scoping review process is used, drawing upon the literature from the last decade (2013-2023) to address the following research questions:

- What is known about gender equality in STE(A)M in Italy, primary post-primary and tertiary education?
- How is gender equality in STE(A)M education promoted in the educational contexts under examination?
- What enablers and barriers have been reported related to closing the gender balance gap in STEAM education?

The review explores relevant practices, interventions, critical enablers, challenges and barriers to gender balance in STEAM education in Italy. Enablers are understood as factors that facilitate the promotion of gender

balance in STEAM education, and barriers refer to challenges and obstacles that hinder this. A clear understanding of the state of gender (im)balance in STEAM education in Italian higher education can help to identify areas for improvement, inform future actions and open up avenues for further research.

2.3 Methods

A scoping review approach was employed for this study, following the guidelines of the 2018 PRISMA framework for scoping reviews (Tricco et al., 2018), as this is deemed appropriate for exploring emerging areas to clarify understanding and to identify where there are gaps in knowledge.

2.3.1 Eligibility criteria

To be eligible for inclusion sources had to be peer reviewed academic Journal articles in order to ensure that only high quality scholarly sources that meet academic integrity principles were examined. The inclusion criteria also required sources to be published in the last decade (2013-2023), to capture the most recent developments in the state of gender balance in STE(A)M education. Articles that focused on primary, post-primary and university students and educators were included.

To qualify for inclusion in the database of this scoping review, studies had to include two or more STEM domains (i.e. science, technology, engineering, mathematics and arts) discussed in an integrated way, in line with an interdisciplinary STEM approach. Similarly, eligible STEAM-related sources included at least one of the STEM domains combined with an element of the arts (i.e. fine arts, e.g. drawing, painting, photography; language arts, e.g.

creative writing and storytelling; and physical arts, e.g. dance and movement. Sources were excluded if the research featured was focused on aspects of STEAM education other than the issue of gender balance.

The exclusion criteria included the following:

- The study is not peer reviewed.
- The study is a (systematic) literature review.
- The study is not relevant to the topic of gender balance in STEAM education in Italy.

2.3.2 Information sources

Searches were conducted across the databases of Scopus, Web of Science, ERIC (ProQuest) and JSTOR. Peer reviewed sources published in the period from 2013-2023 were considered. Keywords included STEM, STEAM, education, gender and Italy. These were intentionally broad to capture as many results as possible.

2.3.3 Search and selection of resources

Applying the search strategies outlined above resulted in the identification of about 150 potential sources. After removing duplicates and screening for inclusion and exclusion criteria, 5 relevant studies were identified. Selected articles are presented in a matrix (see Table 1 below) and for each study the following characteristics are included: i) authors and year of publication, ii) purpose and iii) findings (and recommendations).

Table 1. Matrix of sources on gender balance in STE(A)M education in Italy.

Authors & year of publication	Title	Aims	Findings & Recommendations
E. De Gioannis, F. Bianchi, F. Squazzoni (2023)	Gender bias in the classroom: A network study on self and peer ability attribution	Stereotypes can contribute to the gender gap in STEM by shaping people's expectations on their own and others' performance. When gender is salient, expectations on task performance might reflect gender constructs even when information on individual abilities is available. In the paper, the authors tested this hypothesis in a network study on students from ten high school classes (Level 3, ISCED 2011; 12th grade) in Milan, Italy. Understanding this link between gender and	The students were asked to choose the four best candidates from their classmates for three hypothetical inter-class competitions in reading, math, and science. Females were more likely to be nominated for the reading competition but less likely for science. No statistically significant results for the math competition were found. Female students were less likely to nominate themselves for any competition, regardless of the subject, even controlling for their own performance and self-concept.

		performance expectations when ability information is available, requires reconstructing a context-specific, social construction process involving information, expectations, and social group pressures.	

S. Granato (2023)	Early Influences and the choice of college major: Can policies reduce the gender gap in scientific curricula (STEM)?	Administrative and survey data were used to analyse the determinants of the gender gap in STEM graduation rates among Italian college graduates.	Results show that half of the gender gap in STEM graduation is attributed to the gender difference in maths and science content of the respective high school curricula. This finding indicates that in Italy the gender gap in STEM graduation has its roots in a gendered choice originating many years before and that effective interventions aimed at increasing girls' interests in science and technology should be implemented at an early stage.
L. Corno, M. Carlana (2022)	Shaping genderstereotypical beliefs: the role of parents and peers	Gender segregation in the field of study is still a pervasive phenomenon in many countries. In this paper, the crucial role of parents and peers in adolescents' decision making on their educational choices, leading to a mismatch of talents is highlighted. A lab-in-the-field experiment that exposes 2,500	Thinking about parental recommendation affects students' beliefs on their comparative advantage in math with respect to literature in a gender-stereotypical way: conditional on ability, girls are 33% more likely to think they are better in literature when they expect their mothers to recommend it, and boys are 15% more likely to think they are better in math when they expect their fathers to recommend it. The results also show that while peers do not influence boys' beliefs on their comparative advantage, girls are less confident in their relative ability in math compared to literature when they must interact with male students in

		middle school students in Italy to different information treatments before they choose between a female-typed task (literature) and a male-typed task (math) was designed. The influence of parents and peers in shaping adolescents' beliefs on whether they are better in male-typed fields (math) versus female-typed fields (literature) was explored	areas outside their gender's domain.
M. Filandri and, S. Pasqua (2021)	Being good isn't good enough': gender discrimination in Italian academia	Female presence within the scientific and professional pathways of the STEM area, as well as their career advancement, are significantly lower than the one of males, as confirmed by the most recent Italian data as well as	Gender heterogeneity in academic teams leads to increased performance only when also achieving inclusion, as perceived value of diversity plays a crucial role in boosting performance.

		international literature, highlighting, In Italian academia, there is a significant gender gap in career advancement, unaffected by differences in productivity.	
M. Berra, G. M. Cavaletto (2020)	Overcoming the STEM Gender Gap: from School to Work	The purpose of this work was to develop a best practice in order to bridge the gender gap in the STEM area, both at school and later in the workplace. Results of the action research project named “STEM Women: A Challenge for the School, an Opportunity for Businesses, a Search for Talents”, covered the Piedmont Region. An operational network was set up, including representatives	The STEM Women project aimed to bridge the gender gap in STEM education and promote female self-confidence, leading to increased female representation in technicalscientific tracks and a more diverse workforce in the economy 4.0. To promote female self-confidence in personal scientific ability and help in deciding to choose a career in STEM, researchers and female leaders from technology Companies were asked to hold meetings at high school level, and visits to STEM firms were organized. In the final stages of the research project, a public meeting was held to enable male and female students to discuss the cultural, economic and social implications of increased female presence in the STEM professions.

		from universities, public institutions, schools and technology enterprises. A survey involving a sample of 572 high school students, evaluated male and female STEM preference, quality of teaching and orientation for future employment.	

Due to the limited data available, this scoping review does not yield comprehensive and conclusive results.

2.4 Conclusion

Differently from other countries of the Blooming Consortium, Italy does not hold a good policy for the issue of gender balance in STEM education, neither about the relevance of integrating the Arts with STEM. Therefore there is a need for more research about how STEAM is promoted in Italy education, about interventions for addressing gender balance in STEAM in early years, primary and post-primary education settings, and their effectiveness.

This scoping review does not yield any conclusive results. It clearly illustrates that there is a notable paucity of research examining specifically the state of gender balance, but also diversity and inclusion in general, in STEAM at all levels of Italian education.

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3 Ireland National Report

3.1 A scoping review of gender balance in STE(A)M education in Ireland

3.1.1 The need for gender balance in STEM education and careers

Increasing participation rates in science, technology, engineering, and mathematics (STEM) education and employment, whilst ensuring inclusion and diversity, has become a global imperative. STEM are transforming society and the labour market, creating, therefore, the need to invest in STEM education in order to nurture, develop and deploy STEM talent. In the European Union, employment of STEM skilled labour is increasing but recruitment difficulties have been reported in the majority of Member States (Caprile et al., 2015: 6). Concerns have also been raised about the fact that the number of students choosing STEM fields is not increasing at a European level and women continue to be underrepresented (*ibid*.).

To revert this situation, different policies related to encouraging STEM studies and careers in Europe have been pursued with a strong focus on promoting gender equality. For example, the European Commission and the Helsinki Group on Gender in Research and Innovation, in consultation with the European research area stakeholders' platform, has developed a guide to promote gender equality in research and innovation[3] and has published its Gender Equality Strategy 2020–2025[4], which includes policy objectives and actions towards a gender-equal Europe; UNESCO's (2017)

[3] Directorate-General for Research and Innovation (European Commission); Helsinki Group on Gender in Research and Innovation. Guidance to Facilitate the Implementation of Targets to Promote Gender Equality in Research and Innovation (2018). Available online: https://op.europa.eu/en/publication-detail/-/publication/2aa2585b-1d03-11e8-ac73-01aa75ed71a1
[4] European Commission. Gender Equality Strategy 2020–2025. 2020. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0152&from=EN

report analyzes the causes of the STEM gender gap and presents evidence and possible lines of action; the European Institute for Gender Equality has developed a model to estimate the macroeconomic benefits of gender equality at the European level (Morais Maceira, 2017).

Gender equality is one of the 17 UN Sustainable Development Goals (SDGs):

> "Gender bias is undermining our social fabric and devalues all of us. It is not just a human rights issue; it is a tremendous waste of the world's human potential. By denying women equal rights, we deny half the population a chance to live life at its fullest. Political, economic and social equality for women will benefit all the world's citizens. Together we can eradicate prejudice and work for equal rights and respect for all."

The need to address the current under-representation of women in STEM areas is emphasised through SDG4: '*To ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*' and SDG5: '*To achieve gender equality and empower all women and girls*'.

3.1.2 The STE(A)M landscape in Irish employment and education

Gender imbalance is also present in STEM employment and education in Ireland. Almost one-third of the workforce is working in STEM-related roles and 'out of almost 120,000 people working in STEM, just a quarter are women' (Department of Education and Skills, 2022: 3). In the sector of Irish public higher education, STEM enrolments have marginally increased from 2015/16 to 2021/22. More specifically, across the eight Irish University Association universities, over the 2015 - 2022 period, STEM enrollment increased from 40,554 to 47,171, a rise of more than 16% (IUA, 2023: 1).

According to the same source, this is a favourable comparison to the total enrolments in the same universities, which increased by 13% from 146,514 in 2015–16 to 165,725 in 2021–22. During that same period, the percentage of female students enrolled in STEM programmes increased from 13,247 to 17,728, representing an increase from 32.7% to 37.6% (*ibid.*). The under-representation of women in STEM-related tertiary education and careers could be partially explained by the significant gender imbalances in STEM subject selection at post-primary level, as revealed by a recent literature review on effective interventions for addressing gender balance in STEM at all levels of Irish education conducted by the STEM Education Implementation Advisory Group (Department of Education and Skills, 2020: 12). Taken together, the above data show that there has been some progress in diversity and inclusion in STEM in Ireland in recent years but, clearly, more work is needed to encourage more women and marginalised cohorts to enter STEM courses and careers.

3.1.3 Ireland's STEM Education Policy 2017-2026

Taking steps towards this direction would be essential in order to achieve the ambitious targets set out in Ireland's STEM Education Policy 2017-2026 released by the Department of Education and Skills (2017). Similar to STEM Education policies in other countries, Ireland's policy identifies actions for the improvement of the STEM education experience for all learners from early years to post-primary level. It is envisaged that the country will 'have the best education and training service in Europe by 2026', and that it 'will be internationally recognised as providing the highest quality STEM education experience for learners that nurtures curiosity, inquiry, problem-solving, creativity, ethical behaviour, confidence, and persistence, along with the excitement of collaborative innovation' (*ibid.*: 12). Increasing the uptake of STEM related subjects by 'learners of all backgrounds, ability and

gender, with a particular focus on uptake by females' (p. 13), expecting the latter to increase by 40% (*ibid*.: 14), is clearly stated in the policy. Equally importantly, it is recognized that STEM education should not be confined to formal education (early childhood, primary, post-primary and higher education); STEM learning experiences can be offered in informal settings by a variety of stakeholders and programmes, with support from third-level institutions, business and industry, professional associations, science centres, and community organizations. All stakeholders will need to collaborate in order to 'sustain a supportive STEM education eco-system' (Department of Education and Skills, 2017: 8).

3.1.4 STEM and the Arts in Education

STEAM (science, technology, engineering, arts, and mathematics) education is an innovative approach to learning that promotes creativity and increases student engagement by integrating arts into scientific subjects. Although Ireland does not have a national policy for STEAM education, the STEM Education Policy Statement 2017-2026 recognises the value of the Arts education, considering its critical role in fostering design, creativity and innovation. In the recently published recommendations on STEM and the Arts in Education (Department of Education and Skills, 2023), the importance of building a coordinated approach to STEM and the Arts education is emphasized, identifying opportunities for linking learning across STEM and the Arts in *Aistear*, i.e. the Early Childhood Curriculum Framework, the Draft Primary Curriculum Framework, the Framework for Junior Cycle and Senior Cycle. It is concluded though that 'the forms that linkages between STEM and Arts may take are still at an early phase of development' as there is 'still a level of ambiguity among practitioners and researchers as to what effective STEAM education entails'. (Leavy et al., 11, cited in Department of Education and Skills, 2023: 6). The issue of gender

balance specifically in the area of STEM and the Arts is not cited in these recommendations.

3.2 Objectives

To monitor progress in terms of achieving the goals of Ireland's STEM education policy and further promoting the Arts (or STEAM) in general but also in terms of closing the gender gap in this area, a data-driven approach is needed. This involves gathering information about relevant practices and interventions at all levels of education together with evidence about their effectiveness. Some information has become recently available about effective interventions for addressing gender balance in STEM in early years, primary and post-primary education, identifying some of the challenges and barriers to success (Department of Education and Skills, 2020). This issue is not addressed in recent discussions of STEM and the Arts in Irish education. Also, despite the role of universities as an important stakeholder in the ecosystem of STEM education, limited information is available about initiatives and actions implemented to close the gender gap in this context. This study is driven by the need to explore the state of gender balance in STEAM education in Ireland. It provides a review of evolving literature to map relevant practices at all levels of Irish education (primary, post-primary and tertiary). A scoping review process is used, drawing upon the literature from the last decade (2013-2023) to address the following research questions:

- What is known about gender equality in STE(A)M in Irish, primary post-primary and tertiary education?
- How is gender equality in STE(A)M education promoted in the educational contexts under examination?

- What enablers and barriers have been reported related to closing the gender balance gap in STEAM education?

The review explores relevant practices, interventions, critical enablers, challenges and barriers to gender balance in STEAM education in Ireland. Enablers are understood as factors that facilitate the promotion of gender balance in STEAM education, and barriers refer to challenges and obstacles that hinder this. A clear understanding of the state of gender (im)balance in STEAM education in Irish higher education can help to identify areas for improvement, inform future actions and open up avenues for further research.

3.3 Methods

A scoping review approach was employed for this study, following the guidelines of the 2018 PRISMA framework for scoping reviews (Tricco et al., 2018), as this is deemed appropriate for exploring emerging areas to clarify understanding and to identify where there are gaps in knowledge.

3.3.1 Eligibility criteria

To be eligible for inclusion sources had to be peer reviewed academic Journal articles in order to ensure that only high quality scholarly sources that meet academic integrity principles were examined. Only sources published in English were included because the research reviewed pertains to the Irish education system where the relevant academic literature is published primarily in English. The inclusion criteria also required sources to be published in the last decade (2013-2023), in order to capture the most

recent developments in the state of gender balance in STE(A)M education. Articles that focused on primary, post-primary and university students and educators were included.

To qualify for inclusion in the database of this scoping review, studies had to include two or more STEM domains (i.e. science, technology, engineering, mathematics and arts) discussed in an integrated way, in line with an interdisciplinary STEM approach. Similarly, eligible STEAM-related sources included at least one of the STEM domains combined with an element of the arts (i.e. fine arts, e.g. drawing, painting, photography; language arts, e.g. creative writing and storytelling; and physical arts, e.g. dance and movement. Sources were excluded if the research featured was focused on aspects of STEAM education other than the issue of gender balance.

The exclusion criteria included the following:

- The study is not peer reviewed.
- The study is not written in English.
- The study is a (systematic) literature review.
- The study is not relevant to the topic of gender balance in STEAM education in Ireland.

3.3.3.2 Information sources

Searches were conducted across the databases of Scopus, Web of Science, ERIC (ProQuest) and JSTOR. Peer reviewed sources published in English in the period from 2013-2023 were considered. Keywords included STEM, STEAM, education, gender and Ireland. These were intentionally broad in order to capture as many results as possible.

3.3.3.3 Search and selection of resources

Applying the search strategies outlined above resulted in the identification of 261 potential sources. After removing duplicates and screening for inclusion and exclusion criteria, 5 relevant studies were identified. Charting included: i) year of publication, ii) study population (primary, post-primary, tertiary level students and teachers), and iii) research focus.

3.4 Results

Selected articles are presented in a matrix (see Table 1 below) and for each study the following characteristics are included: i) authors and year of publication, ii) purpose and iii) findings (and recommendations).

Table 1. Matrix of sources on gender balance in STE(A)M education in Ireland.

Authors & year of publication	Title	Aims	Findings & Recommendations
Kiernan, Walsh & White (2023)	Gender in Technology, Engineering and Design: Factors which influence low STEM subject uptake among females at third level	To explore the barriers to post-primary female students choosing STEM disciplines	- Environmental factors, overall interest, self-efficacy, and STEM perceptions were cited by students as influential factors when deciding second level subjects and CAO choices. - There is gender disparity in technology, engineering, and technology-related design fields at third level; however, females are well represented in the Science field, favouring life sciences as opposed to physical sciences. - When examining students' experiences at second level, access to STEM subjects, high-achievement, and environmental factors significantly contribute to the propagation of the disparity. Social factors such as teachers, guidance counsellors, parents, family, and friends can also play a

			significant role when making decisions. - A serious problem is the initial lack of access to STEM subjects; discrimination in providing equal access to STEM for all is still very apparent. - School facilities, environmental and social factors, knowledge, and interest in STEM fields should be taken into consideration when attempting to close the gender gap in STEM fields. - There is a need for more initiatives to help temper the subjectivity of opinion and to report on the facts regarding STEM subjects. - A more structured transition year could be used to grant students access to subjects with which they may be unfamiliar, empowering them to receive a more well-rounded opinion of STEM subjects. - Access to factual, unbiased, objective information streams for students at second level will empower their decision making. Students should be offered access to multiple STEM subjects, as well as unbiased information regarding STEM-based careers in order to demystify and dispel myths to resolve the ambiguity around career choice.

Delaney & Devereux (2021)	High School Rank in Math and English and the Gender Gap in STEM	In mixed- sex schools girls tend to be lower ranked in math and higher ranked in English than boys. We examine whether these differential ranks in English and math by gender have explanatory power for the gender gap in the choice of STEM as a college major and for the larger gender gap in STEM in mixed-sex schools compared to same-sex schools.	- Conditional on achievement at the end of high school, within school-cohort percentile rank in English and math is predictive for field choice, particularly for STEM and Arts and Social Sciences – higher English rank is positively associated with choosing Arts and Social Sciences and negatively with STEM; higher math rank is positively associated with STEM and negatively with Arts and Social Sciences. These effects occur even though we control for an extensive set of measures of absolute achievement at the end of high school, and the institutional setup implies that within-school rank plays no role whatsoever in college admissions decisions. - Subject ranks have some explanatory power for the gender gap in the choice of STEM as a college major in mixed-sex schools –the tendency for girls to be higher ranked in English and lower ranked in math within school-cohorts can explain about 4% of the STEM gender gap in mixed-sex schools and about 10% of the difference in the STEM gender gap between mixed-sex schools and same-sex schools.
Kelly et al. (2019)	STEM and gender at university: focusing on	The purpose of this paper is to identify whether or not females believe	Female STEM undergraduates believe social bias, balancing work and family life and lack of role models are the main cause of less

	Irish undergraduate female students' perceptions	they associate with the culture of STEM by investigating the perceptions of female students currently enrolled in STEM courses.	women in STEM professions and leadership positions. There were statistically significant differences between how male and female students identified with certain traits, with less females claiming to be intelligent and know about latest discoveries than males. Research limitations/implications – To eradicate stereotypical views of scientists, it is recommended that Irish higher-education institutions introduce initiatives to increase the socialisation of STEM females within female networks and develop female students' self-awareness of their own capabilities. The expansion of STEM networks could act as a means to facilitate female students adopting positive science identities, increasing their science capital. Originality/value – In Ireland, there is a paucity of literature relating to females' experience of STEM in higher education. This paper provides evidence that despite their engagement with STEM, female undergraduate students subscribe to the stereotypical image of the scientist. This study highlights the need to change the culture experienced by female STEM undergraduates in Ireland so as to improve the experiences and trajectories of women in higher education.

Farrell & McHugh (2020)	Exploring the relationship between implicit and explicit gender-STEM bias and behavior among STEM students using the Implicit Relational Assessment Procedure	The current study examined the relationship between implicit and explicit gender-STEM bias and behavior in the form of selection of high scorers for STEM-related tasks. This choice tapped into participants' beliefs about the STEM ability of men and women.	Both men and women STEM students demonstrated a statistically significant, strong implicit pro-Men-STEM response bias while women also exhibited a statistically significant, medium strength implicit pro-Women-STEM bias. Explicitly, both groups exhibited stereotype-consistent, male-STEM/ female-Arts biases ranging from medium to large in terms of effect sizes.
Chatzi & Murphy (2022)	Investigation on gender and area of study stereotypes among Irish third level students	To explore the relationship between female students' gender stereotypes (variable) and male students' gender stereotypes (variable) regarding the Science and Liberal arts study areas in the Irish third level education. Research questions: 1) Is there a difference in the stereotypes in	Results indicated that participants felt that, even though both genders devote time to their work equally, it is men that spend more time away from their families, are frequent achievers of high levels on performance and show more natural interest in Science, Technology, Engineering or Maths. Especially among female participants, males scored higher as high achievers in Mathematics and were declared to have more 'natural' interest in Science. Irish third level students follow similar stereotypical patterns in moderately and strongly associating females with Science and males with Liberal Arts, and in slightly associating males with

		studying science, among the Irish third level students? 2) Is there a difference in the stereotypes in studying liberal arts, among the Irish third level students?	Science and females with Liberal arts.

As can be seen in Table 1, research studies in this area appear to have emerged in the last 5 years. The recent interest in this topic could be partially explained by the fact that Ireland's STEM education policy was published in 2017 (Department of Education and Skills, 2017) and the first recommendations about the role of the Arts in STEM education were published in 2023 (Department of Education and Skills, 2023). As regards the study population, two studies are focused on post-primary students and three on university students. An examination of the research focus shows that some studies directly address the issue of gender imbalance in STEM education studies while others provide relevant insights in a rather indirect way.

More specifically, the two studies in the post-primary sector provide information about the barriers to post-primary female students choosing STEM disciplines and explain how differential ranks in English and Mathematics by gender correlate with the gender gap in the choice of STEM as a college major and for the larger gender gap in STEM in mixed-sex schools compared to same-sex schools. Studies at tertiary level shed light into the perceptions of female undergraduate students currently enrolled in STEM courses about STEM culture and the stereotypical image of the scientist and the potential relationship between implicit and explicit

gender-STEM bias and further STEM-related behaviour. The third, and perhaps least relevant study of all, explores female and male students' gender stereotypes and male students' gender stereotypes regarding the Science and Liberal arts study areas.

Due to the limited data available, this scoping review does not yield comprehensive and conclusive results.

3.5 Conclusion

Ireland is one of the few countries with a policy for STEM education and, more recently, the importance of integrating the Arts with STEM has also become prominent but the issue of gender balance in this area has received far too little attention. There is some information available about how STEM is promoted in Irish education and studies commissioned by the Department of Education and Skills provide some insights into interventions for addressing gender balance in STEM in early years, primary and post-primary education settings and their effectiveness. But there is a need for more research which also captures the situation and practices in higher education institutions. The need for more research in general is also echoed in the recent recommendations on STEM and the Arts where it is agreed that STEM and the Arts is 'at an early exploration phase and still not fully assimilated in terms of a common purpose, vision, and the implementation of an agreed and equitable pedagogy' (Department of Education and Skills, 2023: 13).

This scoping review does not yield any conclusive results. It clearly illustrates that there is a notable paucity of research examining specifically the state of gender balance, but also diversity and inclusion in general, in STEAM at all levels of Irish education. It, therefore, opens up many avenues for future research in this area.

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4 Romania National Report

4.1 A scoping review of gender balance in STE(A)M education in Romania

4.1.1 The STE(A)M landscape in Romanian employment and education

Several contradictory features can be identified regarding the gender balance in employment and education in Romania.

Overall, according to a recent World Bank report (2023), Romania is ranked second lowest in terms of gender equality among EU countries. It exhibits the highest gender gaps in labour force participation among all EU countries and significant disparities in entrepreneurship opportunities.

However, the percentage of women currently engaged in tertiary education exceeds that of men, accounting for 21.6% of women compared to 17.8% of men (Eurostat, 2022). According to a study conducted by the European Institute for Gender Equality, there is a gender parity in the percentage of overall graduates from tertiary education, with both women and men at 14% (age of 15-89; European Institute for Gender Equality, 2023). This suggests that, at least at the tertiary level, men and women in Romania have relatively equal access to and completion rates of higher education. However, the same study highlights that a notable gender gap emerges when considering participation in formal or non-formal education and training among the 15-74 age group. Women in Romania participate at a rate of 12%, while men participate slightly more at 13%. This indicates a marginal disparity in engagement with continuous education and training, potentially influencing skill development and career advancement.

Moreover, by having a remarkably small gender pay gap of 3.6% (Eurostat, 2021), it seems like Romania's gender equity in education has translated into tangible progress in the professional realm. Still, there is a significant lack of representation and the presence of women in high-paying fields. This disparity is especially evident in STEAM (Science, Technology, Engineering, Arts, and Mathematics) occupations. Thus, it's important to note that a narrower gender pay gap, while a positive indicator, does not necessarily equate to greater gender equality.

4.1.2. Gender balance in STE(A)M higher education in Romania

Existing data and statistics underscore the persistent underrepresentation of women in science, technology, engineering, arts and mathematics programs at the university level, compared to their European Union counterparts. It is relevant to note that aligning with the European context, Romania includes Bachelor's, master's, and doctoral levels within its tertiary education system. Nevertheless, short-cycle tertiary education, tailored for vocational and occupational work in the labour market, is absent from the country's tertiary educational framework.

Furthermore, when examining tertiary students in specific fields, such as education, health, and welfare, as well as humanities and arts, women constitute a higher percentage of students compared to men. In education, health, and welfare, women make up 34% of students, while men constitute 18%. Similarly, in humanities and arts, women represent 43% of students, while men account for 21%. This points to a notable gender distribution in certain academic disciplines, potentially reflecting societal expectations and preferences (Eurostat, 2023).

The data from the World Economic Forum's global gender gap report reveals significant disparities in the representation of women in higher

education STEAM fields in Romania. Women are markedly underrepresented in areas such as STEM, with the attainment of just 20.25% (Percentage of male/female tertiary education graduates from STEM for females compared to 40.80% for males (World Economic Forum, 2021). Similarly, Engineering, Manufacturing and Construction see females at only 10.95% attainment against 28.31% for males. Other male-dominated domains include Agri/Forestry/Fisheries/Vet Science and ICT. In contrast, women are strongly overrepresented in Education at 6.44% attainment versus the male figure of just 0.93%. Health/Welfare and Social Sciences also attract a disproportionately higher female presence.

In contrast, according to a recent Eurostat report, the number of tertiary graduates in science, mathematics, computing, engineering, manufacturing, and construction has increased relative to the size of the population aged 20-29 years in recent years. In 2014, the ratio of STEM graduates per 1,000 people aged 20-29 years was 18.5, and by 2021, it had risen to 21.9. However, Romania had the narrowest gender gap for this indicator, based on 2019 data. In Romania, the ratio of male STEM graduates was 1.2 times higher than the ratio of female STEM graduates (Eurostat, 2023). This suggests a relatively smaller disparity between male and female STEM graduates in Romania compared to other countries in the EU.

4.1.3. The gap between STEAM education and STEAM careers for women

OECD data for Romania show that even when women successfully earn STEM skills, many choose not to pursue employment in STEM fields: fewer 15 years old girls (11%) than boys (14%) express aspirations for careers in science, technology, or engineering, even among top performers.[5] Proficiency or confidence in STEM does not necessarily translate into a desire among girls neither to pursue careers in these fields nor to continue

[5] OECD, *Education GPS*, Retrieved from http://gpseducation.oecd.org at 04.12.2023

their studies. This trend raises questions about the factors influencing young girls' career aspirations in STEM fields. Societal perceptions, gender stereotypes, and the lack of female role models in STEM professions could contribute to the underrepresentation of women in these areas.

Statistics highlight the challenges of achieving gender equity in Romania in STEAM-related fields. While there has been progress in narrowing the gender gap in STEM education among the younger population, women remain underrepresented in specific STEAM fields, such as STEM, Engineering, Manufacturing and Construction, while being overrepresented in Education, Health/Welfare, and Social Sciences.

4.1.4. Initiatives promoting women participation In STEAM

There are some positive initiatives to promote and support the involvement of women in STEM. Since 2018 Women in Tech® organization, the world's foremost organization for Inclusion, Diversity, and Equity in STEAM, has the mission to bridge the gender gap and empower women to embrace technology. Women in Tech Romania is part of the global Women in Tech movement, a dynamic and inclusive community dedicated to fostering empowerment, diversity, and innovation within the technology sector. The network, through networking events, mentoring programs and skill-building initiatives, supports women to excel in technology-related careers and shape the future of the technology industry in Romania and beyond[6].
Other initiative is The L'Oréal Romania For Women In Science Endowments program[7] This program was launched in 2009 and is run in partnership with the Romanian National Commission for UNESCO.

[6] https://women-in-tech.org/ro/ at 18.12.2023
[7] https://www.forwomeninscience.com/challenge/show/82 at 09.01.2024

Each year, four awards of USD 10,000 are offered to support outstanding doctoral and postdoctoral young female researchers under the age of 40, in the areas of Life Sciences, Exact Sciences, and Computer Science. In 2024 the Romania National Program will offer 2 endowments of 50,000 RON each, to female researchers in the areas of Life Sciences; 2 endowments of 50,000 RON each, to female researchers in the areas of Exact Sciences and 1 endowment of 50,000 RON to a female researcher in the area of Computer Science. The endowments are meant to support the winners in their research work conducted in Romania.

At the European and national level, there is also a gender ratio gap regarding the involvement of women in business development. Thus, in order to encourage women's involvement in business, the Woman Entrepreneur Program/Manager Program[8] will be launched again in 2024 as well. It is a program to encourage entrepreneurship exclusively dedicated to women. With the help of this program, a woman can obtain a non-refundable financing of up to 200,000 lei - approx. 40,000 euros, if she owns or sets up a company in which the social capital is owned in a proportion of at least 50% by a woman! The program is addressed to companies that are Micro, Small or Medium Enterprises, have at least one female partner who owns at least 50% of the company's shares and have fully private capital. In order to develop entrepreneurial skills, during the implementation of the project, she will have to prove that she has completed a course on Entrepreneurial Skills and Digital Skills, within a maximum period of one year. The program specifically encourages STEAM fields, such as Engineering and Manufacturing, targeting research, development, innovation and digitalization in these fields.

In addition to these large initiatives, there are also new but smaller ones developed by non-governmental organizations, which come to support the

[8] https://oportunitati-ue.gov.ro/program/femeia-antreprenor/ at 23.01.2024

involvement of women in the STEAM fields. Thus, the Women in Games Romania Association[9] is a non-profit association that wants to encourage Romanian girls and women to join the video game development industry, support them to reach their potential and become a force for good in the their community. The association's work is necessary because, although women make up 27% of the total gaming industry and 22% occupy a leadership position, they all stand out in related fields such as business coordination/logistics/sales and much less in creation and engineering.[10] If we analyze the statistical data for the year 2020, we will see this reality because women who worked as data analysts or as business intelligence analysts represented 35% of the female employees in the gaming industry in Romania. At the same time, the number of women in the STEAM field was represented by only about 12% as game designers and only about 7% as engineers.[11]

4.2 Objectives

To support STEAM education policies in Romania, a data-driven approach is needed. This involves gathering information about relevant practices and interventions at all levels of education together with evidence about their effectiveness. Some information has become recently available about effective interventions for addressing gender balance in STEAM and support women to envisage and maintain a career in these fields, as illustrated in the previous section. It Is also important to review and map the academic literature on this topic. For this, a scoping review process is used, drawing

[9] https://womeningames.ro/ at 30.01.2024
[10] https://business-review.eu/profiles1/interviews-interviews/teodora-migdalovici-romanian-brands-to-play-a-serious-part-in-gaming-254674 at 30.01.2024
[11] https://www.statista.com/statistics/1275980/romania-women-employed-in-the-gaming-industry-by-profession/ at 30.01.2024

upon the literature published after 2013, to address the following research questions:

- What is known about gender equality in STE(A)M education in Romania?
- How is gender equality in STE(A)M education promoted in the educational contexts under examination?
- What enablers and barriers have been reported related to closing the gender balance gap in STEAM education?

The review explores relevant practices, interventions, critical enablers, challenges and barriers to gender balance in STEAM education in Romania. Enablers are understood as factors that facilitate the promotion of gender balance in STEAM education, and barriers refer to challenges and obstacles that hinder this. A clear understanding of the state of gender (im)balance in STEAM education in Romanian higher education can help to identify areas for improvement, inform future actions and open up avenues for further research.

4.3 Methods

A scoping review approach was employed for this study, following the guidelines of the 2018 PRISMA framework for scoping reviews (Tricco et al., 2018), as this is deemed appropriate for exploring emerging areas to clarify understanding and to identify where there are gaps in knowledge.

4.3.1 Eligibility criteria

To be eligible for inclusion, sources had to be peer reviewed academic journal articles, in order to ensure that only high quality scholarly sources

that meet academic integrity principles were examined. Sources published in English and in Romanian were included. The inclusion criteria also required sources to be published after 2013, in order to capture the most recent developments in the state of gender balance in STE(A)M education. Articles that focused on primary, post-primary and university students and educators were included.

To qualify for inclusion in the database of this scoping review, studies had to refer to STE(A)M in general, or include two or more STEAM domains (i.e. science, technology, engineering, mathematics and arts), discussed in an integrated way, in line with an interdisciplinary STEM approach. Similarly, eligible STEAM-related sources included at least one of the STEM domains combined with an element of the arts (i.e. fine arts, e.g. drawing, painting, photography; language arts, e.g. creative writing and storytelling; and physical arts, e.g. dance and movement.

The exclusion criteria included the following:

- The study is not peer reviewed.
- The study is a (systematic) literature review.
- The study is not relevant to the topic of gender balance in STEAM education in Romania.

4.3.2 Information sources

Searches were conducted across the databases of Scopus, Web of Science, ERIC (ProQuest) and JSTOR. Peer reviewed sources published in English and in Romanian in the period 2013-2024 were considered. Keywords included STEM or STEAM, education, gender and Romania. These were intentionally broad in order to capture as many results as possible.

4.3.3 Search and selection of resources

Applying the search strategies outlined above resulted in the identification of 38 potential sources. After removing duplicates and screening for inclusion and exclusion criteria, 7 relevant studies were identified. Charting included: i) year of publication, ii) study population (primary, post-primary, tertiary level students and teachers), and iii) research focus.

4.4 Results

Authors & year of publication	Title	Aims	Findings & Recommendations
K. Ward, C. Dragne & A. J Lucas. (2014)	Women in Computer Sciences in Romania: Success and Sacrifice	This study aims to explore and understand the professional experiences of women academics in computer science at six Romanian universities, focusing on how gender, technology, and higher education intersect within the socio-political context of a post-socialist, second world economy.	- Women in Romanian computer sciences face subtle gender bias, time poverty, and limited leadership opportunities, despite formal equality and historical inclusion in STEM (Romania's socialist past promoted women's participation in STEM); - Many lack a feminist perspective and prefer individual adaptation over structural change and there is skepticism toward affirmative action, with concerns about undermining merit and collegiality; - Women often leave academia for industry due to financial reasons; - Women experience structural and cultural barriers, including lack of leadership opportunities and a masculine leadership model;

			- Women tend to internalize challenges and respond by overworking rather than challenging systemic issues; - The authors recommend to shift focus from individual adaptation to institutional reform that supports equity and not just parity; - to implement and enforce policies that help women balance academic careers with family responsibilities; - to create leadership standards that value diverse styles and allow women to thrive without conforming to masculine norms; - to educate faculty and administrators on the ethical and practical value of affirmative action and equity-focused policies.
Bălan, S.-M., & Stanciu, C. (2021)	*Gender Stereotypes and STEAM Education*.	To highlight and challenge gender stereotypes in STEAM education by presenting findings from gender-sensitivity workshops, with the goal of raising teacher awareness and promoting gender-inclusive teaching practices.	- Despite efforts to promote STEAM education, gender stereotypes—such as perceiving girls as emotional, passive, and less capable in logic or sports—persist due to deep-rooted cultural norms; - STEAM education holds potential to challenge these biases by engaging students in inclusive, creative activities; - For real change, professional development for educators must include gender-sensitive approaches that model equality and foster critical thinking.

E. M. Ciupercă & A. Stanciu	*Variables of STEM Career of Women in Romania*	Analyzes statistical data on Romanian women in STEM education and the labor market; discusses cultural factors, the motherhood effect, and workforce dropout rates.	- Despite the ideal of self-realization, women in STEM often face indifference, marginalization, and even persecution; these experiences highlight persistent gender-based structural inequalities. - To better understand the underlying causes and experiences, further in-depth, context-specific research on women's behaviors, perspectives, and environments in STEM is needed; - Conduct qualitative research at the European level to capture women's real motivations and experiences in STEM; - Use research findings to propose targeted interventions and policies.
Profiroiu, C. M., & Năstacă, C. C. (2018).	*Gender Equality in the Romanian Educational System*	Explores vertical and horizontal gender segregation in Romanian education from 2003 to 2017; provides data on female representation among teachers and academic leaders	- Despite the ideal of self-realization, women in STEM often face indifference, marginalization, and even persecution. These experiences highlight persistent gender-based structural inequalities. To better understand the underlying causes and experiences, further in-depth, context-specific research on women's behaviors, perspectives, and environments in STEM is needed. - The research recommends to conduct qualitative research at the

			European level to capture women's real motivations and experiences in STEM. - Promote and generalize successful practices to foster a more inclusive and competitive STEM environment across Europe.
Tripon, C. (2024).	*Bridging Horizons: Exploring STEM Students' Perspectives on Service-Learning and Storytelling Activities for Community Engagement and Gender Equality*.	Case study in Romania using service-learning pedagogy to promote inclusive STEM teaching; finds that engaging STEM students in rural, gender-focused projects improved their awareness of gender equality and inclusive practices	- This study highlights service-learning as a powerful tool for preparing STEM students to teach in rural areas. It promotes inclusive education, community engagement, and the development of critical, ethical, and collaborative skills. Service-learning bridges theory and practice, helping students understand real-world challenges while fostering social responsibility and cultural awareness. - The researchers recommend to Integrate service-learning into STEM curricula to enhance teaching relevance and community impact; - To promote inclusive practices like culturally responsive teaching, Universal Design for Learning (UDL), and differentiated instruction. - Support professional development for educators in inclusive and rural-focused teaching methods.

			- to empower student agency through co-created community projects. - Findings may be affected by social desirability bias, short-term data collection, subjectivity in interpretation, and resource limitations in participatory methods. Nonetheless, service-learning proves to be a valuable strategy for enriching STEM education and supporting rural communities.
Delia Voicu, C., Ampartzaki, M., Yilmaz Dogan, Z., & Kalogiannakis, M. (2023).	STEAM Implementation in Preschool and Primary School Education: Experiences from Six Countries	This study aimed to investigate perceptions of the STEAM approach in early education, assess teachers' training needs, and examine its potential to increase participation of young girls and disadvantaged students in STEM.	- Teachers, STEAM professionals, and parents generally support the STEAM approach, recognizing its value in enhancing motivation, creativity, and inclusive learning for all children. - Despite positive attitudes, implementation is hindered by significant challenges including limited curriculum flexibility, inadequate resources, lack of infrastructure, and insufficient teacher training across the six participating countries. - Teachers expressed a strong need for specialized STEAM training, practical tools, digital resources, and collaborative opportunities to enhance their readiness and effectiveness. - The STEAM approach is perceived to contribute positively to cognitive, social-emotional, and

			digital skills development in children, though the integration of SEL remains vaguely understood by many educators. - Teachers and professionals generally did not observe overt gender discrimination, but acknowledged that deeper societal and structural factors may still hinder girls' participation in STEM fields—especially in more traditional or disadvantaged contexts like Türkiye. - Good STEAM practices were defined by participants as engaging, practical, creative, and authentic—attributes seen as essential for fostering equitable learning environments. - Parental awareness of STEAM was low, indicating the need for better outreach and family engagement in STEAM initiatives.
Chiriacescu FS, Chiriacescu B, Grecu AE, Miron C, Panisoara IO, Lazar IM (2023)	Secondary teachers' competencies and attitude: A mediated multigroup model based on usefulness and enjoyment to examine the differences between key	The aim of this research is to examine the mediating role of perceived usefulness and enjoyment in the relationship between secondary teachers' competencies and attitudes toward	- Teachers' competencies have a strong, direct influence on their attitude toward STEM teaching practices in both IBL and INT contexts. - Perceived usefulness and enjoyment partially mediate the relationship between competencies and attitude for both IBL and INT teaching approaches.

	dimensions of STEM teaching practice	STEM teaching practices, and to explore whether these relationships differ across teaching dimensions such as inquiry-based learning (IBL) and integration of STEM content (INT).	- Teaching practice style (IBL vs. INT) does not significantly moderate the direct relationships in the model, indicating consistent patterns across both teaching methods. - The mediating effects of usefulness and enjoyment are smaller compared to the direct influence of competencies, suggesting that competencies are the primary driver of teacher attitude. - The similarities in mediation patterns between IBL and INT open up avenues for further research to investigate potential differences in implementation and impact. - The integrated nature of STEM education presents challenges due to the complexity of connecting multiple disciplines and the need for a transdisciplinary approach and language. - Reduced instructional time for natural sciences in favor of humanistic subjects hinders the effective implementation of IBL and INT, affecting teachers' perception of usefulness and their attitudes. - The study supports the continued promotion of IBL and INT practices for cross-disciplinary and investigative STEM teaching. - Understanding the causal link between competencies and

			attitude offers valuable insights for enhancing STEM teaching experiences.
D. M. Despina (2020)	Smart, Beautiful, and also an IT Engineer? Exploratory Study on Perceived Gender Inequality in the IT Environment	The research aimed to examine the perceptions of employees in the IT&C field regarding the relevance of gender in choosing a professional path, with a focus on identifying the presence or absence of stereotypes, inequalities, or gender discrimination influencing career development.	- The choice to pursue a career in IT is influenced by personal affinity for the field and admiration for role models who have succeeded in IT, becoming career inspirations for respondents. - External environments—both favourable and unfavourable—play a direct or indirect role in shaping decisions to choose a profession in IT. - Respondents' views on gender discrimination in the IT field varied: some recognized the existence of gender discrimination through personal experiences or observations; others denied its presence, either with emotionally charged or neutral discourse. - The study identified two main typologies: one based on respondents' reasons for choosing their professional path; Another based on their perceptions of the presence or absence of gender discrimination in the IT field. - The research is relevant and current, contributing to understanding perceived gender inequalities in Romania's IT sector and highlighting how employees articulate their experiences in this context.

			- The study could be expanded to include perceptions of gender inequality in other predominantly male- or female-dominated professional sectors. This could offer insights into occupational choices in still-gendered career paths in today's society.

4.5. Conclusions

Research and statistics present divergent perspectives on the representation of women in higher education STEAM fields in Romania. As emphasised by the World Economic Forum's global gender gap report, there are significant gender disparities in specific STEAM fields across the general population in Romania. Women are notably underrepresented in Engineering, Manufacturing and Construction, and other male-dominated domains while being overrepresented in Education, Health/Welfare, and Social Sciences. On the other hand, Romania stands out among EU countries, having the narrowest gender gap for STEM graduates, with the ratio of male to female STEM graduates being only 1.2 times higher. Statistics indicate that the gender gap in STEM education is narrowing in Romania, while challenges persist, both in education and in employment. Addressing these challenges requires comprehensive efforts, including initiatives to challenge gender stereotypes, promote inclusivity, and encourage more women to pursue STEAM disciplines. Romania's achievement in narrowing the gender gap in STEM education among the younger population is commendable, but continued efforts are necessary to ensure sustained progress toward gender equity in STEAM fields.

The review of the relevant recent studies identified points out the key role that education plays to ensure a sustainable gender balance in STEAM. Training teachers to use effective, but also gender and culturally-sensitive teaching methods and approached is necessary. The attitudes of teachers are also essential and can have a significant impact. Teachers also need appropriate resources to promote inclusion in STEAM.

Moreover, education can play an important role in preparing young people to respond to the pressures manifested in wider society and in the professional environment of several STEAM fields. Of course, studies also reveal the need for both awareness measures and policies focused on supporting women to engage and maintain a STEAM career.

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Conclusions

This report reveals key findings on significant gender disparities in both STEM education and employment, with entrenched stereotypes and societal biases continuing to influence young women's decisions regarding STEM subjects and careers. Furthermore, while each country has introduced various initiatives to improve female participation in STEM, the effectiveness and reach of these programs vary widely, and sustained efforts are needed to achieve meaningful change. Notable programs in each country demonstrate that mentorship, early exposure, and supportive networks can have a positive impact on young women's interest in STEM.

More specifically the summary of conclusions includes:

- **Persistent Gender Disparities**: The analysis reveals that gender disparities in STEM education are prevalent in all countries studied. These disparities are reinforced by cultural stereotypes and societal expectations that view STEM as a predominantly male domain. Despite improvements in educational policies and gender equality initiatives, these factors continue to dissuade young women from pursuing STEM education and careers.
- **Role of Early Education and Family Influence**: Early education and family attitudes play a crucial role in shaping young women's interests in STEM subjects. In countries like Greece and Italy, societal and familial expectations often guide girls toward non-STEM fields, reflecting a deeply rooted cultural bias. Programs that encourage family support and provide positive STEM experiences from a young age can help combat these biases.
- **Effectiveness of National Initiatives**: Each country has implemented various programs to promote female participation in STEM, such as mentorship, coding workshops, and role model engagement. While these initiatives are valuable, they often lack consistent support and scalability. Countries with comprehensive policies, like Ireland's STEM

Education Policy, show more promise in building a supportive ecosystem for young women in STEM.

- **Need for Enhanced STEAM Integration**: The incorporation of the arts into STEM (STEAM) is recognized as a valuable approach to make STEM more accessible and appealing to a broader audience. However, there is limited integration of arts in STEM education across the countries studied. Increased training for educators and awareness about the benefits of STEAM can help bridge this gap.
- **Recommendations for Future Actions**: To foster a more inclusive STEM environment, the report recommends increased investment in targeted programs, collaboration with industry partners, and policy changes to support gender equality in STEM fields. Long-term, sustained efforts are essential to dismantle barriers, support women through their educational journey, and encourage their participation in STEM careers.

The report underscores the importance of integrating the arts into STEM education (STEAM), particularly as a means to foster creativity and engagement. However, the integration of arts into STEM education is still in nascent stages in many regions. This report aims to inform stakeholders in education, policy-making, and industry, and raises awareness about the critical need for increased female engagement in STEM to foster a more diverse and inclusive workforce.