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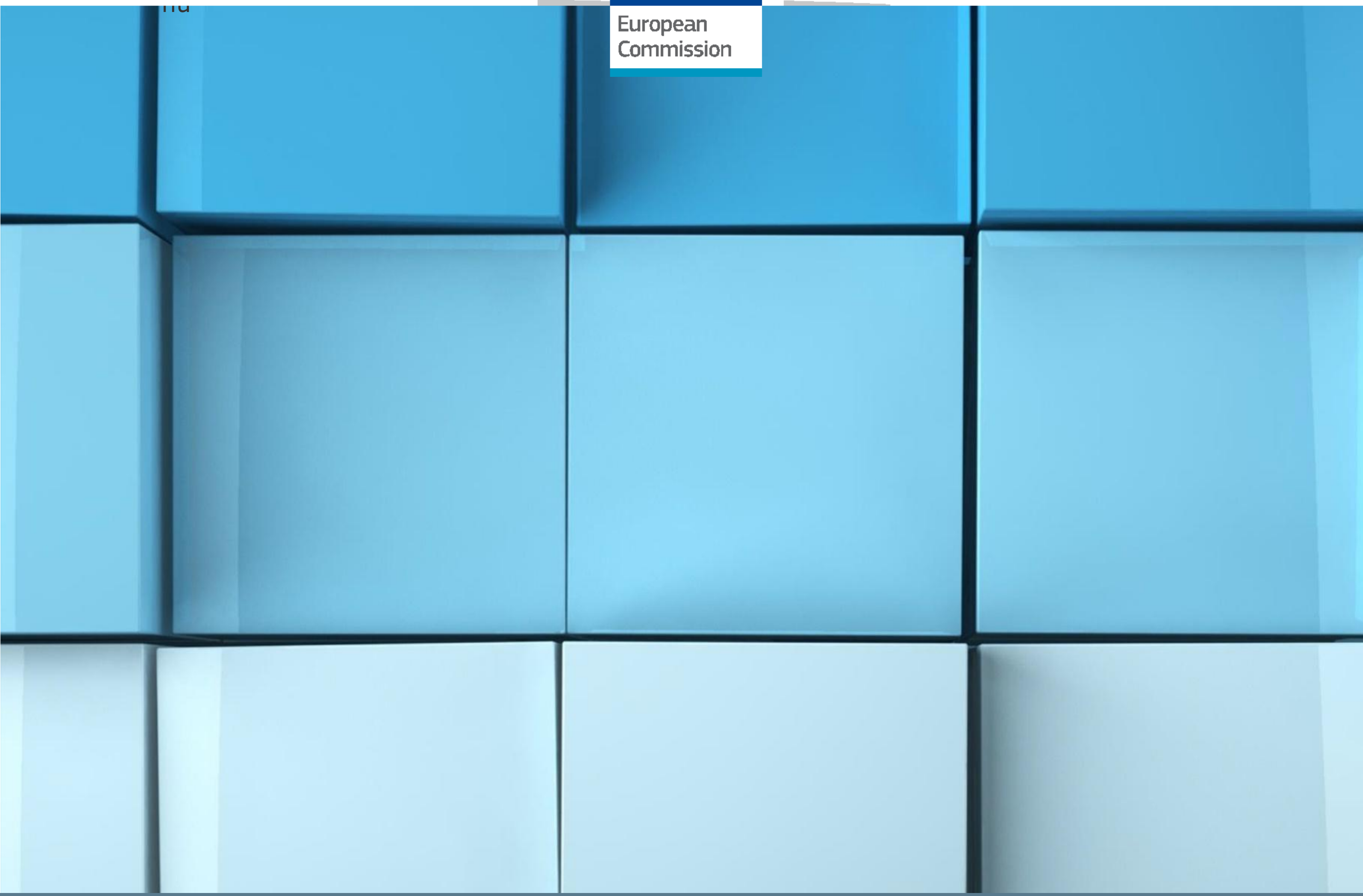

Addressing the gender gap in STEM education across educational levels

Analytical report

NESET

Education and Training

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ABOUT NESET

NESET is an advisory network of experts working on the social dimension of education and training. The European Commission's Directorate-General for Education, Youth, Sport and Culture initiated the establishment of the network as the successor to NESET II (20152018), NESSE (2007-2010) and NESET (20112014). The Public Policy and Management Institute (PPMI) is responsible for the administration of the NESET network. For any inquiries please contact us at: infoneset@ppmi.lt.

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Directorate-General for Education, Youth, Sport and Culture
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Executive summary

Context and rationale

Despite significant advances in STEM education and a growing emphasis on gender equality in research and policy circles, women across Europe remain under-represented in STEM careers and among graduates majoring in STEM-related fields. Key insights from this report highlight several critical aspects in relation to this issue:

- Educational achievement vs. pursuing a career: women and girls often outperform or match men and boys in academic achievements within certain field STEM fields such as biology, but this success does not translate into equivalent representation among STEM professions. This discrepancy underlines a complex interaction of factors that go beyond academic capability and which influence women's career choices and opportunities in STEM.
- Career entry and retention: the transition from education into a career in STEM displays marked gender disparity. Men with STEM degrees are significantly more likely than their female counterparts to continue into STEM careers. This trend suggests that the barriers to entry and retention in STEM careers are more formidable for women, necessitating deeper investigation into workplace cultures, career progression opportunities, and the support mechanisms available for women in STEM.
- Progress is evolving yet insufficient: although there has been some reduction in the gender gap in STEM over the past decade, the pace of change remains slow and uneven across different STEM disciplines and countries. This persistent gap, despite heightened focus and interventions, indicates that existing strategies may not fully address its root causes, or that their implementation lacks the necessary scale or focus to effect widespread change.
- Societal and cultural influences: societal perceptions of gender roles within STEM fields, as well as broader cultural attitudes towards women's participation in science and technology, significantly impact the STEM gender gap. These influences can affect the self-perception, confidence, and career aspirations of young women, pointing to the need for societal-level interventions alongside educational reforms.

The examination of the above elements by the present NESET report highlights the multifaceted nature of the gender gap in STEM education and careers. This issue calls for a comprehensive, multi-level approach that encompasses educational reforms, policy interventions, societal attitude shifts and targeted support mechanisms to bridge this gap effectively. Addressing the gender gap in STEM is not only a matter of educational equity but also an issue of critical economic and societal concern, given the increasing importance of STEM fields in driving innovation, economic growth and addressing global challenges.

Objective of the report

This report aims to consolidate current research findings, policy analyses and best practices in relation to gender disparities in STEM education. This consolidation effort seeks to build a cohesive understanding of the gender gap, drawing on diverse sources including academic studies, grey literature and evaluations of EU-funded projects. In particular, the report examines the links with science and mathematics education due to their significance in EU curricula, in comparison to those with technology and engineering, and the relative scarcity of integrated STEM subjects. Through this analysis, the report provides a foundation for informed decision-making and strategy development.

A key objective of the report is to systematically identify and analyse the factors at individual, contextual and institutional levels that contribute to the gender gap in STEM education. This includes examining aspects such as societal attitudes, educational practices, curriculum design and the role of educators in shaping gender perceptions and choices in STEM. Understanding these factors is crucial to developing targeted interventions.

In addition, the report aims to identify effective strategies and interventions that have been successful in enhancing girls' interest, participation and persistence in STEM from an early age. This involves analysing initiatives across various levels of education, from early childhood through to higher education, in order to identify scalable and replicable practices that can be adopted across different contexts.

Drawing on its analysis of influential factors and successful strategies, the report aims to offer actionable recommendations for policy-makers, educators and other stakeholders. These recommendations are intended to address systemic barriers, promote gender-inclusive educational environments and foster a sustained increase in girls' participation in STEM fields.

Methodology

The methodology employed in this report comprises a literature review complemented by an analysis of EU-funded projects, chosen to shed light on the systemic factors that hinder, as well as strategies to enhance, the engagement of girls in STEM. The literature review analyses published academic studies from 2014-2023 accessed through the ERIC database, along with grey literature. This extensive collection of sources has been instrumental in capturing a broad spectrum of perspectives and findings related to gender disparities in STEM.

In parallel, the analysis of EU-funded projects – drawn from databases including Scientix, CORDIS and the Erasmus+ projects portal – provides a practical lens through which the report examines initiatives specifically designed to support girls in STEM. This aspect of the methodology focuses in particular on identifying, evaluating, and drawing lessons from interventions that have been implemented across Europe with the financial backing of the EU. The selection criteria used to identify these projects ensured that only those projects with a direct emphasis on gender and STEM education were included. To explore the issue across educational levels, the search focused on studies, research projects and policies targeting various age groups, from early childhood education to college.

Findings

The findings of the report reveal that studies carried out over the past decade have predominantly explored individual-level factors such as attitudes and motivation, but lack definitive conclusions as to the drivers of the gender gap in STEM. Overall, the report's key findings regarding the gender gap in STEM education pinpoint factors and strategies across individual, contextual and institutional levels:

1. *Individual-level factors*: it has been found that girls often show lower self-efficacy in STEM subjects compared with boys, despite achieving similar or better academic performance. This suggests that confidence plays a crucial role in girls' decisions to pursue STEM further. Self-efficacy, influenced by gender perceptions and societal expectations, is a significant predictor of sustained interest in STEM. Pedagogical strategies, including gender-neutral approaches, are highlighted for their potential to enhance self-efficacy among both girls and boys.
2. *Contextual-level factors*: family and the broader societal context are highlighted as playing a vital role in shaping girls' decisions regarding STEM education and careers. Early exposure to STEM, supportive environments and the overcoming of societal stereotypes are essential to maintaining girls' interest in STEM fields. The report points out a gap in current research, highlighting the lack of recommendations for robust strategies to help challenge entrenched gender stereotypes in families. While

parental engagement in STEM is recognised as crucial, there is a notable absence of the promotion of comprehensive support and targeted policies for families from varying socioeconomic backgrounds. This lack of support highlights the need for further research and the development of interventions aimed at promoting equitable STEM participation for all.

3. *Institutional-level factors*: barriers at the level of educational institutions, including curricula that are not gender-inclusive, teaching practices that reinforce stereotypes, and a lack of female role models in STEM, contribute to the gender gap. Gender-sensitive teaching methods and the integration of STEM subjects are identified as strategies to enhance girls' participation in STEM.
4. *Successful strategies*: the analysis of EU-funded projects contained in this report reveals several promising practices for addressing the gender gap, such as mentorship programmes, gender-neutral and inclusive teaching approaches, and projects designed to increase girls' engagement in STEM through hands-on, real-world applications. Innovative pedagogical strategies including problem-based learning and interdisciplinary teaching display potential to boost girls' interest and self-efficacy in STEM.

As a general conclusion, the report emphasises the need for systemic changes, and advocates policies that support gender equality in STEM education and the promotion of STEM education from an early age, as well as highlighting the importance of professional development for educators in the adoption of gender-sensitive pedagogies.

Moreover, the report highlights the absence of comprehensive strategies to tackle institutional barriers to STEM education. While pedagogical strategies in STEM education are being developed, the lack of comprehensive institutional policies and programmes represents a considerable obstacle. This gap is particularly important to the system of support for women and girls in STEM, highlighting an urgent need for targeted institutional interventions to create a more inclusive and supportive educational environment for all students. The report highlights the effectiveness in reducing the STEM gender gap of specific practices and interventions, such as gender-sensitive teaching, gender-neutral teaching and innovative learning settings.

Recommendations

Based on their study of academic papers, policy reports and EU-funded projects, the report's authors make the following suggestions:

- Systematic evaluation of STEM education is essential. While many initiatives assess their outcomes, there is a lack of a comprehensive approach to evaluating those factors that influence and sustain students' interest in STEM. Future efforts should employ experimental designs that rigorously examine these factors, drawing on existing research.
- Emphasise self-efficacy in STEM. There is evidence that individuals with higher self-efficacy in STEM achieve better outcomes and remain in these fields longer. Further research is required to understand the impact of this individual-level factor. Surveys designed to measure self-efficacy, administered before and after interventions, could shed light on ways to enhance it. Addressing the so-called 'confidence gap' is crucial to narrowing the gender disparity in STEM, as high self-efficacy is linked to better performance and persistence in these fields.
- Conduct research to establish the criteria necessary for creating gender-inclusive STEM learning environments and methodologies. Such research would include studies on teachers' perceptions and training in relation to STEM and gender, taking into account various influencing factors. Although there are many studies and toolkits aimed at addressing the gender gap in STEM, the EU lacks consistent

policies, a unified understanding of STEM and systemic strategies to tackle this gender disparity.

- Develop policies and practices that focus on teacher professional development, promoting alternative teaching methods that support student self-efficacy and participation. This involves adopting integrated STEM practices and gender-responsive approaches, particularly from an early age, and assessing their implementation in the classroom.
- Advocate for systemic national and local policies that support gender-sensitive or gender-neutral approaches to education. Such policies should aid families, teachers, policy-makers and researchers in creating supportive environments for students. The aim of such measures should be to provide comprehensive support through changes at both contextual and institutional levels.
- Encourage policy reforms in teaching and learning that favour evidence-based pedagogical approaches to fostering interest in STEM, such as integrated STEM. Breaking down barriers between STEM disciplines is seen as vital to equipping students with 21st-century skills; however, the adoption of integrated STEM approaches remains limited across the EU Member States. A collaborative effort is needed to understand and effectively address the gender gap in STEM education.

1. Introduction

STEM (science, technology, engineering and mathematics) education focuses on promoting skills, knowledge and attitudes linked to these specific disciplines. The need for and emphasis on promoting STEM-related education arises from an understanding that: (a) STEM is one of the interdisciplinary areas that provide the necessary skills, competences and dispositions for students to navigate a changing world, and (b) there is growing need for workers with an educational background in different areas of STEM (Cedefop, 2014; OECD, 2019), since it is predicted that there will be a shortage of workers in STEM fields by 2030 (Cedefop, 2014; OECD, 2021).

Recent figures show that fewer than one in 10 students across Europe graduate in a field related to natural sciences, mathematics or statistics (Eurostat, 2022). In some countries such as Bulgaria, Cyprus and Hungary, less than 3% of graduates come from these fields. Several EU countries (Germany, France, Italy, Spain and Czechia) were predicted to have more than 0.5 million STEM job openings per country by 2023 (EU, 2015). More recent data confirm that many of the current labour shortages in Europe are in STEM, and these are likely to increase considerably (ESDE, 2023) due to new STEM job openings. This trend is also evident in Eurostat employment data (2022), which show a 2.5 % increase in the number of people employed in science and technology in 2022 compared with the previous year. Given this need in the workforce, STEM education has been gaining momentum all over the world (Almukhambetova et al., 2023). It has been a central element of the extensive reform efforts and curriculum changes carried out in EU countries and beyond to engage students in STEM practices during primary and/or secondary education (EU STEM Coalition, 2020; EU STEM Coalition, 2016; European Schoolnet and Texas Instruments, 2018; Fondazione Deloitte, 2022; Australian Academy of Science, 2019; NRC, 2013; UNESCO, 2017; United Nations Children’s Fund & ITU, 2020).

Despite this momentum in STEM education, however, women remain underrepresented in STEM careers and as a percentage of graduates in STEM-related fields (EU STEM Coalition, 2020; European Institute for Gender Equality, 2017). Even though women continue to earn university degrees at a higher rate than men in certain STEM fields (e.g. biology), they hold just one-quarter of jobs in STEM-related professions (Fondazione Deloitte, 2022). Male STEM graduates enter STEM-related employment at a rate twice that of female graduates (European Institute for Gender Equality, 2017). Furthermore, according to data from Eurostat (2014, 2022), women predominantly earn degrees in fields such as health and welfare, while men are more likely to graduate in disciplines relating to engineering, manufacturing, technology, science and mathematics, and to be employed in these fields. More recent from data Eurostat (2022) show an increase in the percentage of women working in STEM (52%), with most of these women working in services related to STEM. Despite this increase in the number of women in STEM-related professions, it is important to notice that only 41% of them are working in science and engineering – highlighting the need to focus on bridging the gender gap in these disciplines. Furthermore, when women enter STEM employment, they tend to abandon their chosen fields of specialisation, especially in those fields dominated by men (UNESCO, 2017).

Such a progressive reduction in participation at different stages of the educational process and during career progression has been termed a ‘leaky pipeline’ (Shapiro et al., 2015). This leaky pipeline metaphor can be used to describe what is happening in STEM – especially with regard to the participation of girls and women – across all levels of education. However, it should be noted that the leaky pipeline affects both genders, with both male and female professionals and students ’leaking out’ at various stages; nevertheless, this leak is more pronounced among women than among men. The effect of this differential leakage is to create a gender-based filter that removes more girls and women from the stream (Blickenstaff, 2005).

These gendered differences in the leaky STEM pipeline are attributed to prevailing cultural gender roles and stereotypes. Therefore, the issue of the low representation of women in STEM graduate studies and STEM careers cannot be attributed to women's performance in these fields. A 2017 UNESCO report, 'Cracking the Code: girls' and women's education in STEM' highlights that girls have higher achievement in science compared with mathematics, and tend to outperform boys in certain disciplines such as biology and chemistry, compared with others such as physics and earth sciences. International assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) show that in recent years, the gender gap in educational achievement in STEM has been closing in most countries at primary and early secondary educational levels (Shapiro et al., 2015; Stoet & Geary, 2018). Specifically, Stoet and Geary (2018) used a large dataset from the PISA 2016 study to explore if there is a relationship between achievement in science and mathematics, and gender career choices in STEM. The researchers identified that girls performed equally well or better than boys in most countries, and that there was no statistically significant difference based on gender.

In addition, the most recent PISA report (2023), which contains data from 2022, confirms that while OECD countries are nearing gender parity in maths proficiency, boys still slightly outperform girls. The difference in mathematics scores is nine points in favour of boys. However, in science, the performance gap between boys and girls is negligible, suggesting no significant difference in their achievements in this area (OECD, 2023). Similar trends can be seen across several studies looking at students between the ages of 6 and 15 (Balta et al., 2023; Chan, 2022; Lyons et al., 2022; Punzalan, 2022). These show that girls and boys perform similarly in both science and mathematics. Such findings highlight the hypothesis that the gender gap in STEM undergraduate studies and in career choices relates to factors other than achievement, and may be due to individual traits (i.e. interest, identity), contextual factors (family, religion, culture, stereotypes) and institutional factors (gendered practices and the stereotypical presentation of certain topics) (Danielsson, 2012; UNESCO, 2017).

Evidence suggests that the gender gap is inextricably linked to gender stereotypes which hinder and shape the attitudes and potential of girls and women, as well as their educational and career choices (OECD, 2021; UNESCO, 2017). Gender stereotypes, which may cause differences in STEM education, have been linked to early childhood education and care (Johnson et al., 2022), while gender differences become more evident at higher levels of education (Normandeau, 2017) and in specific fields such as physics (Danielsson, 2012). In addition, traditional gender roles and the reconciliation of work and family life are also seen as factors influencing women's participation in STEM-related jobs (EIGE, 2019).

Girls appear to lose interest in STEM subjects with age, and lower levels of participation can already be observed in secondary education (Chan, 2022). Ensuring that girls and women enjoy equal access to STEM education – and ultimately, to STEM careers – is imperative for human rights (UNESCO, 2017). Equal access to and participation in STEM by girls and women is key to the 2030 Agenda for Sustainable Development, and specifically its pledge to leave no one behind in terms of equality, peace and human progress (OECD, 2017). Equal opportunities are necessary at all educational levels to ensure the participation of women and girls in STEM education and in STEM careers (UNICEF, 2020). Many careers in STEM, especially in male-dominated areas, are related to power and high status. Making these careers more accessible to women could not only increase female participation in STEM, but also increase the number of women in positions of power and decision-making.

In line with the recent emphasis on STEM education at the levels of both research and policy (EU STEM Coalition, 2020; EU STEM Coalition, 2016; European Schoolnet & Texas Instruments, 2018; Fondazione Deloitte, 2022; Australian Academy of Science, 2019; NRC, 2013; UNESCO, 2017), this report acknowledges that the gender gap in STEM education persists, albeit at a lower level than 10 years ago. The report therefore aims to consolidate existing information in order to present the current state of play and to address why the gender gap in STEM education still persists. The overall purpose of this report is to explore the factors that affect gender inequality in STEM education, focusing on shaping and maintaining girls' participation in STEM across educational levels, with an emphasis on the period from early years to secondary education.

A theoretical definition of STEM is discussed in detail in Section 2 of this report; in terms of school education, STEM typically encompasses mathematics and science (which includes biology, chemistry, physics and sometimes geography). The present report emphasises an exploration of factors relating to science and mathematics education for two interrelated reasons: (a) the important role that these two subjects play within the curricula of EU Member States compared with technology and engineering; and (b) the fact that STEM as a unified subject is not a common curriculum subject in EU Member States (EC, 2022). Furthermore, there is a lack of consensus among European countries as to the definition of STEM, leading to varying interpretations of the disciplines it includes. This report draws on data from published research, educational practice (i.e. project outcomes), as well as policies and measures regarding the gender gap in STEM education in schools (including pre-primary, primary and secondary education). The questions guiding this report are as follows:

- Research Question 1: What are the main factors linked to the gender gap in STEM education, with an emphasis on shaping and maintaining participation in STEM education across educational levels (from early years to secondary education)?

- Research Question 2: What examples of practices are implemented at institutional and policy level to address the gender gap in STEM education (from early years to secondary education)?

- Research Question 3: Why is the gender gap in STEM education persistent, despite the diverse measures and policies implemented (from early years to secondary education)?

2. Setting the scene

2.1 Conceptual framework for STEM education

STEM was first presented as an acronym in the 1990s by the National Science Foundation in the USA (Martín-Páez, Aguilera, Perales-Palacios & Vílchez-González, 2019) referring to the individual areas of science, technology, engineering and mathematics. One of the first definitions of STEM education refers to teaching and learning the four subjects separately, with an emphasis on essential knowledge, skills and attitudes related to STEM competences (NSF, 1990). More recent definitions of STEM education present it as an interdisciplinary approach to learning that integrates the core disciplines of science, technology, engineering and mathematics into a cohesive and applied curriculum. According to these trends, the aim of STEM education is to equip students with a deep understanding of science, technology, engineering and mathematics, with an emphasis on fostering critical thinking, problem-solving skills and creativity.

A more recent definition of STEM education, integrated STEM, focuses on the integration of the separate disciplines, and on having a series of conceptual processes and skills from the disciplines work together to find solutions to problems (Bybee, 2013; Zollman, 2012). The focus of this integrated STEM approach is on using knowledge and skills from the four disciplines to develop students' competences (EC, 2018). The competences promoted through integrated STEM education are primarily linked with critical thinking and problem-solving, with an emphasis on making the connection on real-world problems (Choice Report, 2021). The EU STEM Coalition (2016) has highlighted that through the integration of STEM subjects, students can potentially develop their transversal skills and competences, which can support them to become responsible future citizens.

More recent trends also focus on STEAM, which includes the integration of 'Arts' (i.e. visual arts, performing arts, literature, design). According to Quigley and Herro (2019), STEAM recognises educators' commitment to adopting more equitable approaches to learning, with an emphasis on social and creative aspects (Pitri, Evagorou & Stylianou, 2024). Integration of the arts into STEM education has been introduced as a way to foster creativity, innovation and a more holistic approach to problem-solving (Spyropoulou & Kameas, 2020), acknowledging a meaningful engagement between the STEAM disciplines, and developing collaborative skills (McGarry, 2018). By incorporating the arts, STEAM recognises the importance to STEM disciplines of aesthetics, imagination, innovation and cultural understanding (NAEA, 2016). The STEAM approach aims to support learners to become well-rounded individuals with strong STEM skills as well as creativity and an appreciation of the arts (Perignat & Katz-Buonincontro, 2019). Some definitions of STEAM or STE(A)M also include the liberal arts and humanities (Quigley et al., 2017) and involve social sciences as a way to connect STEM disciplines with society.

It should be highlighted that no common definition of STEM education has been agreed between researchers, teachers and policy-makers (Evagorou & Konstantinidou, 2023; Scientix Observatory Paper, 2018). This inconsistency regarding definitions has resulted in differing interpretations of STEM education, different approaches to STEM teaching and learning, and different implementations of what is perceived as STEM education (Evagorou & Konstantinidou, 2023) between European countries (e.g. in Germany, Austria, Cyprus, Czechia, Norway and the Netherlands). The limited understanding and research on STEM competences (i.e. knowledge, skills, attitudes and values) has been highlighted in an OECD report (2019), which also refers to the need for education to rethink the boundaries between traditional curriculum subjects.

Although EU countries do not share a common understanding, definition or framework for STEM education (Evagorou & Konstantinidou, 2023), they appear to agree that STEM education should focus on competences, and that it should break down the traditional boundaries between disciplines, provide collaboration between different stakeholders, and place an emphasis on educating teachers in new pedagogical approaches (EU STEM Coalition, 2016; Scientix Observatory, 2018). The present report explores studies and EU projects that address STEM either as separate subjects (with an emphasis mainly on science and mathematics due to the important role these subjects play in EU Member States' curricula), or as integrated STEM (where such examples are available). A discussion of STEAM education and practices has also been included as part of the analysis, and aims to explore any benefits of the different approaches in terms of addressing the gender gap.

Studies which focus on identifying gender differences in STEM education are widely available (Steegh et al., 2019) – but explaining and understanding the reasons behind such gender differences in STEM education (and remedies for it) require further attention. The low rate of female students choosing to study STEM fields (Cheng et al., 2021) and the under-representation of women in STEM professions (especially in certain areas such as science and engineering jobs) is a cause of concern, for both researchers and policy-makers, and merits investigation (Chine, 2021; Gonzalez & Kuenzi, 2012). Notably, countering such disparities is a challenge with no 'one-size-fits-all' solution.

2.2 Factors shaping girls' participation in STEM

An initial analysis of the relevant literature and policy documents highlights a combination of factors that can potentially influence the shaping and maintaining of girls' interest in STEM. These factors are linked to individual characteristics, as well as the influence of family, peers and school, and differences in local or family cultures (Almukhambetova & Kuzhabekova, 2020; McMaster, Carey, Martin & Martin, 2023; UNESCO, 2017). These factors are mutually reinforcing, since socio-cultural environments shaped by family, school and cultural context interact with factors at an individual level, producing differences in individuals' careers choices. In other words, the factors that influence the gender divide in STEM derive from three broad categories: individual-, contextual- and institutional-level factors.

2.2.1 Individual-level factors

Individual-level factors relate to internal influences that affect a person's behaviours and choices. These include self-efficacy, attitudes (e.g. enjoyment, personal values), demographics, a sense of belonging, personal motivation, individual expectations for STEM academic success, and gender identity.

Self-efficacy in STEM is defined as a person's idea of their ability in STEM and is accepted as an indicator of student success (Chine, 2021; Hattie, 2009). In a study in the field of psychology, van Aalderen-Smeets and van der Molen (2018) have highlighted that self-efficacy is a belief a person holds for themselves, and that beliefs are independent of actual abilities.

Other important aspects of individual-level factors include attitudes and motivation, which reveal learners' dispositions towards STEM. Attitudes relate to individuals' evaluations and feelings toward a thing (i.e. ideas, subjects, classes), while motivation refers to the driving forces that underlie the individual's behaviour, guiding them towards particular goals or outcomes. Students' dispositions are linked to their 'STEM identities' (Dou & Cian, 2021) and to their sense of belonging. In turn, an individual's identity is linked to their interactions with others (Gee, 2000), and their self-perception within a given field is linked to how others view them in that field (Kim et al., 2018). 'STEM identity', according to Dou and Cian (2021), is connected to an individual's broader self-conception as well as their perceptions of STEM and of STEM professionals. Factors such as an individual's level of engagement in STEM, their sense of belonging and their self-identification within a STEM domain can either be constrained or supported by their other identities (e.g. gender, ethnicity) and their past experiences in relation to STEM (Avraamidou, 2020).

2.2.2 Contextual-level factors

Contextual-level factors include societal and cultural issues, family context, and social class. Family factors include the level of parental education, family gender values, the number of girls and boys in the family, the socio-economic status of the family, and its science and cultural capital. An individual's cultural capital refers to the cultural knowledge, experiences and resources available to a person, which can influence their educational achievement (Bourdieu, 2004). Cultural capital is connected to science capital, which is the sum of an individual's science-related knowledge, attitudes, experiences and resources, and encompasses the person's familiarity with science and the science-related social and cultural resources available to them (Archer et al., 2014). An examination of a family's social class matters because students' science and cultural capital are directly linked to and shaped by their parents' socioeconomic status (SES), meaning that students with lower-SES backgrounds (i.e. from families that are economically disadvantaged) are less likely to aspire to careers in science (Archer et al., 2014).

Sociocultural context also has an important impact on maintaining gender stereotypes in STEM fields. Numerous examples exist of social constructs relating to STEM disciplines – for instance, with regard to technology skills (the notion that men are better at using certain types of electrical apparatus); mathematical skills (the belief held by some that men possess better spatial skills than women; Balta et al., 2023); health and care-related professions (considered by some to be more feminine; Chine, 2021). Overcoming such long-standing gender stereotypes is not easy or immediate, as it requires the reconfiguration of the gender-technology relationships within a country's culture through the active participation of parents, policy-makers and institutions.

2.2.3 Institutional-level factors

Institutional-level factors include the curriculum; the school's culture and context; the role, biases, values and STEM competences of teachers; textbooks; peer influences; and role models. For example, one important aspect of attracting girls and women into STEM and maintaining their interest is a curriculum that is designed in such a way that it is of interest to all students, irrespective of their gender, by being gender-neutral, gender-sensitive, or gender-inclusive (Wright & Delgado 2023).

According to Forde (2014), a gender-neutral approach dismisses the significance of gender, rejecting assumptions about gendered abilities and dispositions. However, this may overlook the underlying power dynamics inherent in gender hierarchies. As a more nuanced policy choice, a gender-sensitive approach recognises the gender binary and concentrates on adjusting materials, content, experiences and role models to reflect the specific interests and needs of both genders, acknowledging the impact of gender without reinforcing rigid stereotypes or hierarchies. Lastly, a gender-inclusive pedagogy focuses on including gender identities that defy sexual and gender norms.

Gender-sensitive teaching promotes the intentional development of inclusive practices to support and nurture gender equality and diversity in the classroom. It is an approach to teaching that investigates the connection between the processes of learning and institutionalised power dynamics, and is based on gender-affirmative practices – not least those enshrined in the central tenets of feminist pedagogy.

2.2.4 STEM in higher education and beyond

The main emphasis of the present report is on the transition from early education to the end of secondary education. While the field of tertiary education and beyond falls outside the scope of this report, it nevertheless highlights the importance of exploring this field in terms of women's participation (Tomassini, 2021). While most published studies focus on students' persistence in STEM and success at secondary and post-secondary levels, there is a notable gap in exploring the transition from STEM higher education into career paths. One of the studies exploring STEM in higher education and beyond (Sassler, Glass, Levitte & Michelmore, 2017) reports that many women exit STEM after graduating due to male-dominated environments and working cultures. A review by Blickenstaff (2005) of prior research on women in science careers identifies various social, political and pedagogical factors that contribute to the diminishing persistence of women over the course of their academic and professional journeys. These factors include masculine overtones in classroom practices in higher education, as well as the masculine orientation of STEM academic work. According to Blickenstaff (2005), such practices may act as 'filters', discouraging women from continuing to practise STEM beyond higher education. The findings of the aforementioned study suggest that changes in the way STEM is taught in higher education could potentially support the maintenance of more women in STEM at this level and should be further explored.

2.3 Methodology

For the purpose of this report, we adopted a three-fold approach: first, we conducted a literature review of peer-reviewed research papers focused on STEM, gender, science, and mathematics; second, we reviewed EU-funded projects focused on STEM and gender equality listed in three platforms (Erasmus+, Scientix, and CORDIS); finally, we reviewed grey literature on third-country initiatives in STEM and gender equality.

<u>Step A</u>. A literature review was conducted of published peer-reviewed studies, using the ERIC database with the following keywords: STEM & gender; science & gender; mathematics & gender. No geographical criterion was introduced to the search, such that we could retrieve papers from both EU and non-EU countries. The purpose of this literature review was to address all three research questions. The choice of keywords is based on the emphasis of European curricula on science and mathematics and not on STEM. The choice of database (ERIC) is justified by ERIC's strong emphasis on educational research and its comprehensive coverage of scholarly articles and research studies.

The above review focused on publications from the years 2014-2023[1] and produced a database of 3,505 peer-reviewed publications. All abstracts were read by the researchers to identify which of them fit the criteria for this review. Publications that were not relevant (i.e. they did not focus on the aspect of gender, did not focus on STEM education, did not include science or mathematics or both, did not focus on students, or were very specific to contexts outside Europe) were excluded, leaving the database with a total of 930 titles.

The initial exclusion process was conducted in collaboration between the first three authors of the report. Following this, the remaining 930 papers were read in full by the first three authors, who filtered them on the basis of the inclusion criteria listed in Table 1 below, as well as whether the studies included research data (i.e. reviews were not included). The final list of papers contained 106 publications (see Annex 1, Table 1). Based on the factors

[1] Note: the search was carried out on 30 March 2023, and therefore only papers available up to that date were considered.

shaping girls' participation in STEM laid down in the section above, the authors looked for data under the following categories:

A. Individual-level factors related to shaping and maintaining girls' participation in STEM.

B. Contextual-level factors related to shaping and maintaining girls' participation in STEM.

C. Institutional-level factors related to shaping and maintaining girls' participation in STEM.

D. Examples of practices to address the gender gap in STEM.

E. Examples of policies that address the gender gap in STEM.

F. Possible explanations for the persistence of the gender gap in STEM.

Table 1. Inclusion criteria for research papers

Individual-level factors	**Contextual-level factors**	**Institutional-level factors**
• Self-efficacy • Attitudes • Demographics • Sense of belonging • Motivation • Individual expectations • Academic success in STEM	• Societal and cultural issues/values • Family context and background • Parental education • Family gender values • Socioeconomic status (SES) of family	• Curricula • School culture and context • Roles, biases, values and STEM competences of teachers • Textbooks • Peer influence • Role models in schools
Gender		

All 106 papers were read during the preparation of the report. During this step, the analysis focused on identifying factors linked to the shaping and maintaining of girls' interest in STEM education (Research Question 1) and identifying why the gender gap in STEM education persists despite the diverse measures and policies implemented (Research Question 3).

Step B. Review of EU-funded projects (e.g. Erasmus+ and Horizon), with an emphasis on STEM and gender, to identify practices that shape and maintain the participation of girls in STEM (Research Question 1), and how to address this gap (Research Question 2). In addition, during Step B the researchers aimed to understand whether (and how) relevant EU-funded projects apply a systematic evaluation of the project's outcomes, which could provide a solid basis for explaining the reasons for the gender gap in STEM. Due to the vast number of EU projects that focus on STEM and gender, specific keywords were used to make this search more specific. The search focused on projects aimed at shaping and maintaining girls' participation in STEM education. It focused on different educational levels (early childhood, primary, and secondary) and used empirical methods for evaluation. In this step, the researchers reviewed the EU-funded projects listed (a) on the Scientix website (https://www.scientix.eu/), (b) by the Community Research and Development Information Service (CORDIS, https://cordis.europa.eu/projects) and (c) on the Erasmus+ projects results platform (https://erasmus-plus.ec.europa.eu/projects). From these three platforms, 37 projects out of 1.710 in the years 2014-2023 were identified as focusing on the gender divide in STEM (the main factors, target groups and suggested/developed activities of these projects are presented in Table 2 in Annex 2).

(a) On the website of Scientix, the community for science education in Europe, when 'gender in STEM' was chosen as a topic, 57 projects were listed for the years 2014-2023. However, when the summaries of the projects were read, it was clear that not all of these projects focused on 'gender in STEM', meaning that they did not have specific aims or activities relating to 'gender in STEM'. The projects were therefore reviewed one by one to ascertain whether each project had a focus on 'gender in STEM'. This check narrowed the list down to 9 projects (see Annex 2).

(b) A review of projects on STEM education with an emphasis on gender was also carried out using CORDIS, the European Commission's primary source of results for projects funded under the EU's Framework Programmes for research and innovation (from FP1 to Horizon Europe). The database provides valuable information in various languages concerning EU STEM projects. For each project, the information provided includes each project's participants, reports, deliverables and links to open-access publications. Searching the database produced a list of 1,092 STE(A)M projects from 2014-2023. After reviewing each project, only 11 were identified as having a focus on the gender divide in STEM education. Projects focusing on STEM education but without an emphasis on the gender divide in STEM were thus excluded from the list.

(c) In addition to the two platforms mentioned above, the website providing Erasmus+ project results was also examined to ensure all relevant projects were included. From this source, 561 STEM education projects were found. After close examination of these projects and after excluding duplications from other databases, 17 projects were added to the list.

A total of 37 projects focusing on the gender gap in STEM were analysed with regard to their aims, rationale, target groups, activities, the evaluation approaches reported, the reports published, and other outcomes. This analysis yielded a list of factors which, according to these projects, could influence the gender divide in STEM. A list of activities developed under these projects was extracted as examples of good practice.

Step C. Policy reports and grey literature from third countries were analysed using the same keywords as in Step A. A total of 10 policy reports and grey publications were analysed (see Section 3.2 for more details) to identify factors linked to shaping and maintaining girls' participation in STEM education (Research Question 1), and why is the gender gap in STEM education persists despite the diverse measures and policies implemented (Research Question 3).

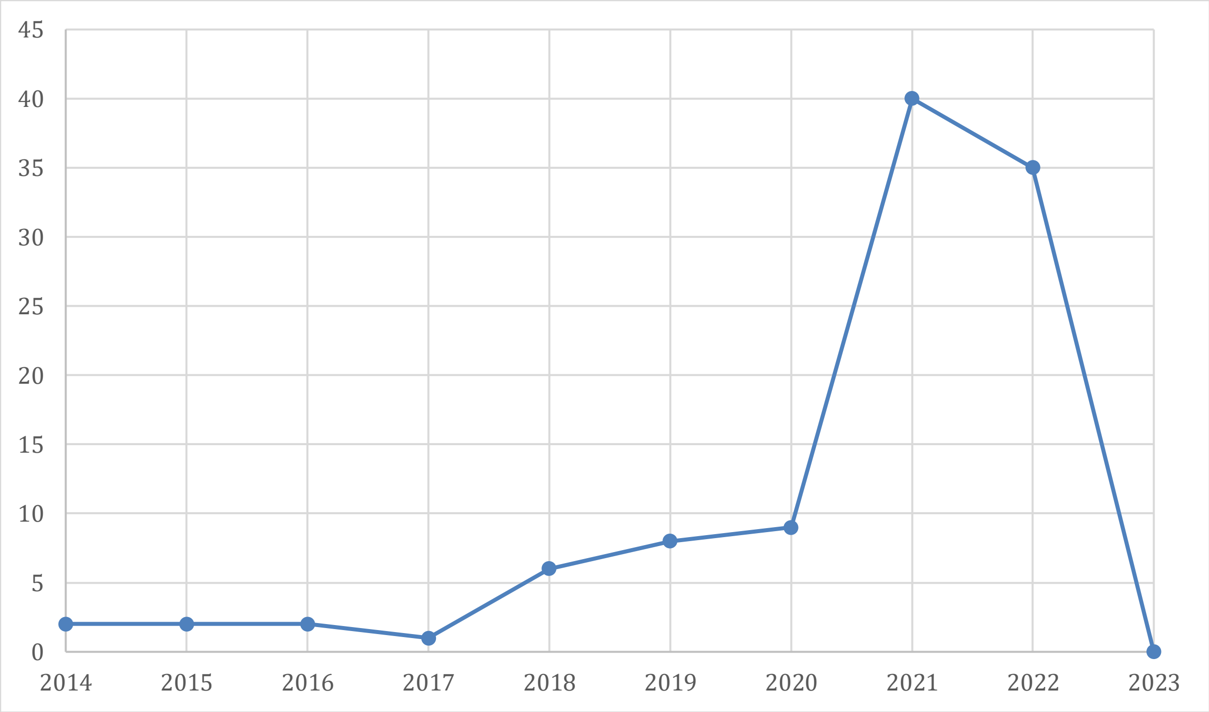
3. Results

The results of the study team's analysis are presented in two sections. The first of these provides an overview of the literature and the policy reports, while the second focuses on the results of the analysis of the EU-funded projects.

3.1 Literature focusing on the gender gap in STEM

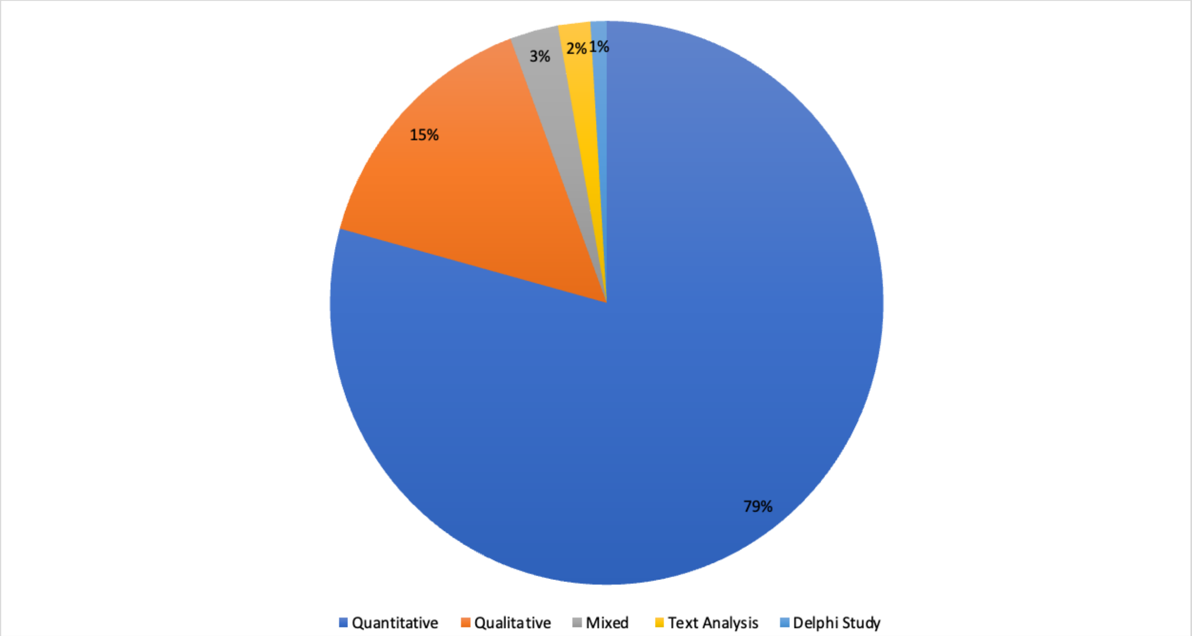
The analysis of research papers from 2014-2023 on STEM education reveals an increase in the number of studies on STEM education published, particularly between 2017 and 2021. This may be explained by the emphasis on STEM education in international policies in the preceding years, starting in 2013 in the USA (Achieve, 2013) and in 2015 in Australia, with the National STEM School Education Strategy. Due to the timing of the search carried out for this report, for the year 2023 only articles published up to March were included.

Figure 1. Number of papers on STEM and gender between 2014 and 2023



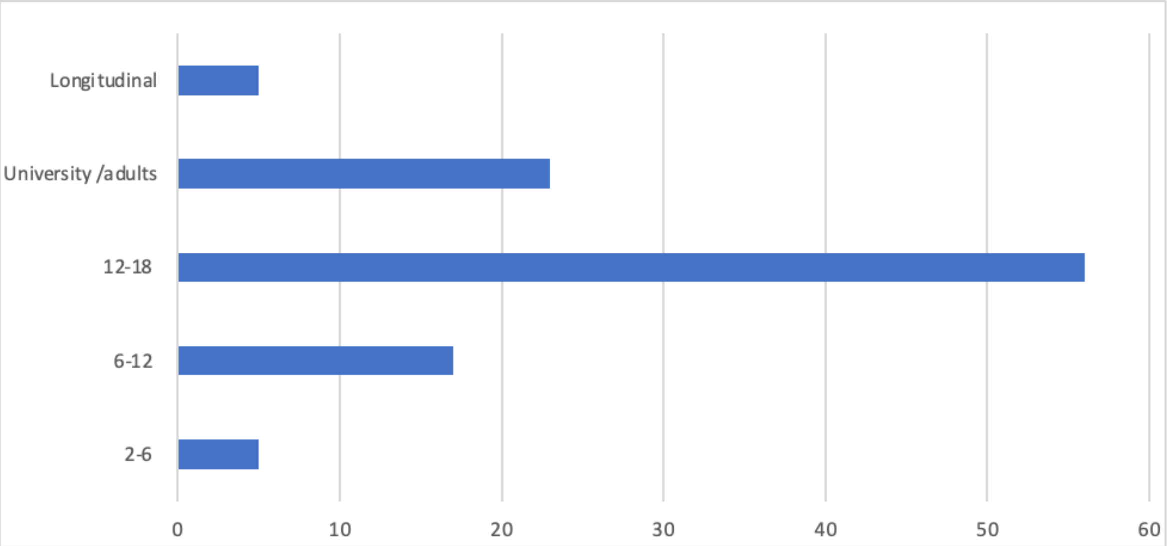
Source: own elaboration from published research database analysis.

Figure 2. Methods applied in STEM and gender papers between 2014 and 2023



Source: own elaboration from published research database analysis.

Figure 3. Number of studies on STEM and gender per age group



Source: own elaboration from published research database analysis.

The largest shares of studies were conducted in the USA (27), Australia (8), Türkiye (7), a combination of different countries comparing datasets between countries (6), Germany (4), the Netherlands (2), China (2) and Spain (2). The rest of the countries covered were represented by only one paper: Belgium, Cambodia, Canada, Croatia, Finland, Greece, Hong Kong, Indonesia, Ireland, Italy, Japan, Kazakhstan, Kenya, the Philippines, Saudi Arabia, South Africa, Switzerland, Sweden, Tanzania, the UAE and the UK.

The array of countries represented in all referred publications supports the finding that STEM and gender issues are being discussed in various cultures, and that this is viewed across continents as an issue that needs to be addressed. One hypothesis is that the USA and Australia have produced more studies due to having had in place in recent years national policies that place an emphasis on improving STEM education, as well providing more equitable opportunities to women. According to published studies, these policies place emphasis on two levels – contextual and institutional – and propose innovative pedagogies to support STEM instruction. These include gender-neutral language, contextual play for young students (2-3 years old), integration between the different STEM subjects, and recognising the teacher's role in the process (Fleer, 2021; Kirkham et al., 2022; McLure et al., 2022; Scholes et al., 2022).

Most studies from 2014-2023 focus on self-efficacy, attitudes and motivation and comparisons between boys and girls (e,g, Babarovic, 2022; Elsayed et al., 2022; Nursultan et al., 2023). In terms of contextual factors, most studies have explored the role of family (parents or siblings), and of cultural factors that might be associated with gender stereotypes (e.g. Nursultan et al., 2023; Susilawati et al., 2022). Lastly, in terms of institutional-level factors, most studies have examined the effects of alternative pedagogical approaches on STEM learning and the maintenance of self-efficacy and interest in STEM among girls.

Some of the pedagogical approaches studied include integrated STEM education, which places an emphasis on skills and interdisciplinarity (Anwar et al., 2022); using gender-neutral language as a way to remove stereotypes from the classroom (Scholes et al., 2022); introducing role models into STEM teaching (Siani et al., 2021); and focusing on the professional development of teachers as a way to support them in implementing all of the aforementioned practices. STEAM was only present as an approach in two studies (Kirkham et al., 2021; Wajngurt et al., 2019). The section that follows presents an overview of the findings of the papers from the literature review in relation to the three different sets of factors: individual-level, contextual-level and institutional-level.

3.1.1 Individual-level factors

The majority of the studies exploring gender gap and gender inequalities in STEM education during 2014-2023 focus on individual-level factors (e.g. enjoyment, attitudes, motivation, demographics, self-efficacy, learning style), with data being collected mostly through large-scale quantitative studies such as PISA, TIMMS or other local studies. Specifically, most of the studies from the last three years focus on differences between boys and girls in terms of self-efficacy, attitudes and motivation (e.g. Babarovic, 2022; Elsayed et al., 2022; Nursultan et al., 2023). In most cases, these studies focus on whether there is a relationship between gender and attitudes, motivation and enjoyment. Their findings are not conclusive, with some studies showing that girls' attitudes, interest and motivation are higher during the early years of primary school (Mitchell et al., 2022), while others show that boys' motivation and attitudes are higher in secondary school (Donmez et al., 2022; Lv et al., 2022), without examining or controlling for other contextual or institutional factors. Meanwhile, a longitudinal study that explored the interest of primary school students in STEM over three years identified that boys were more interested than girls during all of the three years followed, and that all students, regardless of gender, lost interest in STEM much more quickly than in other subjects (Babarovic, 2022).

One of the main findings in all studies focusing on self-efficacy (an individual's ideas about their abilities) in relation to STEM education or STEM career aspirations, is that self-efficacy is an important predictor of future interest in STEM and of uptake among both girls and boys (e.g. Elsayed, Clerking, Pitsia, Aljabri & Al Harbi, 2022). Research shows that secondary school students with higher self-efficacy tend to hold positive attitudes towards science and have a greater likelihood of pursuing STEM topics in their academic path (Balta et al., 2023). However, evidence shows that self-efficacy is also strongly connected to traditional gendered beliefs. For example, Chan (2022) found that girls in secondary education have lower self-efficacy in STEM than boys, even in cases where girls' actual performance is better than that of boys. Moreover, self-efficacy decreases with time among both girls and boys in traditional formal educational settings (De Loof et al., 2022).

In contrast, those studies which focus on comparing changes in self-efficacy after specific pedagogical approaches (e.g. integrated STEM, gender-sensitive pedagogies) have been implemented show that in such situations, self-efficacy increases for both boys and girls, compared with traditional instruction (Anwar et al., 2022). One study focusing on a pedagogy that supports gender-neutral lessons for primary school students found that girls' self-efficacy and interest in STEM increased after this intervention (Mitchel et al., 2022).

Furthermore, comparisons of self-efficacy between women and men follow the same trend among students at the university level, with men having higher self-efficacy than women despite achieving the same level of academic performance in STEM fields (Robinson et al., 2022). Another important finding highlighted by Robinson et al. is that in future career decisions, women rely on a broader array of self-efficacy aspects, encompassing both academic success and life satisfaction, while for men the emphasis is only on academic success.

In addition, **confidence** has been found to be the primary factor involved in the mediation of maths anxiety (Soysal, Bani-Yaghoub & Riggers-Piehl, 2022). Students with low science self-efficacy may experience less enjoyment of and interest in science – even if they regard science as being important for their lives (Dohn, 2022). Furthermore, boys have shown a significantly higher level of self-concept and interest in science and mathematics than girls, experiencing less anxiety in mathematics (Zhang, 2022).

It has been pointed out that participating in STEM camps, summer schools, and other community-building STEM activities influences an individual's sense of belonging in STEM, especially for girls and other groups underrepresented in STEM (Ibourk, Hughes & Mathis, 2022; Sheffield et al., 2018). However, it should be highlighted that access to non-formal learning in STEM is not always available to all students, thereby causing equity issues (Godec, Archer & Dawson, 2022). More recent work has focused on gender-sensitive as well as gender and sexual diversity-inclusive practices in STEM, which also take into account the concerns of and impacts on LGBTQ students (Wright, & Delgado, 2023). These studies have built foundations to prepare teachers on how to include such gender-inclusive practices in their classes. A plethora of studies have explored the relationship between ethnicity and gender (e.g. Avraamidou, 2020), with most of these studies focusing on women of colour. Their findings suggest that discrimination against these women in science exists, which merits further exploration.

3.1.2 Contextual-level factors

Findings from international studies show different levels of achievement in STEM in **different countries**. For instance, Finland emerges as a high achiever in international studies such as TIMSS and PISA, and at the same time appears in the list of EU countries with a low level of representation of women among STEM professions (Sosammon, 2018). In contrast, in Bulgaria and Lithuania, students under-performed in STEM in PISA 2022, but at the same time these countries have the highest proportions of women in STEM jobs in Europe (Eurostat, 2023). This is termed the 'gender equality paradox', whereby women are less likely to be awarded STEM degrees in wealthier and gender-equal societies (EU Coalition, 2022; Sosammon 2018). Another distinguishing feature of these countries at a societal and cultural level is the fact that Lithuania was part of the former Soviet Union, while Bulgaria was one of its satellite allies. This is of interest, especially given that the number of women working in STEM fields in the Soviet Union and the former Eastern Bloc was higher than in Western countries (Kataeva, 2022; Lippman & Senic, 2018). Recent work exploring gender and STEM in post-communist countries highlights that Soviet strategies included policies that encouraged curricula focusing on science, mathematics and engineering, support for female students to follow STEM careers, public facilities to support the domestic responsibilities of women, and a limited emphasis on stereotypes presenting women as lacking physical strength (Grigoleit-Richter, 2017; Kataeva, 2022). A similar example can be seen in the case of former-Soviet Kazakhstan, which has created highly selective STEM schools for talented students (Almukhambetova, Torrano & Nam, 2023).

An additional factor at the contextual level is family. Family factor includes parental education, family gender values, the number of girls and boys in the family, the socioeconomic status of the family, and its science and cultural capital. High-achieving male students from families with a science background have been found to be more likely to aspire to a science career (Archer, Moote, MacLeod, De Silva, Khatibi & Azam, 2018; Francis & DeWitt, 2020). Other studies of primary school students (6-12 years old) show that among this age group, achievement and motivation are similar between boys and girls, yet boys exhibit higher confidence than girls and report greater enjoyment of STEM activities (McMaster et al., 2023). Furthermore, girls lose interest in STEM subjects as they get older, particularly between early and late adolescence (UNESCO, 2017) and this is even more evident in their career choices. What remains unanswered are the reasons leading to this 'leak' and why more girls drop out of STEM as they grow older in comparison to boys. Factors related to the contextual level might contribute to these findings. For example, a study in the US focusing on black women in STEM reports that supportive family members positively influence on developing girls' interest and motivation for learning about STEM subjects (Ibourk, Hughes & Mathis, 2022). These findings are supported by a meta-analysis of publications carried out by Šimunović and Babarović (2020), which suggests that the role of fathers in the process of socialisation should be explored across different developmental stages in a child's life.

Furthermore, **what happens in early childhood** in relation to STEM is of importance – but only limited studies on this are available (e.g. Stephenson et al, 2022). Researchers in this area have identified that young children hold stereotypical ideas from early on in their lives, and many young children – especially those with low-SES and minority backgrounds – are not exposed to STEM, and lack basic STEM skills and interest (Hachey, 2020). A study reported in a grey publication (IBD, 2019) refers to a project in Colombia entitled 'Little Adventurers' ('*Pequenas Aventureras'*), which targets students aged 3-5 years and their parents, placing an emphasis on educating parents about STEM stereotypes. Initial findings from this project, which implemented an experimental design, suggest that children had better STEM knowledge and skills after the implementation of the programme (IBD, 2019). It is imperative to further explore early childhood education in relation to STEM and gender – a need also recommended by UNESCO (2020).

Moreover, in a longitudinal study in the US, Chine (2021) concluded that students with **highly educated parents** showed statistically higher achievement in mathematics than students with less educated parents. Similar findings are reported by Simunovic and Babarovic (2020), who explored the role of parents and concluded that parental beliefs affect students' self-efficacy in STEM. In addition, it is argued that through their **cultural and science capital** (Godec, Archer, Dawson, 2020), families can have a positive impact on the attitudes, expectations and behaviours of children, thereby promoting academic success and self-efficacy (Jæger & Møllegaard, 2017). By 'science capital', we refer to what people know about science, how they think about it, what they do, and whom they know (Godec, Archer, Dawson, 2020). Science capital (e.g. contacts, social networks, knowing people who work in STEM or who possess valued forms of science capital) and cultural capital (qualifications, enduring habits/dispositions, scientific literacy, knowing the rules of the game) are considered to be influential in science gender stereotypes (Archer, DeWitt, Willys, 2014). According to a longitudinal study from the UK, students with low science capital are unlikely to become interested in STEM careers (Archer, Moote, MacLeod, Francis & DeWitt, 2020). For example, gender-based stereotypes or equitable gender attitudes can be transmitted among members of a given family, generation after generation (Archer, 2018; DeWitt & Archer, 2015). A lack of family role models related to STEM (Ibourk, Hughes & Mathis, 2022) can also affect aspirations towards STEM careers.

One study focusing on career-related discussions between Finnish parents and their adolescent children (Ikonen, Hirvonen, Leinonen, Kesonen, Hietala, Hivronen & Asikainen, 2020) revealed that mothers are more aware of the individual and societal consequences of the gender gap and that parents who were more informed about STEM careers and the gender gap could better support their daughters. This finding suggests that the role of the family is of great importance in supporting girls in STEM, especially for students from minority groups (IBD, 2019), and should be further explored. Furthermore, the role of the parents in engaging students in out-of-school STEM activities or in promoting a competitive attitude in relation to STEM is accepted as an important family-related factor. Conversely, in some countries and cultures, many girls are discouraged from choosing STEM careers because they believe that if they get involved in STEM professions, they will not have time to start a family, and this will affect their professional and personal balance (Balta et al., 2023).

3.1.3 Institutional-level factors

Institutional-level factors include the curriculum; the school’s culture and context; the roles, biases, values and STEM competences of teachers; textbooks; peer influence; and role models. Among institutional-level factors, most studies have examined the effects of alternative pedagogical approaches on STEM learning and the maintenance of self-efficacy and interest in STEM by girls. Some of the pedagogical approaches studied include integrated STEM education, which emphasises skills and interdisciplinarity (Anwar et al., 2022), using gender-neutral language as a way to remove stereotypes from the classroom (Scholes et al., 2022), introducing role models into STEM teaching (Siani et al., 2021), and focusing on the professional development of teachers as a way to support them in implementing all of the aforementioned practices.

An important aspect in attracting girls and women into STEM and maintaining their interest is the presence of a **gender-sensitive and gender-inclusive curriculum** that is designed in a way that interests both boys and girls (Wright & Delgado, 2023). Very few European countries possess curricula that focus explicitly on women in science (Brett, 2022), with most of these initiatives being on a pilot level and focusing on interventions that examine the impact of specific pedagogical practices that can potentially support both girls and boys in improving their attitudes towards STEM (e.g. De Loof, Boeve-de Pauw & Van Petegem, 2022). One such example comes from a longitudinal study in Belgium exploring the impact of an integrated STEM curriculum in comparison to traditional STEM teaching (teaching the subjects separately) in relation to students’ attitudes, motivation and self-efficacy. Recent studies – especially those from the US and Australia – have focused on transforming curricula to include gender-inclusive practices, but this theme is still under-researched. Furthermore, STEM curricula at secondary education level in most EU countries focus on separate subjects, with no integration between disciplines (Evagorou & Konstantinidou, 2023).

Some of the studies reviewed focus on interventions, teaching practices or changes to the school programme that could help to bridge the gender gap in STEM. Examples of these include focusing on gender-sensitive teaching practices (Hughes et al., 2020); single-sex schools as a way to empower girls (Law & Sikora, 2020); non-formal learning activities (Lock et al., 2019; Todd & Zvoch, 2019); using videos as a way to increase literacy about gender bias against women (Pietri et al., 2017); and using friendship networks as a way to influence retention in STEM (Raabe et al., 2019).

One of the studies reviewed (LaForce et al., 2019) presents an example of inclusive STEM schools in the USA. Inclusive STEM schools are characterised by an open admission process as an alternative to academically stringent institutions. They allow students from diverse backgrounds to engage with STEM curricula and make the connection between STEM and real life. These schools incorporate elements such as problem-based learning, rigorous learning, and the personalisation of learning. According to findings from LaForce et al. (2019), girls achieve higher grades than boys in these schools but continue to exhibit less positive attitudes towards STEM.

When implementing STEM, early childhood education and primary schools focus on integrated approaches and problem-solving, connecting STEM with real-life problems. Given that girls show more positive attitudes towards STEM subjects up until the end of primary school, one hypothesis is that the systematic inclusion into curricula of integrated STEM approaches could be a way to support not only girls but also diverse groups of learners, as well to shape and maintain participation in STEM. An additional point related to the role of the curriculum is linked to studies that have used in-school and out-of-school interventions designed to connect under-represented students with STEM professionals and careers. Such studies have yielded positive data with regard to increasing awareness and interest in STEM careers among girls. Specifically, out-of-school contexts provide greater benefits for students than in-school contexts (Blanchard et al., 2012; Pitri, Evagorou & Stylianou, 2024). Furthermore, one gap in curriculum development relates to a lack of consistent and systematic evaluation of the curriculum and how it is implemented in practice (Bilgin et al., 2022).

Other studies have shown that **teachers** can have a positive effect on girls' interest in a STEM career. Conversely, teachers can have a negative effect when they transmit gender stereotypes or biases (Ibourk, Hughes & Mathis, 2022; van den Hurk et al., 2019). Teachers' instructional approaches, beliefs, attitudes, and behaviours (UNESCO, 2008) can positively affect girls in maintaining their interest and pursuing STEM careers. For instance, when primary and secondary school students are engaged in discussions about their goals and the opportunities available in STEM, they have time to link their interests to these subjects and demonstrate higher self-efficacy in these fields prior to college (Kier et al., 2013). Stereotypes may be reinforced by teachers who have different expectations for boys vs. girls as mathematics and science learners (VanLeuvan, 2004). Teachers' beliefs about STEM abilities may also lead to different learning opportunities for boys compared with girls. Research has shown that teachers' interactions with students (Sadker, 1994) and their own stereotypes and biases (Ibourk, Hughes & Mathis, 2022) may differ in relation to boys and girls. What we know is that inaccurate stereotypes of STEM professionals are formed at an early age (Ibourk, Hughes & Mathis, 2022). Another notable issue is that of gender-based grouping and seating arrangements in the exercise of science (Blickenstaff, 2005). Avoiding such practices from the primary school level onwards could prevent students from exercising distinctly 'masculine' or 'feminine' roles.

With regard to **gender role models in STEM**, women are under-represented in mathematics and science-based professions; thus, girls may have few opportunities to meet female role models and obtain information about the range of opportunities and career options available in STEM fields from their perspective. Interaction with female scientists can positively affect students' science-related career goals and can improve adolescents' attitudes towards science and towards women in science (Ibourk, Hughes & Mathis, 2022). Previous studies have indicated that girls from Kazakhastan who graduate from schools in which mathematics is emphasised and where extracurricular STEM subjects are offered regularly tend to become interested in STEM careers (Almukhambetova & Kuzhabekova, 2020). However, the absence of other women in their discipline leads to a sense of isolation or intimidation (e.g. 'Most of my engineering professors have been men') (Herrera, Rodriguez-Operana, Sánchez, Cerrillos & Marquez, 2022).

Furthermore, **instructional approaches** in primary education – for example, those based on inquiry-based learning, which has been shown to improve problem-solving skills, students' creativity and scientific reasoning – can be promoted, as well as formative and skills-based assessment by teachers. Although this type of learning environment can promote gender inclusion, students' cooperation and active participation, and the development of STEM competences, there is a need to gather further research evidence/data on STEM achievements and gender differences at the level of primary education. As Balta et al. (2023) point out, **grade level** is an important factor in shaping the development of students' interest in STEM, with secondary school being a critical level, particularly among girls. Although students can be actively engaged in scientific thinking and practices from an early age (Hachey, 2020) through science activities, they usually begin to engage in STEM subjects in the last years of primary school.

Research has shown that **exposure of students to STEM subjects** in secondary education can help to eliminate the gender gap (Fondazione Deloitte, 2022). However, interest in STEM is higher among students in lower-secondary education than it is in higher secondary education. According to Balta et al (2023), this indicates that students follow the paths of their interest development. So far, only a few studies with a longitudinal aspect have focused on shaping and maintaining students' interest in STEM across age groups.

3.2. Grey literature on third countries that focuses on gender and STEM

The review of grey literature on gender and STEM carried out for this study focused on three main categories: (a) summarising the current situation with regard to STEM and gender; (b) describing strategies that have been applied to sustain and improve girls' interest in STEM and providing recommendations for actions that can be taken; and (c) proposing policies that can narrow the gender gap.

The current situation with regard to STEM and gender: one example of grey literature that presents the current situation in STEM and gender is a UNESCO (2020) report that focuses specifically on gender inequality in STEM in Asia. UNESCO (2020) reports that from an early age, girls are exposed to messages suggesting that STEM subjects are more suitable for boys, thereby discouraging them from choosing STEM courses at school or pursuing advanced studies in these fields. For those girls and women who do go into STEM, numerous obstacles impede their success: discrimination, societal pressure for early marriage, expectations to shoulder household and family responsibilities, and persistent 'glass ceilings'. All of the above can hinder women's aspirations towards STEM careers. Collectively, these factors result in young girls lacking examples of successful women in STEM, thus reinforcing the perception that they cannot thrive in this field. The findings presented in the UNESCO report are similar to those of other reports on STEM education policies in Europe (Choice, 2019; European Schoolnet and Texas Instruments, 2018; Eurydice, 2011; EU, 2004; EU, 2019).

Strategies and recommendations that can be applied to sustain and improve girls' interest in STEM: SciGirls Seven Strategies is an example of such a strategy, funded by the National Science Foundation in the USA (see Billington et al., 2014). SciGirls highlights strategies that can support girls in STEM. These include establishing a nexus between STEM and girls' everyday lives; offering support to girls as they explore questions and tackle problems using STEM methodologies; instilling empowerment in girls to confront difficulties; fostering an environment that encourages girls to recognise and question stereotypes within STEM; highlighting the collaborative, social and community-centric nature of STEM; and creating avenues for girls to engage with and gain insights from a diverse spectrum of STEM role models.

An additional example comes from the UNESCO (2020) policy report, which presented seven recommendations linked to bridging the gender gap in STEM in Asia. These are:

enhance STEM curricula and instructional materials to foster equal participation and include gender equality expertise in their development; strengthen the capacity of teachers to encourage girls in STEM by raising awareness of stereotypes and gender disparities and promoting STEM careers; increase awareness of gender equality in STEM among parents and communities, involving them in STEM programmes; promote the stories of successful female STEM professionals and their involvement in classes in order to challenge stereotypes; encourage participation in STEM by girls and women in rural areas through inclusive gender equality policies and STEM programmes; improve access to STEM activities for women and girls; establish and enforce policies that support gender equality in STEM, addressing systemic barriers and promoting initiatives for girls' STEM education and women's participation in STEM fields.

Other reports – for example, 'Cracking the code: Girls' and women's education in STEM' (UNESCO, 2017) – highlight the need for schools to provide equal opportunities for girls. This can be achieved through access to teachers who specialise in STEM teaching who can positively impact girls. Furthermore, learning materials play an important role and should incorporate positive images and text relating to women and girls, as well as their experiences with real-life STEM, apprenticeships and mentoring. In addition, the assessment tools used should not be gender-biased, and should be accompanied by measures to promote gender equality (e.g. legislation or policies such as quota) and to deconstruct gender stereotypes presented in the media. Lastly, STEM camps for girls and families, as well as peer-level interventions, are also important.

Policies to narrow the gender gap: in a policy report by Soo Boon (2016) regarding the Malaysian experience of girls' participation in STEM, the following policies were recommended: encouraging the development of inter-school activities; STEM awareness programmes for primary school students and parents; building public awareness of STEM; and raising students' interest through new learning approaches. The Malaysian government has also pursued a 60:40 policy, aimed at placing 60% of the students in secondary schools into a STEM stream. Furthermore, it has developed STEM curricula at all educational levels starting from pre-school, and has created girls-only and co-educational schools. Lastly, as part of its policies, the Malaysian government highlights the need for gender-responsive STEM education and has created training tools for curriculum development (UNESCO, 2017). Another example is that of Australia, which has established a National STEM School Education Strategy (Education Council, 2015) focusing on the overall improvement of STEM education in the country. One of the policies supported by the National STEM School Education Strategy report is the engagement of the school administration in this process. Specifically, school leaders are first trained on STEM practices and their importance, followed by the school's teachers. Furthermore, the same strategy focuses on supporting schools to create partnerships with STEM experts as a way to reinforce the connection between STEM practices, enterprises, school and real life.

3.3 EU-funded projects focusing on the gender divide in STEM

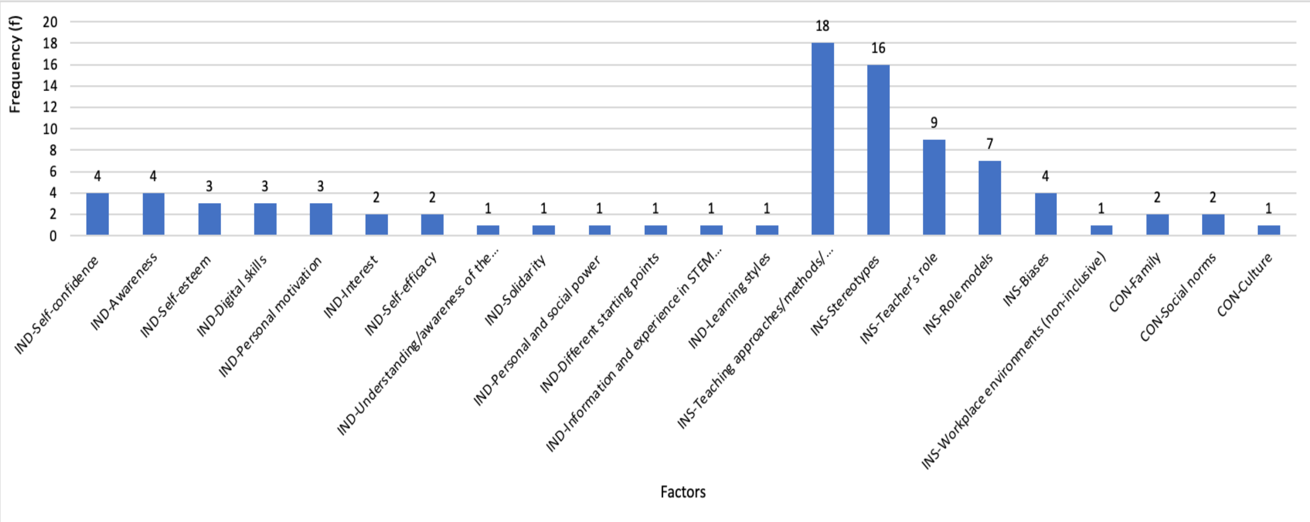
The European Commission has put significant efforts into addressing issues of gender inequality in STEM, primarily by funding research and projects aimed at strengthening gender equality in STEM fields.

An overview of the analysis of projects from the three platforms (CORDIS, Scientix & Erasmus) reveals a tendency to address gender issues over recent years. Data show that in 2022, ten projects were funded by Erasmus+ programme with a focus on gender. In previous years, the numbers of projects were lower, with one or two projects in each of the years 2014 to 2021.

3.3.1 Overview of factors influencing the gender gap in STEM

The rationale and aims of the EU funded projects were explored, with the aim of addressing Question 1 (factors linked to the gender gap in STEM education). The factors that the projects aimed to address in relation to the gender gap in STEM education were coded, and projects were grouped according to the factors on which they focused. This analysis provided a complete overview of the factors targeted by projects implemented in 2014-2023 (see Figure 4 below and Table 2 in Annex 2).

Figure 4. Overview of factors seen as influencing the gender divide in STEM by the projects



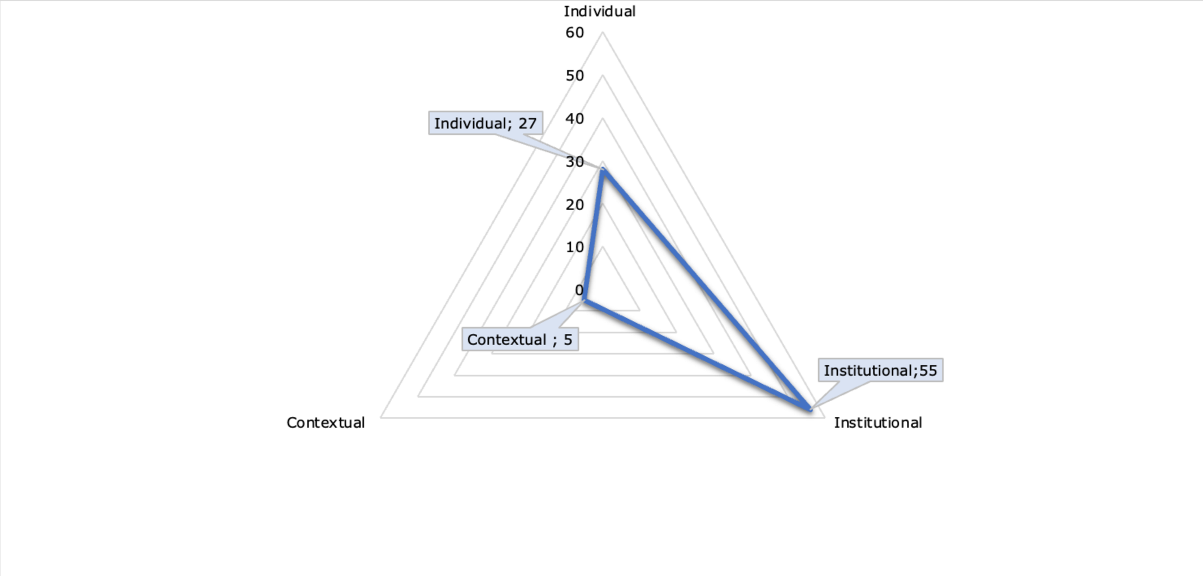
Source: own elaboration from analysis of the projects
IND: individual-level factors
INS: institutional-level factors
CON: contextual-level factors

As Figure 4 (above) and Figure 5 (below) show that when it comes to the gender divide in STEM education, the primary focus of funded projects has been on **'Institutional-level factors'** (f=55). Among these institutional factors (Figure 4), 'the current way of teaching STEM subjects' (Teaching methods/approaches/materials) (f=18) is seen as an important factor. Many projects aim to develop innovative methods (e.g. summer camps, workshops, lesson materials, online and blended learning, etc.) for teaching STEM subjects, based on the notion that current teaching methods are not gender-inclusive. In addition, 'stereotypes' in areas of STEM are presented in the projects (f=16) as having important links to the gender divide in STEM. The 'Teacher's role' (f=9), 'Biases about girls' skills and competencies' (f=4), and 'Non-inclusive workplace environments' (f=1) are other factors addressed by the projects. Among institutional factors, the existence or lack of 'role models' (f=7) is also present as a factor shaping girls' interest and motivation in STEM learning.

Compared with institutional factors, **'Individual-level factors'** (f=28) are less frequently covered by the projects. Among individual factors, 'Self-confidence' (f=4), 'Awareness' (f=4), 'Self-esteem' (f=3), 'Digital skills' (f=3) and 'Personal motivation' (f=3) are seen as key factors. In addition, 'Interest' (f=2), 'Self-efficacy' (f=2), 'Understanding/awareness of the diversity of careers in STEM' (f=1), 'Solidarity' (f=1), 'Personal and social power' (f=1), 'Different starting points of students' (f=1), 'Information and experience in STEM subjects' (f=1) and 'Learning styles' (f=1) are stated as influencing girls' interest and motivation towards STEM. Hence, the majority of projects have focused on those social-cognitive factors that are considered to be crucial in closing the gender gap in STEM education and careers. Furthermore, developing certain skills such as digital skills, spatial skills, etc. are also seen to be essential in motivating girls towards STEM learning. Digital skills are also presented as being important in these projects, and are linked to future STEM careers.

'Contextual-level factors' are the least often mentioned group of factors (f=5) in the projects. Among them, 'Family' (f=2), 'Social norms' (f=2) and 'Culture' are mentioned as significant factors with respect to the gender divide in STEM.

Figure 5. Factors seen by the projects as influencing the gender divide in STEM, grouped by individual, contextual and institutional factors



Source: own elaboration from analysis of the projects

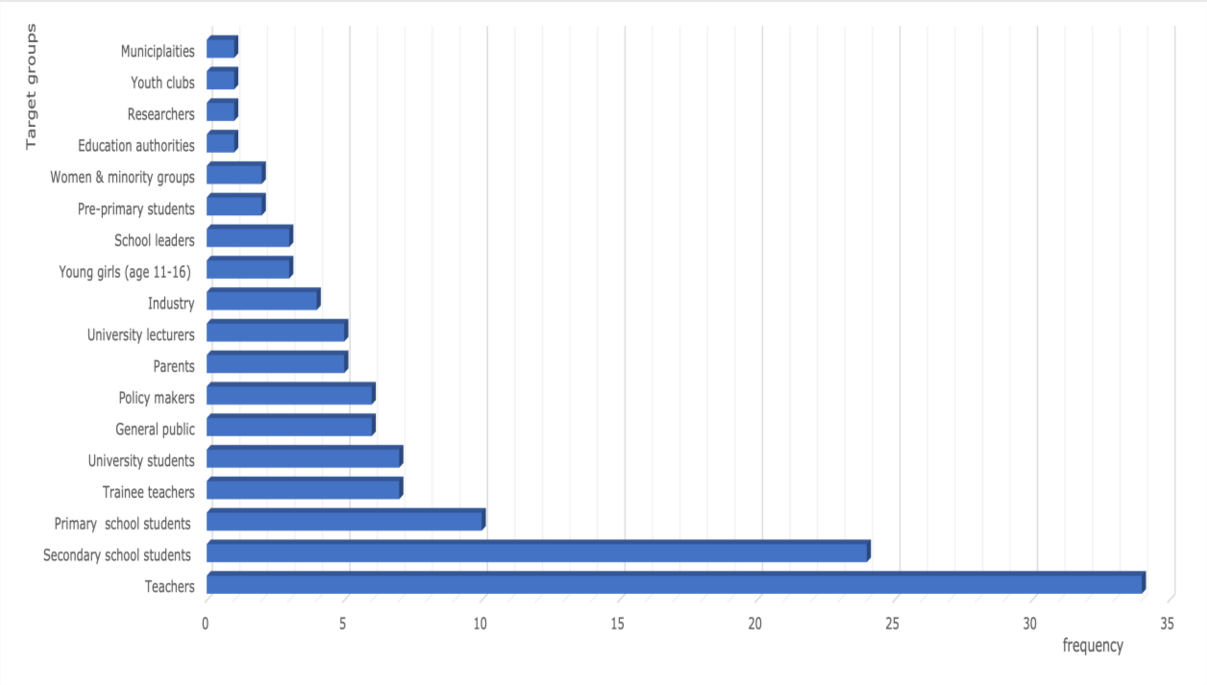
As Figure 6 shows, most projects targeted teachers and teacher trainers, with the aim of fostering girls' engagement in STEM education. However, pre-school and/or primary education were not the focus of the majority of the STEM education projects. A few examples are given in Box 1. Also worthy of note is the fact that school leaders are the group least frequently targeted by projects.

Box 1. Examples of EU-funded projects targeting educators

1) The Empowering Girls in STEAM through Robotics and Coding (RoboGirls) project (Erasmus+), oriented towards primary and secondary school students. The project aims to collaborate with educators to organise and implement STEAM activities and events with an emphasis on including robotics as tool. This project highlights the need to narrow the gender gap in STEAM and empower and encourage girls to play a role in STEM.
2) The project 'Gender Equality in Science, Technology, Engineering, Art and Mathematics' (Erasmus+) addressed gender equality at pre-school, primary and lower-secondary education levels. This STEAM project focused on gender stereotypes at these three levels of education, and aimed to reduce gender inequalities by developing innovative and interactive materials. Pre-school, primary and lower-secondary teachers were supported towards this goal by providing them with training materials to deal with diversity and gender-balance in their classrooms. The project's ultimate goal was to create an early education environment in which girls could feel appreciated and

motivated to participate in STEAM activities with an equal level of responsibility to boys, among other aspects.
3) The 'IN2STE(A)M' project (Erasmus+) aimed to enhance the development of of teachers' and educators' competence for teaching and exposing young children to STE(A)M concepts at primary school, with a focus on girls, in order to foster creativity, critical thinking and problem-solving competences. The project adopted an inclusive teaching methodology that aimed to stimulate young girls to develop their potential and to motivate towards a future career in a STEM field.

Figure 6. Target groups of the projects



Source: own elaboration from analysis of the projects

The EU-funded projects analysed aimed to enhance **individual-level factors** by developing and offering 'online training activities', 'teacher professional development MOOCs (massive open online courses)', 'mentoring activities for girls', 'examplar resources/educational materials', 'self-assessment tools', 'STEM workshops', and so on. Some examples regarding the approach, aims and products of a few projects are described in the paragraphs that follow.

The 'FemSTEM Coaching Project' (Erasmus+) seeks to address the gender gap in transversal skills within the STEM sector. The objective of this project is to empower women by equipping them with tools and techniques that enhance their confidence and transversal skills. This is achieved through a comprehensive approach involving online training and the establishment of peer-support coaching circles. The target participants are all women in STEM, with a particular emphasis on providing support to those experiencing a dual disadvantage, such as individuals from minority ethnic backgrounds, those with lower socioeconomic status, older workers, and persons with disabilities. The coaching programme adopted the 'Recruitment, Retention and Progression' (RRP) Framework. The findings derived from focus groups and questionnaires conducted show a substantial interest among women in participating in training sessions aimed at refining their transversal skills. The most sought-after transversal skills identified were self-confidence, leadership and networking. Considering these results, several recommendations have been proposed. First, the promotion of female role models in STEM should be undertaken strategically to resonate with female STEM students and professionals, aligning with their lives and aspirations. Second, a distinct emphasis should be placed on engaging young girls and recent graduates in targeted initiatives.

The 'Girls in STEM Career Project' (Erasmus+) is intricately linked to promoting inclusiveness and diversity in education, and non-discrimination. The primary objective of the project is to facilitate the early-stage development of STEM skills among female students. This entails support for the development of their cross-disciplinary skills and the nurturing of green skills, thereby fostering interest and awareness in STEM careers. Its aim is to empower girls to actively participate in the realms of science and technology in the future. The project's activities are designed to serve a dual purpose. First, they seek to engender an awareness of sustainable living through active participation in STEM workshops. Second, the initiative strives to instil recognition and realisation regarding STEM careers as pivotal professions for the future.

The 'WOMEN STEM UP' project (Erasmus+) confronts a significant challenge associated with the enduring gender disparity in STEM higher education, and subsequently, within the labour market. Employing a gender-based approach, the project strategically endeavours to both recruit and retain women in STEM, with the primary objectives of addressing gender stereotypes and enhancing female confidence and creativity. The educational framework involves instructing educators and university staff in the adoption of gender-neutral teaching methods and tools. Noteworthy outcomes stemming from the project include the formulation of the 'Women STEM UP for GOOD' programme. This initiative seeks to inspire female students to engage in socially conscious projects that incorporate gender considerations. In addition, the project has yielded educational resources featuring the narratives of accomplished women, a mentorship programme, and a training regimen providing career guidance and tools aimed at fortifying gender equality competences within the STEM domain.

The objective of the 'RoboGirls' project (Erasmus+) is to foster girls' confidence and self-esteem in STEAM, and to encourage girls to consider their future in STEM disciplines. This is achieved through the enhancement of teachers' capabilities to implement hands-on STEAM activities, specifically those that make use of robotics and other technological tools – all while employing gender equality approaches. The initiative encompasses the development of gender-inclusive activities and learning materials, with a particular emphasis on open educational resources centred around robotics.

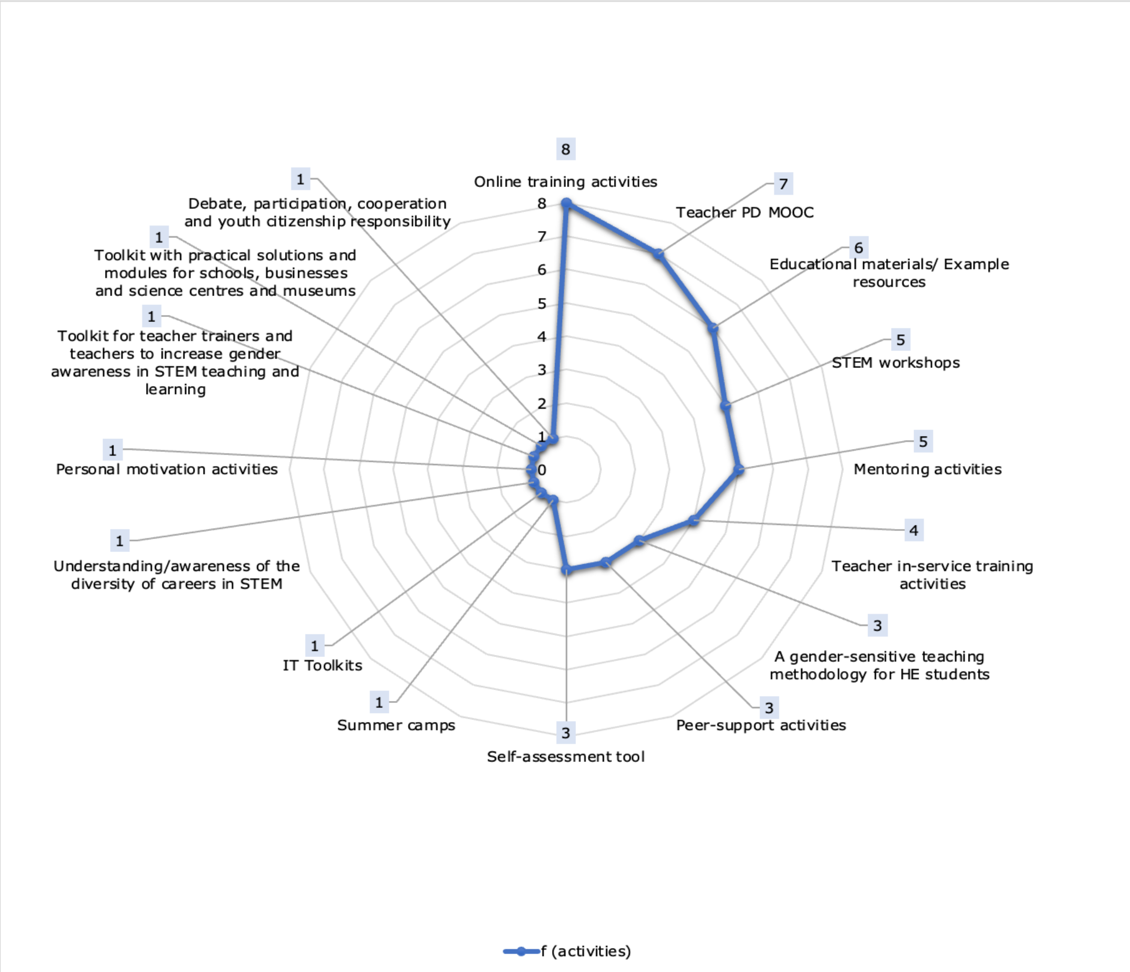
Institutional-level factors play a pivotal role in fostering gender balance within STEM education. This is achieved through the design and implementation of teacher development programmes and activities, as well as the provision of materials and tools aimed at engaging girls in STEM learning. Concurrently, these initiatives support educators in incorporating methodologies for gender equality into their instructional practices. A case in point is the STING project, which actively promotes the integration of gender considerations into STEM education through the provision of teacher professional development activities. These activities support teachers to heighten their awareness of gender and other forms of diversity in teaching and learning practices, with the ultimate goal of enhancing outcomes in STEM education. Specifically, the toolkit includes activities designed to strengthen gender awareness with regard to identity and prejudice, elucidating their potential impact on future student behaviour. Teacher professional development activities also involve the identification of role models and an examination of stereotypes perpetuated through educational and daily life contexts. In addition, there is reflection on how adults interpret the profile of scientists.

Contextual-level factors encompass social and cultural aspects – among others, the family context, which can affect gender equality. Despite the crucial role they play, the search conducted for the present study has identified only a few projects from 2014-2023 that have dealt with contextual-level factors. Some examples of activities are project-based learning, evening classes, makerspace environments, and international fairs and conferences.

3.3.2. Activities implemented by projects based on a three-level factor classification

Numerous projects and activities concentrate on addressing factors at the individual and institutional levels, with an emphasis on 'individual-level factors' and 'institutional-level factors'. Notably, a diverse array of activities has been planned and developed within EU-funded initiatives to cater for individual-level factors. Figure 7 offers a comprehensive overview of these activities, with frequencies denoted in blue boxes to indicate the numbers of each type of activity found in the projects analysed. Primarily, activities pertaining to individual-level factors include online training sessions, massive open online courses (MOOCs) for teacher professional development, STEM workshops, mentoring initiatives, and peer-support activities. Together, these initiatives represent a concerted effort directed towards enhancing and supporting individuals at a foundational level, thereby contributing to the overarching goals of fostering gender inclusivity in STEM education.

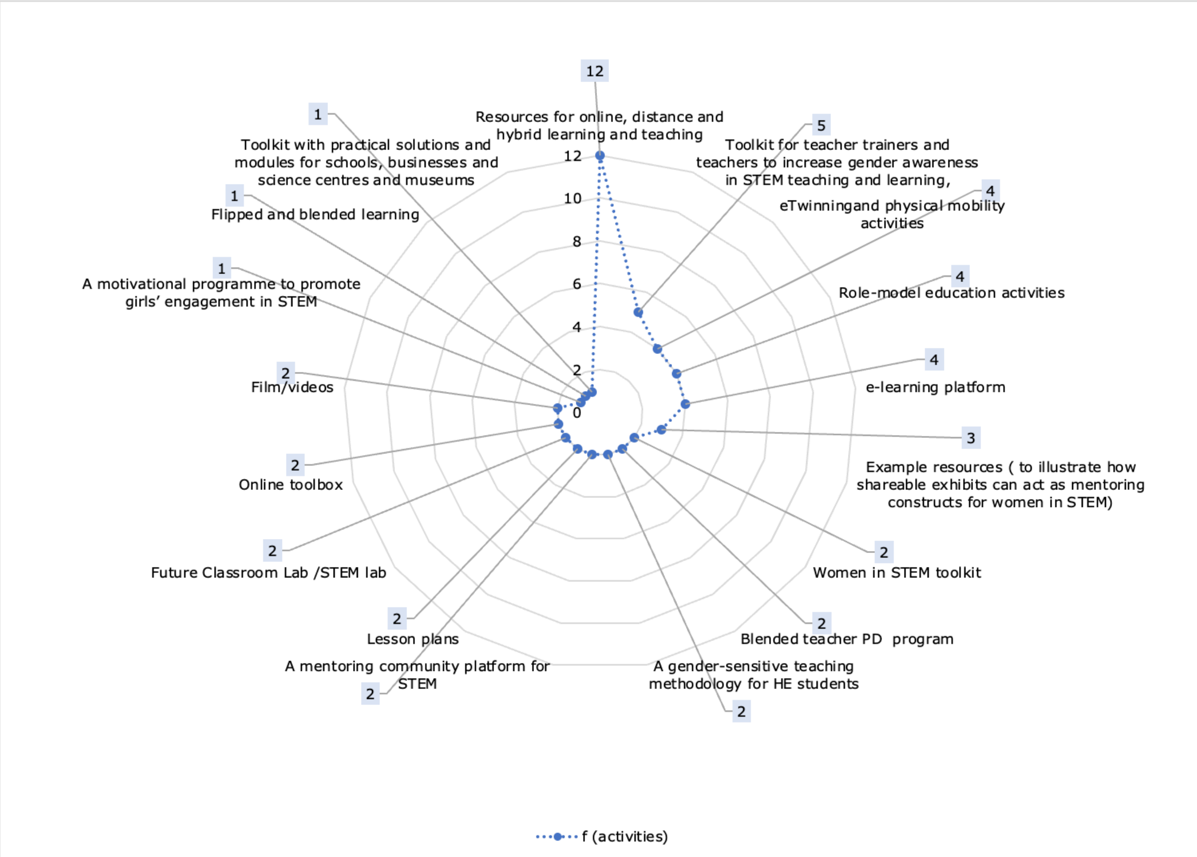
Figure 7. Project activities directed towards 'individual-level factors'



Source: own elaboration from analysis of the projects

Similarly, Figure 8 presents an overview of the activities developed with regard to **institutional-level factors**. Projects in this category mostly focus on developing resources for traditional, online and hybrid learning and teaching, and on the development of toolkits. For example, the FESTEM project (Erasmus+) aimed to promote innovative methods and pedagogy. One of the resources it developed is a toolbox that includes traditional and digital educational materials to promote and support gender-inclusive teaching and learning. The development of toolkits for teacher trainers and teachers to increase gender awareness in STEM teaching and learning is a relatively common activity aimed at institutional-level factors. For example, the STING project (Erasmus+) provides a toolkit including activities to increase gender awareness in relation to identity, and for identifying role models as well as stereotypes that are promoted through education and/or daily life. Another example, the GIGS Toolkit, developed as part of the GIGS project (Erasmus+), includes online teacher training courses on engaging girls in STEM through real-life contexts and the use of digital technology.

Figure 8. Project activities aimed at institutional-level factors



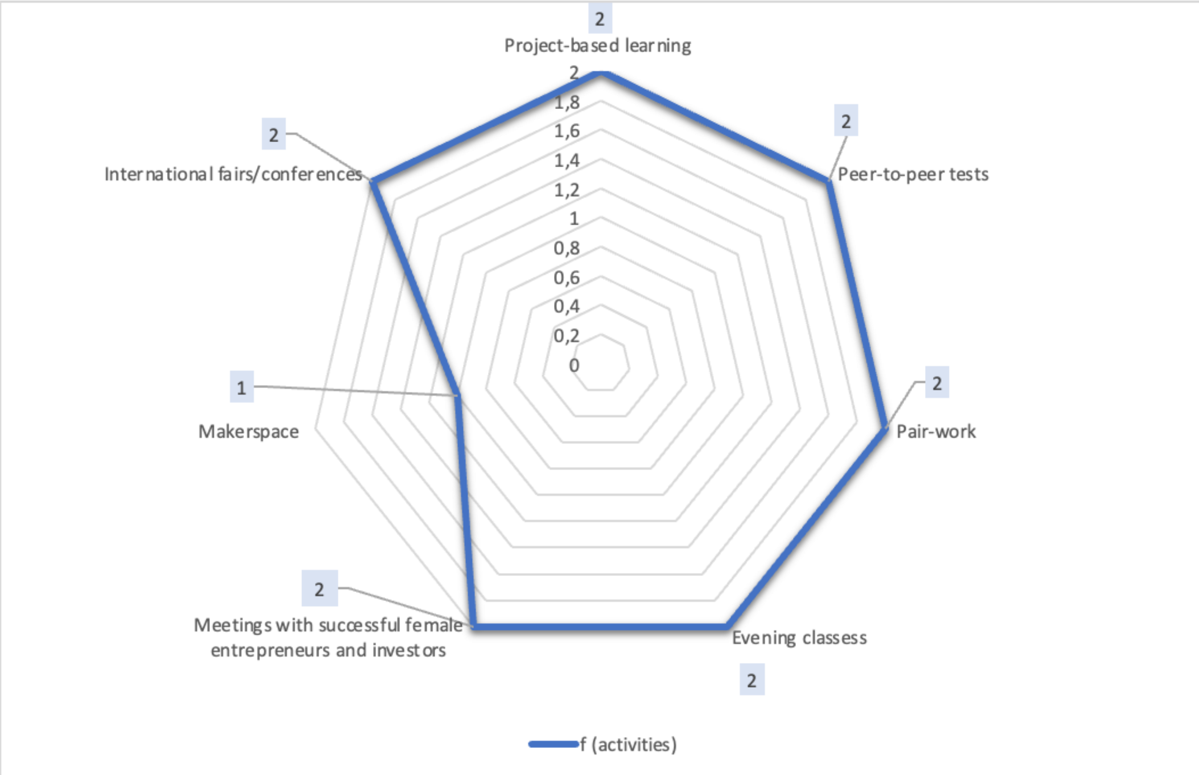
Source: own elaboration from analysis of the projects

One aspect that should be highlighted is that many projects have introduced 'role models' as an effective and practical way to address the gender gap and improve girls' interest and motivation in STEM learning. Across diverse activities such as toolkits, online resources, games MOOCs, the 'role model' approach emerges as a common and impactful theme. A notable instance is found in the Gender4Stem (Erasmus+) project, in which a 'Role Model Pool' has been established featuring women professionals across various STEM domains. The project team created a databank of women in STEM, which is updated regularly. Furthermore, the integration of role models has been systematically woven into other educational activities developed within EU-funded projects, highlighting the widespread adoption of this approach as a means to inspire and engage individuals in STEM learning.

In the STING (Erasmus+) project, a noteworthy activity known as the 'Architect Game' was devised, with the aim of identifying stereotypes in education and daily life. This interactive exercise, developed by the project, includes a reflection activity designed to showcase how adults interpret the profile of a scientist. Among the objectives of this activity is the idea of fostering awareness about how role models and stereotypes are presented through both educational contexts and everyday experiences. Similarly, one distinctive output within the FEMALES (Erasmus+) project takes the form of 'Role Model Educational Tools'. The project created a card game and an e-book entitled 'Female Legends of Science'. Together, the card game and e-book showcase female scientists from diverse countries, serving as educational tools to promote the recognition and appreciation of female role models in science. One output of the AR4STEM (Erasmus+) project is a 'Motivational Programme to Encourage Girls' Engagement in STEM'. Within this initiative, the use of role models is highlighted as the most effective strategy to support the involvement of girls in STEM disciplines.

Figure 9 below provides an overview of **contextual-level factors** addressed by the projects. Some projects have developed project-based learning activities, while others have designed peer-to-peer tests, activities for working in pairs, and evening classes. Meetings with successful female entrepreneurs and investors, a makerspace and international fairs/conferences can also be found among the projects' activities.

Figure 9. Project activities aimed at contextual-level factors

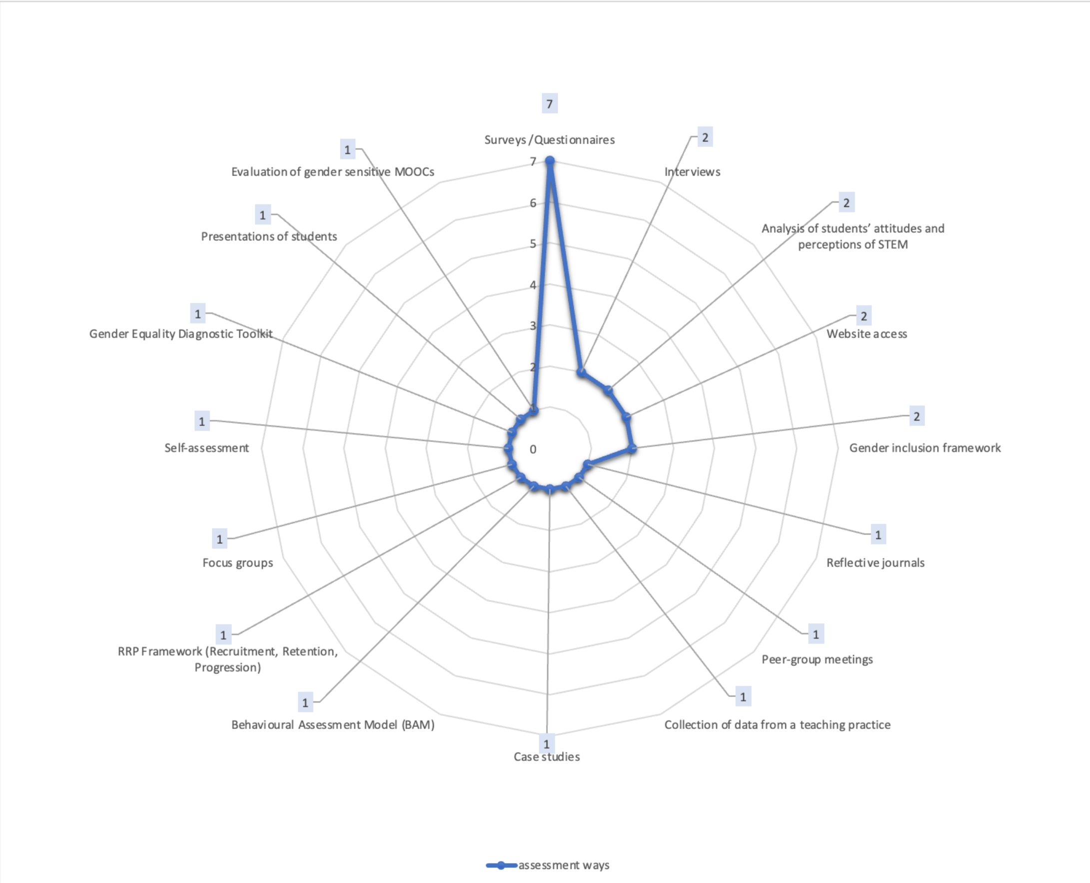


Source: own elaboration from analysis of the projects

Furthermore, various projects have implemented additional practices to enhance girls' engagement and motivation towards STEM education. Notably, self-efficacy emerges as a critical individual factor influencing girls' participation and motivation in STEM learning. The 'Coaching Circles' activity of the FemSTEM (Erasmus+) project is designed explicitly to support the development of self-efficacy in girls through peer-support mechanisms. The Gender4Stem (Erasmus+) project adopted a mentoring approach, leading to the establishment of a 'Mentor Network'. This network was strategically devised to provide mentorship and guidance to girls with regard to STEM, with the aim of motivating and supporting their active engagement in these disciplines.

Several projects, including FemSTEM (Erasmus+), Girls in STEM Career (Erasmus+), and Women Stem Up (Erasmus+) focus on the targeted development and enhancement of girls' skills, including digital skills, collaboration skills, green skills, STEM skills and transversal skills, among others. These skills-building initiatives are integral to supporting the holistic development of girls, and contribute to the development of self-efficacy. In addition, the collection of activities derived from exemplary practices across Europe is a shared approach adopted by various projects, highlighted in initiatives such as Hypatia (Horizon 2020), FemSTEM (Erasmus+) and AR4STEM (Erasmus+). This collaborative approach entails leveraging successful practices from different regions to inform and enrich the strategies implemented within the projects, fostering a collective and synergistic effort to advance gender inclusivity in STEM education. One feature of the practices/approaches developed in these projects that should be highlighted is that they are accessible, practical and ready to use. In addition, many of the practices developed by the projects are 'digital', thereby increasing their accessibility.

Figure 10. Assessment methods/tools used in the projects



Source: own elaboration from analysis of the projects

As shown in Figure 10, most of the projects used surveys/questionnaires to assess the impact of their activities. In these cases, the surveys and questionnaires were administered in all partner countries. Furthermore, interviews with students and teachers were used to gather information about the impact of the project's activities (e.g. workshops). Other assessment methods include reflective journals, focus groups, self-assessment questionnaires, case studies, etc. However, not all of the projects planned explicit assessment, or shared it on the project websites.

Impact evaluations are only available in a very few Erasmus+ STEM education projects. One example is that of IN2STE(A)M. This project designed and implemented diverse tools to improve teachers' attitudes and skills, adopting inclusive and multidisciplinary teaching approaches that integrate social science, arts and science concepts. An impact evaluation report on the project can be accessed (https://in2steam.eu/outputs/), and contains useful information regarding the implementation of the project's creative workshops in STE(A)M education, the so-called 'IN2STE(A)M Labs' (Erasmus+). The report includes a summary of the learning outcomes and impacts on the target groups (teachers and students in primary education) with regard to the acquisition of key competences and knowledge in STE(A)M. The report highlights that participants improved their skills and knowledge as per the design of the project: combatting gender stereotypes and fostering confidence and passion in STEM. To assess competences in cognitive and social-emotional skills, and to understand the project's impact on girls' learning and behaviour, a Behavioral Assessment Model (BAM) was developed. This served as a practical guide for teachers to effectively assess STE(A)M skills. Self-awareness and self-confidence – individual factors that affect gender equality, as has already been discussed in this report – are integrated within the social and emotional skills in this model.

4. Findings

4.1 Findings in relation to the main factors linked to the gender gap in STEM education

Finding 1. Further exploration is needed into improving students' attitudes, interest, motivation and self-efficacy, with an emphasis on gender-inclusive practices.

The majority of studies exploring gender gap and gender inequalities in STEM education from 2014 to 2023 have focused on individual-level factors (enjoyment, attitudes, motivation, demographics, self-efficacy, etc.) with data being collected mostly via large-scale quantitative studies such as PISA, TIMMS or other local studies. In most cases, the findings of these studies focus on whether there is a relationship between gender and attitudes, motivation and enjoyment. These findings are inconclusive, with some studies showing that girls' attitudes, interest and motivation are higher during the early years of primary school, while others show that boys' motivation and attitudes are higher in secondary school, without examining or controlling for other contextual or institutional factors.

Individual-level factors are also emphasised in the projects reviewed that deal with the gender gap in STEM education. Most of these EU-funded projects accept that individual-level factors are crucial with respect to girls choosing to study and pursue careers in STEM. Therefore, the projects targeted the development of lesson materials, workshops, summer camps and self-assessment tools to support girls with regard to these individual-level factors. In addition, awareness, interest and digital skills have also been recognised as powerful factors at this level. However, the materials and practices developed by these EU-funded projects to address individual-level factors have not yet been systematically evaluated, thereby leaving a gap in our knowledge.

Finding 2. Self-efficacy in STEM is a good predictor of future interest in STEM for both girls and boys, but girls and women tend to exhibit lower levels of self-efficacy.

One of the main findings in all of the studies and projects focusing on social cognitive factors with respect to STEM education or STEM career aspirations is self-efficacy. Self-efficacy in STEM is an important predictor of future STEM interest and uptake for both girls and boys. Students with higher self-efficacy tend to hold positive attitudes towards science, and have a greater likelihood of following STEM topics in their academic path. One interesting finding is that girls have lower self-efficacy in STEM than boys, even in cases where their actual performance is higher than that of boys – and the self-efficacy of both boys and girls decreases with time in traditional, formal educational settings. Interventions focusing on comparing changes in self-efficacy after specific pedagogical approaches (e.g. integrated STEM, gender-inclusive pedagogies) show that compared with traditional instruction, self-efficacy in these situations increases for both boys and girls.

It is also important to note that self-efficacy has been found to be connected to gendered beliefs among secondary school students. Examples in the literature and in project implementations suggest that after engaging in pedagogies that support gender-neutral or gender-inclusive instruction, girls' self-efficacy and interest in STEM increase. Furthermore, comparisons of self-efficacy between men and women among students at university level follow the same trend, with men having higher self-efficacy than women despite achieving the same level of academic performance in STEM fields. Another important finding highlighted is that for future career decisions, women rely on a broader array of self-efficacy aspects, encompassing both academic success and life satisfaction, while for men the emphasis is only on academic success.

Moreover, in the projects reviewed, social cognitive factors such as self-confidence, self-efficacy and self-esteem are treated as the most crucial individual-level factors in the implementation of the projects. Many projects have developed various activities and materials to support the self-efficacy of girls in the context of STEM education. Examples of these activities and tools include online training, peer support, educational resources, a community mentoring platform, mentoring activities/resources, summer camps, interdisciplinary workshops, and the use of role models.

Finding 3. The role of the family and the environment is important in shaping decisions.

Societal and cultural issues, values, family, siblings, and the overall context in which the students live play an important role in the enhancement of individual-level factors. For example, a supportive family correlates positively with interest in STEM, and so does exposure to STEM activities in non-formal learning through family. Two important questions that need to be addressed, however, are how to support families that might traditionally hold gender stereotypes with regard to STEM and do not support their daughters, and how to provide equal and inclusive access to STEM-related activities for all families. Parental involvement in STEM education is worth exploring, given its potential effects on academic outcomes, processes and personal aspects such as students' self-efficacy, self-regulation and motivation. The need for parents to receive support and information in order to facilitate their children's STEM learning was identified in various studies, policy documents, and some projects.

The perceptions of parents, teachers and school principals are instrumental to the development of a family-friendly school culture that supports a family-school partnership approach. Further research on parental involvement in STEM classrooms could help in understanding the interplay between the classroom context and varying levels of parents' self-efficacy across STEM content areas as it relates to children's STEM achievement and aspirations for a career in STEM. In addition, policies addressed towards families from differing social and cultural backgrounds as to how to support their children and overcome stereotypical perceptions are also important, and are still missing. This need also arises from a lack of EU-funded projects that focus on societal factors – more specifically, on supporting families.

Finding 4. Institutional-level barriers continue to persist.

What is largely missing from studies and projects is examples of how to systemically support students in STEM – especially women and girls – at an institutional level (i.e. through school policies and national policies). Some studies have focused on various pedagogical strategies to support girls at the school level (i.e. problem-based learning, gender-neutral activities, integrated STEM, non-formal STEM learning activities), with positive results on girls' self-efficacy. Furthermore, three projects – namely, Hypatia, Girls Into Global STEM, and STING – have created toolkits and suggested activities to address the gender balance issue in STEM. Findings on the institutional level suggest that the traditional curriculum is less effective at supporting girls than alternative approaches. Furthermore, there is a lack of a systemic approach combining top-down policies and bottom-up initiatives with programmes for specific groups. Many researchers have turned to non-formal learning experiences as a way to promote students' interest in STEM education and STEM careers – a tactic that is also found in some of the research projects reviewed in this report (e.g. Girls in STEM, My STEAM Network, Gender4STEM). One of the main reasons for using non-formal learning settings is the flexibility of the curriculum in such settings, which allows the integration of multiple disciplines. However, one limitation of non-formal learning settings is that they do not provide equal access for all and may therefore profit students and families that already have positive dispositions towards STEM. Thus, how to offer these possibilities consistently through the formal educational system is an issue that still needs to be addressed.

The promotion of teacher development programmes (TDP) on gender-inclusive learning environments for STEM and STEAM education is necessary, taking into consideration the individual-, contextual- and institutional-level factors. As with personal attributes, preferences and expectations are influenced by people's cultural environments and within educational environments, which are in turn shaped by culture. Although for the purposes of this report, these factors have been addressed separately, the authors understand these as being interconnected; thus, TDP should address them as being interlinked. The roles of both teachers and students are affected not only by the educational context but also by their cultural environment. Therefore, time and effort need to be invested in exploring specific designs for learning environments that can stimulate the awareness of all these factors not only among teachers but also among students. While several projects have created toolkits for teachers, this has been done in a way that does not systemically target the problem at an institutional level.

4.2 Findings in relation to the potential and effectiveness of small-scale interventions to address the gender gap in STEM

Finding 5. A number of promising practices and interventions have been adopted that offer the potential to address the gender gap in STEM, but these have usually been implemented on a small-scale

Some published studies describe examples of practices that can address the gender gap in STEM. One of the drawbacks of these examples, however, is that they focus on small-scale studies and report findings from implementation with specific groups of students. Given that these practices have not been implemented on a large-scale, we cannot therefore be sure of their impact. Nevertheless, a number of examples can still be considered as successful on a small-scale (although these are not necessarily replicable or scalable). These practices include:

(a) The use of gender-sensitive teaching and gender sensitive curricula, also including an emphasis on the gender-neutral use of language. For example, one study focused on introducing gender-neutral activities to 6- and 7-year-old students, with positive results on girls' self-efficacy. Examples are available of toolkits on how to implement gender-sensitive pedagogy in STEM, but these are mostly addressed towards higher education.

(b) Innovative pedagogical approaches in the teaching of STEM, such as integrated STEM that focuses on problem-solving and making connections to real-life problems. Findings show that when these approaches were implemented at secondary schools in Belgium, students – and especially girls – did not lose their interest in science. The most recent EU-funded projects (e.g. MOST, Multipliers) focusing on open schooling activities to introduce STEM have also reported positive outcomes on students' attitudes by making connections to everyday life, but work on these projects is still ongoing, and their findings are not formally published.

(c) Participating in STEM in non-formal learning settings (e.g. in camps, afternoon clubs, summer school). Participation in non-formal learning settings can increase young girls' interest in STEM, mostly due to the flexibility of the curriculum in such contexts to include longer investigations and different activities such as role models, which are usually not included in formal education curricula. EU-funded projects have prepared toolkits on how to support teachers and other stakeholders (i.e. non-formal learning educators) to introduce the aforementioned practices. These toolkits can be used to support change in practices and to train the teachers, but this should be carried out in a more systematic way.

(d) Strategies for engagement with gender equality. Such strategies aim to improve the recruitment and retention of girls and women in STEM disciplines. Many women self-select out of STEM because of gender stereotypes that can affect women's capacity to identify with and feel safe in a STEM environment or career. The literature and projects reviewed for this report appear to indicate that the identification of women role models in STEM fields is beneficial to the recruitment and retention of girls and women in STEM disciplines. However, it should be emphasised that changing educational cultures at an individual, interpersonal and institutional level is a very complex issue that requires a multifaceted approach and cannot be solved solely through the introduction of women role models.

General conclusion: there remains a lack of a systemic approach to address the gender gap

Despite the plethora of studies exploring the various factors relating to the gender gap in STEM, and despite a considerable and growing number of projects that have developed toolkits to address this issue, there remains a lack of a systemic approach.

(a) We know which factors influence the gender gap, but as yet we have not systematically worked towards improving practices in relation to those factors. The studies and projects cited in this report have identified the need for different pedagogical practices that depart from the traditional teaching model, as well as recognising the important role of family and other contextual and institutional factors. The analysis of the EU-funded projects in this report highlights certain areas that remain under-developed – for example, possible reductions in the gender gap that could be achieved by training families and teachers in how to be gender-inclusive and gender-sensitive in their interactions with their children and students. Even though such measures have been identified as important in closing the gender gap, based on the analysis of projects in the present report, there are no EU-funded projects focusing on training parents and families, leaders (e.g. school principals) and policy-makers (e.g. curriculum designers) on the importance of gender-inclusive and gender-sensitive practices.

(b) Despite many EU-funded projects focusing on STEM and gender, the outcomes and toolkits developed have not been systematically evaluated on a large scale. Each project has evaluated its products and toolkits only within the consortium countries. Furthermore, most of the outputs of these projects are usually disseminated within the partner countries in each project, which means that useful tools are not sustained beyond the lifetimes of the projects and consortia.

(c) Despite the importance of various factors at a contextual and institutional level, policies have focused on programmes aimed at girls, thus ignoring the possibility of a holistic approach to promoting gender-inclusive practices through the inclusion of families, managers, colleagues and teachers. For example, a leaflet entitled 'Bridging the gender gap in STEM' (EU, 2022), presents examples of activities carried out in the EU to foster gender equality in STEM. These activities include fostering the greater participation of girls in STEM, and retaining and promoting more women in research. None of the activities identified in this publication adopts a holistic and systematic approach that addresses factors at a contextual, institutional and personal level.

One example of the implementation of a national STEM policy that can be considered successful is that of Australia, which set up the National STEM School Education Strategy 2016-2026 (Education Council, 2015). The National STEM Strategy focuses on the overall improvement of STEM education in Australia, and not specifically on addressing the gender gap. However, some the policies suggested in the strategy are appropriate for improving the gender gap in STEM. The five areas of action in the Australian National STEM strategy are as follows: '(1) increasing student STEM ability, engagement, participation and aspiration, (2) increasing teacher capacity and STEM teaching quality, (3) supporting STEM education opportunities within school systems, (4) facilitating effective partnerships with tertiary education providers, business and industry, and (5) building a strong evidence base" (Education Council, 2015, p. 6). As part of this initiative, a National STEM School Education Resources Toolkit was designed to support schools in establishing new STEM initiatives, collaborating with industry, and evaluating the activities they carry out. Furthermore, emphasis is given to providing guiding principles for schools in order to support them in implementing STEM education. For example, the role of principals and other school leaders is recognised as important in achieving better student outcomes in STEM, and special emphasis is given to training school leaders. Furthermore, minimum national requirements for teacher professional development have been set for STEM teachers (Education Council, 2018), which focus on preparing all teachers to introduce STEM into their classes. The same national strategy recognises the importance of partnering with enterprises to make connections between STEM and everyday life and industry. Partnering with enterprises is similar to the open schooling projects recently funded by the EU, which focuses on collaborations between schools, enterprises, the community and other stakeholders. Lastly, Australian policy on STEM focuses on the need to chart, at a national level, a STEM data indicator that includes participation and attainment, also including an emphasis on under-represented students, in order to monitor students' progress in STEM. Australia's National STEM Strategy can be considered exemplary for two main reasons: (a) it is systemic, focusing on various aspects of the educational system (e.g. preparing school leaders, training STEM teachers, monitoring student outcomes and mapping specific expected outcomes); and (b) it is systematic, as an evaluation strategy has been set up to evaluate different aspects of the strategy's implementation (e.g. the development of materials for teachers, teacher training, leader training). What is still missing from the example of Australia is how to include a student's family into the negotiation of the student's STEM identity.

The reasons for the gender gap in STEM have been researched, and EU-funded projects have developed an array of useful activities, tools, toolkits and outputs to address factors mainly at the individual level – some of which are described in this report. However, analysis of the potential of these activities to address the gender gap is so far limited, mainly due to a lack of evidence coming from these EU-funded projects. There is also lack of evidence from the studies published, as most of the activities and practices analysed in these studies are implemented on a small-scale. Within the EU, policies to address the gender gap in STEM mostly focus on the individual or institutional level. Such policies (e.g. those presented in 'Bridging the gender gap in STEM') are recommendations for which no evidence is available with regard to their application or impact. Therefore, the question of how to effectively address the gender gap should be approached by designing systematic policies that are put in action and evaluated.

5. Recommendations

The recommendations below are based on the analysis of academic research papers, policy reports and EU-funded projects presented in the previous sections of the report:

- Focus on the consistent evaluation of STEM education. While EU projects and other initiatives in STEM do evaluate their outcomes, this is not necessarily carried out in a systematic way that focuses on evaluating those factors that could shape and maintain students' interest in STEM. Future projects should focus on an experimental design in order to systematically explore factors which (according to hypotheses) affect the shaping and maintenance of students' interest in STEM (also see van den Hurk, 2019, and Australian Academy of Science, 2019).

- Focus on interventions and studies on self-efficacy in STEM. Individuals with high STEM self-efficacy perform better and persist in STEM disciplines longer relative to those whose STEM self-efficacy is lower (Rittmayer & Beier, 2008). Thus, further research is needed to assess the influence of this individual-level factor. Self-efficacy can be measured using specific surveys that can be designed and implemented as pre- and post-tests with the goal of understanding how it can be improved. Rittmayer and Beier (2008) suggest that a 'confidence gap' is partly responsible for the gender gap in STEM. Taking into consideration that this factor is a key predictor of STEM performance and perseverance, more efforts are required to focus on closing this gap. One question that should be addressed at this level is how to improve and retain girls' and women's self-efficacy throughout their academic careers, and which pedagogies are critical to supporting them. If we know that self-efficacy can be positively affected by students' success in performing a STEM task (and vice versa), it is crucial to pay attention to the characteristics of STEM interventions and methodologies, as well how to continue with successful interventions from primary to tertiary education.

- Further research is necessary to identify the criteria needed to design learning environments, activities and methodologies that can help to close the gender divide in STEM education. Furthermore, studies should be developed at different levels of education concerning teachers' perceptions, beliefs and training with regard to STEM and gender, paying attention to individual, contextual and institutional factors. This is necessary to improve gender-inclusive STEM education from the early years of education. As a closing remark, it is important to note that despite the plethora of studies published and the development of toolkits to support the gender gap, there are no consistent policies and strategies on STEM in the European Union, no shared understanding of STEM (Evagorou & Konstantinidou, 2023), and no systemic policies at national or regional level to address the gender gap in STEM.

- Develop policies and promote practices that target teacher professional development, emphasising the introduction of alternative teaching approaches that have been proven effective in supporting students' self-efficacy and participation. Such efforts could include integrated STEM practices and gender-responsive STEM practices. As most gender-responsive practices available come from university mentors, there is still a need for more practices aimed at early ages (Knezz, Stephanie, Pietri, Evava, Gillian-Daniel & Donald, 2022), along with an evaluation of how these practices are implemented in the classroom.

- Promote systemic policies at national and local levels that will support families, teachers, policy-makers and fellow scholars in following gender-sensitive or gender-neutral approaches as a way to enhance the role of the family and the environment as well as the role of the school as an institution, and provide systematic guidance to families of all socioeconomic statuses. Such policies should focus on introducing changes and support with regard to contextual- and institutional-level factors in an integrated way in order to provide holistic support for students.

- Through policy changes in teaching and learning, promote various evidence-based pedagogical approaches that can support students' interest in STEM (e.g. integrated STEM). The need to break down barriers between the STEM disciplines in education has been highlighted in various reports (e.g. in Fondazione Deloitte, 2022) as a way to provide students with 21st-century skills; however, only a small number of EU countries are moving towards an integrated STEM approach (ProSTEM Teacher Academy Policy Report, 2023). The use of multifaceted approaches is needed in order to understand how to close the gender gap in STEM education through a collaborative approach.

6. References

Almukhambetova, A., Torrano, D.H. & Nam, A. (2023). Fixing the Leaky Pipeline for Talented Women in STEM. *International Journal of Science and Mathematics Education,* 21, 305–324. https://doi.org/10.1007/s10763-021-10239-1

Almukhambetova, A. & Kuzhabekova, A. (2020). Factors affecting the decision of female students to enrol in undergraduate science, technology, engineering and mathematics majors in Kazakhstan. *International Journal of Science Education*, *42*(6), 934-954.

Archer, L., Moote, J., MacLeod, E., Francis, B. & DeWitt, J. (2020). A*SPIRES 2: Young people's science and career aspirations, age 10-19*. London: UCL Institute of Education.

Archer, L. (2018). Engaging Children with Science: Science Capital Approach. *Primary Science*, *154*, 5-7.

Australian Academy of Science (2019). *Women in STEM Decadal Plan* (Australian Academy of Science)

Balta, N., Japashov, N., Mansurova, A., Tzafilkou, K., Oliveira, A. W., & Lathrop, R. (2023). Middle- and secondary-school students' STEM career interest and its relationship to gender, grades, and family size in Kazakhstan. *Science Education*, 107, 401–426. https://doi.org/10.1002/sce.21776

Babarovic, T. (2022). Development of STEM Vocational Interests During Elementary and Middle School: A Cohort-Sequential Longitudinal Study, *Journal of Career Development*, 49, 6, 1230-1250.

Brett, L. (2022). *Women in STEM in the European Union – Facts and Figures*. European Student Think Tank, March 24th 2023 available https://esthinktank.com/2022/03/24/women-in-stem-in-the-european-union-facts-and-figures/

Blanchard, M.R., Albert, J.L., Alsbury, T.L., Williams, B. (2012). NSF ITEST Annual Project Outcomes Report: Innovative technology experiences for students and teachers. *STEM Teams: Promoting Science, Technology, Engineering, and Mathematics (STEM) career interest, skills, and knowledge through Strategic Teaming.* Arlington: National Science Foundation.

Bilgin, A. S., Molina Ascanio, M., Milanovic, I., Kirsch, M., Beernaert, Y., Scicluna, D., Noriega, M., Farrugia, J., Evagorou, M., Molina, P., Kapoor, K., Malmberg, B., Trullàs, M., Pedralli, M., Neuberg, C., Koliakou, I., Magid-Podolsky, S., Herrero, B., Bultynck, L., Niewint-Gori, J., Fabry, E., Quarta, B., Miotti, B., Muscat, M., Vargas, R., Gras-Velázquez, A. (2022). *STEM Female Leaders – The way forward for reducing the gender gap in STEM fields. SCIENTIX report*. http://www.scientix.eu/web/guest/observatory

Billington, B., Britsch, B., Karl, R., Carter, S., Freese, J., and Regalla, L. (2014). *SciGirls Seven: How to engage girls in STEM*. Minneapolis, MN: Twin Cities Public Television. http://tpt.vo.llnwd.net/o26/scigirls/ScigirlsSeven_Print. pdf

Blažev, M., Karabegović, M., Burušić, J. et al. (2017). Predicting gender-STEM stereotyped beliefs among boys and girls from prior school achievement and interest in STEM school subjects. *Social Psychology Education,* 20, 831–847. https://doi.org/10.1007/s11218-017-9397-7

Blickenstaff, J. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education*, 17(4), 369–386. https://doi.org/10.1080/09540250500145072

Blickenstaff, J. C. (2005). Women and Science Careers: Leaky Pipeline or Gender Filter? *Gender and Education*, 17(4), 369-386.

Butler, J. 1990. *Gender trouble: feminism and the subversion of gender*, London: Routledge.

Bourdieu, P. (2004). *Science of science and reflexivity*. Polity.

Bourdieu, P. (1986). The forms of capital. In: Richardson, J. (Ed.). *Handbook of Theory and Research for the Sociology of Education*. 241–58, Greenwood.

Bybee, R.W. (2013). *The case for STEM education challenges and opportunities*. Washington, DC: National STEM Teachers Association.

Capobianco, B. M., Diefes-Dux, H. A., Mena, I., & Weller, J. (2011). What is an engineer? Implications of elementary school student conceptions for engineering education. *Journal of Engineering Education, 100*(2), 304–328.

Cedefop (2014). *Rising STEMs*. Available: https://www.cedefop.europa.eu/en/data-insights/rising-stems

Chan, R. C. (2022). A social cognitive perspective on gender disparities in self-efficacy, interest, and aspirations in science, technology, engineering, and mathematics (STEM): the influence of cultural and gender norms. *International Journal of STEM Education*, *9*(1), 1-13.

Chine, D. R. (2021). A *Pathway to Success? A Longitudinal Study Using Hierarchical Linear Modelling of Student and School Effects on Academic Achievement in a Middle School STEM Program*. Youngstown State University.

Choice (2019). *State of the arts analysis of existing initiatives, best practices and attitudes towards STEAM in educational contexts.* Deliverable of Choice Project available here: https://www.euchoice.eu/_files/ugd/6c0a6f_088c756fa05040d0a4b87a0e7d3b885d.pdf

Curriculum Development Division (CDD), Ministry of Education Malaysia. (2016). *Sharing Malaysian Experience in Participation of Girls in STEM Education*. Geneva, Switzerland, UNESCO International Bureau of Education (IBE).

Czerniak, C.M., Brenneman, K., Clements, D.H., Duschl, R.A., Fleer, M., Greenfield, D., Hadani, H., Romance, N., Sarama, J., et al. (2020). The Importance of Early STEM Education. In C.C Johnson, M.J. Mohr-Schroeder, T.J. Moore, D. Lyn (Eds). *Handbook of Research on STEM Education, 1st ed*. pp. 87–100. Springer.

Danielsson, A. (2012). Exploring woman university physics students 'doing physics' and 'doing science'. *Gender and Education*, 24(1), 25–39.

De Loof, H., Boeve-de Pauw, J. & Van Petegem, P. (2022). Engaging students with integrated STEM education: A happy marriage or a failed engagement? *International Journal of Science and Mathematics Education, 20*(7), 1291-1313.

De Silva, A. D. A., Khatibi, A., & Azam, S. F. (2018). Can parental involvement mitigate "swing away from science"? Sri Lankan perspectives. *Cogent Education*, *5*(1), 1467244.

DeWitt, J. & Archer, L. (2015). Who Aspires to a Science Career? A comparison of survey responses from primary and secondary school students, *International Journal of Science Education*, 37:13, 2170-2192, DOI: 10.1080/09500693.2015.1071899

Donmez, I., Idin, S., & Gurbuz, S. (2022). Determining lower-secondary students' STEM motivation: A profile from Türkiye, *Journal of Baltic Science Education*, 21, 38-51.

Dou, R., & Cian, H. (2021). Constructing STEM identity: An expanded structural model for STEM identity research. *Journal of Research in Science Teaching*, 14(2), 33. https://doi.org/10.1002/tea.21734

Durrani, N., CohenMiller, A., Kataeva, Z., Bekzhanova, Z., Seitkhadyrova, A., & Badanova, A. (2022). 'The fearful khan and the delightful beauties': The construction of gender in secondary school textbooks in Kazakhstan. *International Journal of Educational Development*, 88, 1–17. https://doi.org/10.1016/j.ijedudev.2021.102508

Education Council (2015). *National STEM School Education Strategy 2016-2026*. Education Council: Australia.

Education Council (2018). *Optimising STEM industry-school partnerships: Inspiring Australia's Next Generation*. Education Council: Australia.

ESDE (2023). *Employment and Social Development in Europe 2023*. DG – Employment, Social Affairs & Inclusion. https://op.europa.eu/webpub/empl/esde-2023/esde-review.html

European Commission, European Education and Culture Executive Agency, Baïdak, N., Horváth, A., Motiejūnaitė-Schulmeister, A. (2022). In: *Increasing achievement and motivation in mathematics and science learning in schools*, (A. Horváth, ed.), Publications Office of the European Union. https://data.europa.eu/doi/10.2797/031821

Elsayed, M.A.A., Clerkin, A., Pitsia, V., Aljabri, N. & Al-Kharbi, K. (2022). Boys' underachievement in mathematics and science: An analysis of national and international assessment data from the Kingdom of Saudi Arabia. *Large-scale Assessment in Education 10*, 23. https://doi.org/10.1186/s40536-022-00141-9

European Institute for Gender Equality (EIGE) (2019). *Tackling the gender pay gap: not without a better work-life balance.* doi: 10.2839/725703. Available: https://eige.europa.eu/publications-resources/publications/tackling-gender-pay-gap-not-without-better-work-life-balance?language_content_entity=en

European Schoolnet and Texas Instruments (2018). *STEM Education Policies in Europe – Scientix Observatory Report*. Scientix. Available: http://www.eun.org/resources/detail?publicationID=1481

Eurostat (2022). *Science and technology workforce: women in majority*. Available: https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20230602-1

Eurostat (2022). *Tertiary Education Statistics.* Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tertiary_education_statistics#Graduates

European Commission, Directorate-General for Research and Innovation (2022), *Bridging the gender gap in STEM – Strengthening opportunities for women in research and* *innovation*, Publications Office of the European Union. https://data.europa.eu/doi/10.2777/774922

European Commission (2015). *Does the EU need more STEM graduates?* Directorate-General for Education and Culture.

European Commission (2019). *Key competences for lifelong learning*, Publications Office Directorate-General for Education, Youth, Sport and Culture. https://data.europa.eu/doi/10.2766/569540

European Institute for Gender Equality (2017). *Gender equality index 2017: Measuring gender equality in the European Union 2005–2015*. Brussels: European Commission.

EU STEM Coalition (2020). *In-depth interview with Commissioner Mariya Gabriel on the participation of women in STEM and ICT*. Retrieved from https://www.stemcoalition.eu/publications/depth-interview-commissioner-mariya-gabriel-participation-women-stem-and-ict

EU STEM Coalition (2016). *STEM Skills for a Future-proof Europe*. EU STEM Coalition, The Netherlands. http://www.aede-france.org/ERASMUS-DAY-EU-STEM-Brochure.html

Evagorou, M. & Konstantinidou, E. (2023). *Policy Brief 1*. https://drive.google.com/file/d/1xQzT1w3LDhogAqBU6-3cqfLT7hZXBcdT/view?usp=share_link

Fondazione Deloitte (2022). *Observatorio STEM Rethink STE(AM) education. A sustainable future through scientific, tech and humanistic skills.* Fondazione Deloitte.

Forde, C. (2014). Is 'gender-sensitive education' a useful concept for educational policy? *Cultural Studies of Science Education* 9, 369–376. https://doi.org/10.1007/s11422-012-9432-0

Gee, J. (2000). Identity as an analytic lens for research in education. *Review of Research in Education*, 25, 99–125. https://doi.org/10.2307/1167322

Grigoleit-Richter, G. (2017). Highly skilled and highly mobile? Examining gendered and ethicised labour market conditions for migrant women in STEM-professions in Germany, *Journal of Ethnic and Migration Studies, 43* (16), 2738-2755, DOI: 10.1080/1369183X.2017.1314597

Godec, S., Archer, L. & Dawson, E. (2022). Interested but not being served: mapping young people's participation in informal STEM education through an equity lens. *Research Papers in Education*, *37* (2), 221-248.

Gonzalez, H. B., & Kuenzi, J. J. (2012, August). *Science, technology, engineering, and mathematics (STEM) education: A primer.* Washington, DC: Congressional Research Service, Library of Congress.

Hachey, A. (2020). Success for all: fostering early childhood STEM identity. *Journal of Research in Innovative Teaching & Learning, 13* (1), 135-139.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* Routledge.

Hazari, Z., Dou, R., Sonnert, G. & Sadler, P. (2022). Examining the relationship between informal science experiences and physics identity: Unrealized possibilities. *Physical Review Physics Education Research,* 18, 010107. https://doi.org/10.1103/PhysRevPhysEducRes.18.010107

Heeg, D., Smith, T. & Avraamidou, L. (2022). Children's Experiences and Self-Identification with Science in the Context of an out-of-school STEM Program. *EURASIA Journal of Mathematics, Science and Technology Education*, 18(4).

Herrera, Felisha A., Victoria C. Rodriguez-Operana, Gabriela Kovats Sánchez, Aileen Cerrillos, and Briana Marquez (2022). *"It Was Hard, and It Still Is...": Women of Color Navigating HSI STEM Transfer Pathways.* AERA Open 8.

Hughes, R., Schellinger, J., Billington, B., Britsch, B., & Santiago, A. (2020). A summary of effective gender equitable teaching practices in informal STEM education spaces. *Journal of STEM Outreach*, *3*(1), 1-9.

IBD (2019). *Pequeñas Aventureras (Little Adventurer Girls) – Education to close the language, science, and math gaps between girls and boys in early childhood.* https://desarrollo-infantil.iadb.org/en/innovations/lac_region/pequenas-aventureras-little-adventurer-girls-education-close-language accessed April 12th, 2023.

Ibourk, A., Hughes, R., & Mathis, C. (2022). "It is what it is": Using Storied-Identity and intersectionality lenses to understand the trajectory of a young Black woman's science and math identities. *Journal of Research in Science Teaching, 59*(7), 1099-1133.

Jansen, M., Schroeders, U. & Ludtke, O. (2014). Academic self-concept in science: Multidimensionality, relations to achievement measures and gender differences*. Learning and Individual Differences,* 20, 11-12.

Jæger, M. M., & Møllegaard, S. (2017). Cultural capital, teacher bias, and educational success: New evidence from monozygotic twins. *Social Science Research, 65*, 130-144.

Johnson, T. Burgoyne, A., Mix, K. Young, C. & Levine, S. (2022). Spatial and mathematics skills: Similarities and differences related to age, SES, and gender. *Cognition*, 218, 104918.

Kataeva, Z. (2022). Gender and the navigation of STEM careers in higher education institutions: Narratives of female faculty in post-Soviet Tajikistan, Compare: *A Journal of Comparative and International Education*, DOI: 10.1080/03057925.2022.2078954

Kim, A. Y., Sinatra, G. M., & Seyranian, V. (2018). Developing a STEM identity among young women: A social identity perspective. *Review of Educational Research*, 88(4), 589–625. https://doi.org/10.3102/0034654318779957

Law, H. & Sikora, J. (2020). Do single-sex schools help Australians major in STEMM at university?, *School Effectiveness and School Improvement*, 31 (4), 605-627, DOI: 10.1080/09243453.2020.1755319

Lock, R. M., Hazari, Z., & Potvin, G. (2019). Impact of out-of-class science and engineering activities on physics identity and career intentions. *Physical Review Physics Education Research*, *15*(2), 020137.

Lippman, Q., & Senic, C. (2018). Math, Girls and Socialism. *Journal of Comparative Economics* 46 (3), 874–888.

Lv, B., Wang, J., Zheng, Y., Peng, X. & Ping, X. (2022). Gender differences in high school students' STEM career expectations: An analysis based on multi-group structural equation model, *Journal of Research in Science Teaching*, 59 (10), 1739-1764.

Makarova, E., Aeschlimann B, & Herzog, W. (2019). The Gender Gap in STEM Fields: The Impact of the Gender Stereotype of Math and Science on Secondary Students' Career Aspirations. *Frontiers in Edu*cation 4 (60). doi: 10.3389/feduc.2019.00060

Manchencko, M., Parmaxi, A., Christou, E., Economides, A., Perifanou, M., Puente Hevia, D.M., Fernandez Valdes, J., Loucaidou, E., Chatzikyriakou, A., Katic, S. & Vidmar, S.C. (2022). *Gender-sensitive pedagogy for STEM disciplines.* Paper Presented at 14th International Conference on Education and New Learning Technologies, 4-6 July 2020, Palma, Spain. https://doi.org/10.21125/edulearn.2022.1424

McNally, (2020). *Gender Differences in Tertiary Education: What explains STEM Participation?* EENEE Analytical Report No. 41 Prepared for the European Commission. https://eenee.eu/wp-content/uploads/2021/05/EENEE_AR41-2.pdf

Master, A. (2021). Gender Stereotypes Influence Children's STEM Motivation. *Child Development Perspectives*, 15, 203-210. https://doi.org/10.1111/cdep.12424

Martín-Páez, T., Aguilera, D., Perales-Palacios, FJ., Vílchez-González, JM. (2019). What are we talking about when we talk about STEM education? A review of literature. *Science Education*, 103: 799– 822. https://doi.org/10.1002/sce.21522

McGarry, K. (2018). Making partnerships with STEAM. *Art Education, 71*(2), 28-34.

McMaster, N., Carey, M., Martin, D., & Martin, J. (2023). Raising Primary School Boys' and Girls' Awareness and Interest in STEM-Related Activities, Subjects, and Careers: An Exploratory Case Study. *Journal of New Approaches in Educational Research, 12*(1), 1-18. doi: http://dx.doi.org/10.7821/naer.2023.1.1135

Mitchell, A., Lott, K.H., & Tofel-Grehl, C. (2022). Cookie-Jar Alarms: An Analysis of First-Grade Students' Gendered Conceptions of Engineers following a Programming Design Task. *Education Sciences, 12*, 110. https://doi.org/10.3390/educsci12020110

National Art Education Association (NAEA). *Using art education to build a stronger workforce*. https://arteducators-prod.s3.amazonaws.com/documents/535/ff8bfae5-6b4f-4352-b900-4fc1182ad2b1.pdf?1455134278

National Research Council (NRC) (2013). *Next generation science standards: For states, by states.*

Normandeau, S. (2017). *The fork in the road towards gender equality*. OECD.

OECD (2019). Education at a Glance 2019: OECD Indicators.https://doi.org/10.1787/cf3c1241-en

OECD (2021). Education at a glance 2021: OECD indicators. https://doi.org/10.1787/b35a14e5-en

OECD (2021). Early Learning and Child Well-being: A Study of Five-year-Olds in England, Estonia, and the United States, OECD Publishing, accessed 3 April 2023, <https://www.oecd.org/education/school/early-learning-and-child-well-being-study/early-learning-and-child-well-being-3990407f-en.htm>.

OECD (2023), PISA 2022 Results (Volume I): The State of Learning and Equity in Education, PISA, OECD Publishing, Paris, https://doi.org/10.1787/53f23881-en.

Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking skills and creativity*, *31*, 31-43.

Pietri, E. S., Moss-Racusin, C. A., Dovidio, J. F., Guha, D., Roussos, G., Brescoll, V.L., & Handelsman, J. (2017). Using video to increase gender bias literacy toward women in science. *Psychology of Women Quarterly*, 41, 175–196. https://doi.org/10.1177/0361684316674721

Pitri, E., Evagorou, M. & Stylianou, A. (2024). *Reflections on the design of STEAM curricula for 12–14-year-old girls*.

Quigley, D. & Herro, D. (2019). *An educator's guide to STEAM: Engaging students using real world problems.* Teachers College Press.

Quigley, C.F., Herro, D. & Jamil, F.M. (2017). Developing a conceptual model of STEAM teaching practices. School Science and Mathematics, 117 (1-2), 1-12.

Raabe, I. J., Boda, Z., & Stadtfeld, C. (2019). The social pipeline: How friend influence and peer exposure widen the STEM gender gap. *Sociology of Education*, *92*(2), 105-123.

Robinson, K., Perez, T. White-Levatich, A. & Linnenbrink-Garcia, L. (2022). Gender differences and roles of two science self-efficacy beliefs in predicting post-college outcomes, *The Journal of Experimental Education*, 90(2), 344-363, DOI: 10.1080/00220973.2020.1808944

Roberts, K. (2014). *Engaging more women and girls in mathematics and STEM fields: The international evidence*. Report prepared for the Australian Mathematical Sciences Institute.

Sammet, K. & Kekelis, L. (2016). Changing the Game for Girls in STEM. Findings on High Impact Programs and System-Building Strategies. Chevron.

Sáinz, M., Fàbregues, S., Romano, M. J., & López, B. S. (2022). Interventions to increase young people's interest in STEM. A scoping review. *Frontiers in psychology*, *13*, 954996. https://doi.org/10.3389/fpsyg.2022.954996

Šimunović, M., & Babarović, T. (2020). The role of parents' beliefs in students' motivation, achievement, and choices in the STEM domain: a review and directions for future research. *Soc. Psychol. Educ.* 23, 701–719 (2020). https://doi.org/10.1007/s11218-020-09555-1

Shafer, L. (2018). *Preventing Gender Bias. In Usable Knowledge*. https://www.gse.harvard.edu/news/uk/18/11/preventing-gender-bias

Shapiro, M., Grossman, D. Carter, S., Martin, K., Deyton, P. & Hammer, D. (2015). Middle School Girls and the "Leaky Pipeline" to Leadership, *Middle School Journal, 46* (5), 3-13, DOI: 10.1080/00940771.2015.11461919

Sossamon, J. (2018). *In countries with higher gender equality, women are less likely to get STEM degrees*. World Economic Forum. Available from: https://www.weforum.org/agenda/2018/02/does-gender-equality-result-in-fewer-female-stem-grads

Spyropoulou, N. & Kameas, A. (2020). *Methodology for the development of a competence framework for STE(A)M educators*. Timisoara: European Distance and E-Learning Network.

Steegh, A.M., Höffler, T.N., Keller, M.M., & Parchmann, I. (2019). Gender differences in mathematics and science competitions: A systematic review. *Journal of Research in Science Teaching, 56*(10), 1431–1460. https://doi.org/10.1002/tea.21580

Steffens, M. C., & Jelenec, P. (2011). Separating implicit gender stereotypes regarding math and language. Implicit ability stereotypes are self-serving for boys and men, but not for girls and women. *Sex Roles, 64,* 324–335. doi:10.1007/s11199-010-9924-x.

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

Todd, B., Zvoch, K. (2019). Exploring Girls' Science Affinities Through an Informal Science Education Program. *Research in Science Education* 49, 1647–1676. https://doi.org/10.1007/s11165-017-9670-y

UNESCO (2017). *Training Tools for Curriculum Development: A Resource Pack for Gender-Responsive STEM Education*. IBE-UNESCO.

UNESCO (2017). *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM)*. Paris: United Nations Educational, Scientific and Cultural Organization.

UNESCO (2020). STEM Education for Girls and Women. Breaking Barriers and Exploring Gender Inequality in Asia. UNESCO Bangkok Office. Open Access: https://unesdoc.unesco.org/ark:/48223/pf0000375106

United Nations Children's Fund, ITU (2020). *Towards an equal future: Reimagining girls' education through STEM*. New York: UNICEF.

Urhahne, D., & Wijnia, L. (2021). A review on the accuracy of teacher judgments. *Educational Research Review*, 32(4), 100374. https://doi.org/10.1016/j.edurev.2020.100374

Van Aalderen-Smeets, S.I., Walma van der Molen, J.H., Xenidou-Dervou, I. (2019). Implicit STEM ability beliefs predict secondary school students' STEM self-efficacy beliefs and their intention to opt for a STEM field career, *Journal of Research in Science Teaching*, 56, 465–485. https://doi.org/10.1002/tea.21506

VanLeuvan, P. (2004). Young women's science/mathematics career goals from seventh grade to high school graduation. *The Journal of Educational Research, 97*(5), 248–268.

Wammes, D., Slof, B., Schot, W. *et al.* (2023). Teacher judgement accuracy of technical abilities in primary education. *Int. J. Technol. Des. Educ.* 33, 415–438, https://doi.org/10.1007/s10798-022-09734-5

Wajngurt, C., & Sloan, P.J. (2019). Overcoming Gender Bias in STEM: The Effect of Adding the Arts (STEAM). *InSight: A Journal of Scholarly Teaching*, *14*, 13-28.

Wright, G. W. & Delgado, C. (2023). Generating a framework for gender and sexual diversity-inclusive STEM education. *Science Education*, 1-28. DOI: 10.1002/sce.21786

Zollman, A. (2012). Learning for STEM literacy: STEM literacy for learning. *School Science and Mathematics*, 112 (1), 12-19.

Annex 1. Table of reviewed papers

Table 1. Papers reviewed for the report

Authors	Year	Journal	Title
Balta et al.	2023	Science Education	Middle- and Secondary-School Students' STEM Career Interest and Its Relationship to Gender, Grades, and Family Size in Kazakhstan
Scholes et al.	2022	International Journal of Inclusive Education	I am Good at Science but I Don't Want to Be a Scientist: Australian Primary School Student Stereotypes of Science and Scientists
Chan, R.	2022	International Journal of STEM Education	A Social-Cognitive Perspective on Gender Disparities in Self-Efficacy, Interest, and Aspirations in Science, Technology, Engineering, and Mathematics (STEM): The Influence of Cultural and Gender Norms
Susilawati & Nurfina	2022	European Journal of Educational Research	Attitudes towards Science: A Study of Gender Differences and Grade Level
Elsayed et al.	2022	Large Scale Assessments in Education	Boys' Underachievement in Mathematics and Science: An Analysis of National and International Assessment Data from the Kingdom of Saudi Arabia
Vooren et al.	2022	International Journal of STEM Education	Comparing Success of Female Students to Their Male Counterparts in the STEM Fields: An Empirical Analysis from Enrolment Until Graduation Using Longitudinal Register Data
Lyons et al.	2022	Mind, Brain and Education	Complicated Gender Gaps in Mathematics Achievement: Elevated Stakes during Performance as One Explanation
Mitchell et al.	2022	Education Sciences	Cookie-Jar Alarms: An Analysis of First-Grade Students' Gendered Conceptions of Engineers Following a Programming Design Task
Donnmez et al.	2022	Journal of Baltic Education	Determining Lower-Secondary Students' STEM Motivation: A Profile from Türkiye
Babarovic	2022	Journal of Career Development	Development of STEM Vocational Interests during Elementary and Middle School: A Cohort-Sequential Longitudinal Study
Villanueva et al.	2022	Research in Science Education	Drama-Based Activities for STEM Education: Encouraging Scientific Aspirations and Debunking Stereotypes in Secondary School Students in Spain and the UK
Simeon et al.	2022	International Journal of Technology and Design Education	Effect of Design Thinking Approach on Students' Achievement in Some Selected Physics Concepts in the Context of STEM Learning
Atasoy et al.	2022	Journal of Learning and Teaching in Digital Age	Effect of ICT Use, Parental Support and Student Hindering on Science Achievement: Evidence from PISA 2018
Sayilgan et al.	2022	International Journal of Contemporary Educational Research	Effect of STEM Designed Activities on Academic Achievement of 7th Grade Elementary School Students in Force and Energy Unit
De Loof et al.	2022	International Journal of Science and Mathematics Education	Engaging Students with Integrated STEM Education: A Happy Marriage or a Failed Engagement?
Siani et al.	2022	New Directions in the Teaching of Physical Science	Gender Balance and Impact of Role Models in Secondary Science Education
McLure et al.	2022	Learning Environments Research	Gender Differences among Students Undertaking iSTEM Projects in Multidisciplinary vs Unidisciplinary STEM Classrooms in Government vs Nongovernment Schools: Classroom Emotional Climate and Attitudes

Robinson et al.	2022	The Journal of Experimental Education	Gender Differences and Roles of Two Science Self-Efficacy Beliefs in Predicting Post-College Outcomes
Lv et al.	2022	Journal of Research in Science Teaching	Gender Differences in High School Students' STEM Career Expectations: An Analysis Based on Multi-Group Structural Equation Model
Cascella et al.	2022	European Educational Research Journal	Gender Differences in Mathematics Outcomes at Different Levels of Locality to Inform Policy and Practice
Anaya et al.	2022	Education Economics	Gender Gaps in Math Performance, Perceived Mathematical Ability and College STEM Education: The Role of Parental Occupation
McCoy et al.	2022	Oxford Review of Education	Gender Stereotyping in Mothers' and Teachers' Perceptions of Boys' and Girls' Mathematics Performance in Ireland
Kirkham & Chapman	2022	Journal of Career Development	Gender, Achievement Level and Sociocultural Factors in the Mathematics Course Choices of Year 10 Students in Western Australia
Xu et al.	2022	Journal of Career Development	Impact of STEM Sense of Belonging on Career Interest: The Role of STEM Attitudes
De Gioannis	2022	Social Psychology of Education	Implicit Gender-Science Stereotypes and College-Major Intentions of Italian Adolescents
Stephenson et al.	2022	Research in Science Education	Increasing Girls' STEM Engagement in Early Childhood: Conditions Created by the Conceptual PlayWorld Model
Iwuanyanwu	2022	School Science and Mathematics	Is Science Really for Me? Gender Differences in Student Attitudes toward Science
Cwik et al.	2022	Physical Review Physics Education	Longitudinal Analysis of Women and Men's Motivational Beliefs in a Two-Semester Introductory Physics Course Sequence for Students on the Bioscience Track
Woithe et al.	2022	Journal of Research in Science Teaching	Motivational Outcomes of the Science Outreach Lab S'Cool LAB at CERN: A Multilevel Analysis
Hall et al.	2022	School Science and Mathematics	Much to Do about Identity: Successful Women in Science Reflect on Their School Years
Johnson et al.	2022	Cognition	Spatial and Mathematics Skills: Similarities and Differences Related to Age, SES, and Gender
Punzalan	2022	International Journal of Research in Education and Science	STEM Interests and Future Career Perspectives of Junior High School Students: A Gender Study
McLure et al.	2022	Social Psychology of Education	Structural Relationships between Classroom Emotional Climate, Teacher-Student Interpersonal Relationships and Students' Attitudes to STEM
Anwar et al.	2022	Journal of Research in Science Teaching	The Effectiveness of an Integrated STEM Curriculum Unit on Middle School Students' Life Science Learning
Zhao et al.	2022	Australian Educational Research	The Interactive Effects of Gender and Implicit Theories of Abilities on Mathematics and Science Achievements
Matete	2022	Forum for International Research in Education	Why Are Women Under-Represented in STEM in Higher Education in Tanzania?
Ottemo et al.	2021	Gender and Education	(Dis)Embodied Masculinity and the Meaning of (Non)Style in Physics and Computer Engineering Education
Kirkham & Chapman	2021	The International Journal of Art and Design Education	Females Don't Need to Be Reluctant: Employing Design Thinking to Harness Creative Confidence and Interest in STEAM
Martin et al.	2021	Science Education	If We Don't Have Diversity, There's No Future to See: High-School Student; Perceptions of Race and Gender Representation in STEM
Becker et al.	2021	Journal of Chemical Education	College Chemistry Textbooks Fail on Gender Representation

Eam et al.	2021	Research in Science and Technological Education	Correlates of STEM Major Choice: A Quantitative Look at Cambodian University Freshmen
Cwik et al.	2021	Physical Review Physics Education	Damage Caused by Societal Stereotypes: Women Have Lower Physics Self-Efficacy Controlling for Grade Even in Courses in Which They Outnumber Men
Leyva et al.	2021	Cognition and Instruction	Detailing Racialized and Gendered Mechanisms of Undergraduate Precalculus and Calculus Classroom Instruction
Jansen et al.	2021	Journal of Educational Psychology	Dimensional Comparison Effects on (Gendered) Educational Choices
Hermann et al.	2021	Research Papers in Education	Educational Policies and the Gender Gap in Test Scores: A Cross-Country Analysis
Li et al.	2021	Physical Review Physics Education	Effect of Gender, Self-Efficacy, and Interest on Perception of the Learning Environment and Outcomes in Calculus-Based Introductory Physics Courses
Perdana et al.	2021	International Journal of Evaluation and Research in Education	Elementary Students' Attitudes towards STEM and 21st-Century Skills
Riegle-Crumb et al.	2021	Sociology of Education	Examining High School Students' Gendered Beliefs about Math: Predictors and Implications for Choice of STEM College Majors
Cohen et al.	2021	Science Education	Examining the Effect of Early STEM Experiences as a Form of STEM Capital and Identity Capital on STEM Identity: A Gender Study
Wan	2021	Research in Science Education	Exploring the Effects of Intrinsic Motive, Utilitarian Motive, and Self-Efficacy on Students' Science Learning in the Classroom Using the Expectancy-Value Theory
Cairns et al.	2021	The Asia Pacific Education Researcher	Exploring the Relations of Gender, Science Dispositions and Science Achievement on STEM Career Aspirations for Adolescents in Public Schools in the UAE
Mitsopoulou & Pavlatou	2021	Education Sciences	Factors Associated with the Development of Secondary School Students' Interest towards STEM Studies
Steegh et al.	2021	Journal of Research in Science Teaching	First Steps toward Gender Equity in the Chemistry Olympiad: Understanding the Role of Implicit Gender-Science Stereotypes
Riney & Ku	2021	Journal of Educational Research and Innovation	Gender Differences in Socio-Emotional and Socio-Cultural Perspectives of Middle School Students in STEM Learning
Romero-Abrio et al.	2021	European Early Childhood Education Research Journal	Gender Equality in Five- to Six-Year-Old Preschoolers' Early Competences in Science Do Not Protect Schoolgirls from Gender Stereotypes
Ayuso et al.	2021	Transactions on Education	Gender Gap in STEM: A Cross-Sectional Study of Primary School Students' Self-Perception and Test Anxiety in Mathematics
Beckmann	2021	British Journal of Sociology of Education	Gendered Career Expectations in Context: The Relevance of Normative and Comparative Reference Groups
Starr & Simpkins	2021	Social Psychology of Education	High School Students' Math and Science Gender Stereotypes: Relations with Their STEM Outcomes and Socializers' Stereotypes
Stevenson et al.	2021	International Journal of Science Education	How Outdoor Science Education Can Help Girls Stay Engaged with Science
Hall et al.	2021	Science Education	Identifying the Psychological Processes Used by Male and Female Students When Learning about Science Technology Engineering and Mathematics: A Linguistic Inquiry

Jiang et al.	2021	Journal of Baltic Education	Impact of Instruction on Science Performance: Learning Initiative as a Mediator and Gender as a Limited Moderator
Demir et al.	2021	Journal of Science Learning	Investigation of Middle School Students' Attitudes towards Science, Technology, Engineering and Mathematics (STEM) Education and Determination of the Predictors
Ndeke & Barmao	2021	Education Quarterly Review	Learner's Perceptions of the Influence of Teachers' Nonverbal Communication on Their Aspirations to Pursue STEM Courses
Heeg & Avraamidou	2021	Eurasia Journal of Mathematics, Science and Technology Education	Life-Experiences of Female Students in Physics: The Outsiders Within
Robinson et al.	2021	Physical Review Physics Education	Positive Attitudinal Shifts and a Narrowing Gender Gap: Do Expertlike Attitudes Correlate to Higher Learning Gains for Women in the Physics Classroom?
Fleer	2021	Early Childhood Education	Re-Imagining Play Spaces in Early Childhood Education: Supporting Girls' Motive Orientation to STEM in Times of COVID-19
Kang et al.	2021	Research in Science Education	Role of Interest and Self-Concept in Predicting Science Aspirations: Gender Study
Schiefer et al.	2021	Journal of Educational Psychology	Scaling up an Extracurricular Science Intervention for Elementary School Students: It Works, and Girls Benefit More from It than Boys
Miles & Naumann	2021	International Journal of Science Education	Science Self-Efficacy in the Relationship between Gender & Science Identity
Karalar et al.	2021	International Electronic Journal of Elementary Education	STEM in Transition from Primary School to Middle School: Primary School Students' Attitudes
Ortega et al.	2021	Journal for the Study of Education and Development	The Inclusion of Girls in Chilean Mathematics Classrooms: Gender Bias in Teacher-Student Interaction Networks
Cui et al.	2021	Early Education and Development	The Influence of Parental Educational Involvement in Early Childhood on 4th Grade Students' Mathematics Achievement
Ferretti & Giberti	2021	International Journal of Science and Mathematics Education	The Properties of Powers: Didactic Contract and Gender Gap
Atabey & Topcu	2021	Journal of Education in Science Environment and Health	The Relationship between Turkish Middle School Students' 21st Century Skills and STEM Career Interest: Gender Effect
Stmunovic & Babarovic	2021	Research in Science Education	The Role of Parental Socialising Behaviours in Two Domains of Student STEM Career Interest
Nalipay et al.	2021	School Psychology International	The Social Contagion of Utility Value: How Parents' Beliefs about the Usefulness of Science Predict Their Children's Motivation and Achievement
Hatisaru	2021	European Journal of STEM Education	Theory-Driven Determinants of School Students' STEM Career Goals: A Preliminary Investigation
Fisher et al.	2020	International Journal of Science Education	The Experience of Undergraduate Students in Science Disciplines with Higher Female Representation
Gilligan et al.	2020	European Early Childhood Education Research Journal	We Practise Everyday: Parents' Attitudes Towards Early Science Learning and Education among a Sample of Urban Families in Ireland
Avraamidou	2020	Journal of Research in Science Teaching	I Am a Young Immigrant Woman Doing Physics and on Top of That I Am Muslim: Identities, Intersections, and Negotiations
Wieselmann et al.	2020	Journal of Research in Science Teaching	I Just Do What the Boys Tell Me: Exploring Small Group Student Interactions in an Integrated STEM Unit

Robnett & John	2020	Child Development	Wrong to Exclude Girls from Something They Love. Adolescents Attitudes about Sexism in Science, Technology, Engineering, and Math
Swafford & Anderson	2020	Journal of Research in Technical Careers	Addressing the Gender Gap: Women's Perceived Barriers to Pursuing STEM Careers
Law & Sikora	2020	School Effectiveness and School Improvement	Do Single-Sex Schools Help Australians Major in STEMM at University?
Farrell et al.	2020	Social Psychology of Education	Examining the Effectiveness of Brief Interventions to Strengthen a Positive Implicit Relation between Women and STEM across Two Timepoints
Akhigbe & Adeyemi	2020	Journal of Pedagogical Research	Using Gender Responsive Collaborative Learning Strategy to Improve Students' Achievement and Attitude towards Learning Science in Virtual and Hands-On Laboratory Environment
Todd & Zvoch	2019	Research in Science Education	Exploring Girls Science Affinities through an Informal Science Education Program
Bakker et al.	2019	Developmental Science	Gender Equality in 4- to 5-Year-Old Preschoolers' Early Numerical Competencies
Ergon	2019	Journal of Baltic Science Education	Identification of the Interest of Turkish Middle-School Students in STEM Careers: Gender and Grade Level Differences
Lock et al.	2019	Physical Review Physics Education	Impact of Out-of-Class Science and Engineering Activities on Physics Identity and Career Intentions
Wajngurt & Sloan	2019	Journal of Scholarly Teaching	Overcoming Gender Bias in STEM: The Effect of Adding the Arts (STEAM)
LaForce et al.	2019	European Journal of STEM Education	Revisiting Race and Gender Differences in STEM: Can Inclusive STEM High Schools Reduce Gaps?
Jungert et al.	2019	European Journal of Psychology of Education	Systemizing and the Gender Gap: Examining Academic Achievement and Perseverance in STEM
Raabe et al.	2019	Sociology of Education	The Social Pipeline: How Friend Influence and Peer Exposure Widen the STEM Gender Gap
Miller-Friedmann et al.	2018	Chemistry Education Research and Practice	Approaching Gender Equity in Academic Chemistry: Lessons Learned from Successful Female Chemists in the UK
De Silva et al.	2018	Cogent Education	Can Parental Involvement Mitigate & Swing Away from Science Sri Lankan Perspectives
Archer	2018	Primary Science	Engaging Children with Science: A Science Capital Approach
van der Vleuten et al.	2018	Educational Research and Evaluation	Gender Norms and STEM: The Importance of Friends for Stopping Leakage from the STEM Pipeline
Sheffield et al.	2018	Journal of Higher Education Outreach and Engagement	Lessons Learned from the STEM Entrepreneurship Academy
Miller et al.	2018	Child Development	The Development of Childrens Gender-Science Stereotypes: A Meta-Analysis of 5 Decades of U.S. Draw-A-Scientist Studies
Blaaev et al.	2017	Social Psychology of Education	Predicting Gender-STEM Stereotyped Beliefs among Boys and Girls from Prior School Achievement and Interest in STEM School Subjects
Moss-Racusin et al.	2016	Life Sciences Education	A Scientific Diversity Intervention to Reduce Gender Bias in a Sample of Life Scientists
Osagie & Alutu	2016	International Education Studies	Factors Affecting Gender Equity in the Choice of Science and Technology Careers among Secondary School Students in Edo State, Nigeria
Levine et al.	2015	Journal of Chemical Education	Addressing the STEM Gender Gap by Designing and Implementing an Educational Outreach Chemistry Camp for Middle School Girls
DeWitt & Archer	2015	International Journal of Science Education	Who Aspires to a Science Career? A Comparison of Survey Responses from Primary and Secondary School Students

Moser & Hannover	2014	European Journal of Psychology of Education	How Gender Fair Are German Schoolbooks in the Twenty-First Century? An Analysis of Language and Illustrations in Schoolbooks for Mathematics and German
Grossman & Michelle	2014	Journal of Cases in Educational Leadership	Perceived Gender and Racial/Ethnic Barriers to STEM Success

Annex 2. List of projects analysed

Table 2. List of the EU-funded projects focusing on the gender gap in STEM

	Title	Funding	Coordinator	Country	Partners	Target group	Start year	End year
1	STING – STEM Teacher Training Innovation for Gender Balance https://stingeuproject.wordpress.com	Erasmus+	Elhuyar Fundazio	Spain	European University Cyprus (CY), Center for formidling af naturvidenskab og moderne teknologi fond (DK), Ustanova HISA Experimentov (SI), Hacettepe University (TR), Nemo Science Museum (NL), Norwegian University of Science and Technology (NO), St Mary's University College (UK).	teachers, trainee teachers	2014	2017
2	MISSTOHIT: From Misconceptions to Learning Insights through Inquiry with Playful Physical Objects http://misstohit.deusto.es/	Erasmus+	University of Deusto http://www.deusto.es/	Spain	Consiglio Nazionale Delle Ricerche (IT), Fundacion Bancaria Caixa D'estalvisi Pensions De Barcelona La Caixa (ES), Investic Tecnologías de la Colaboración SL (ES), Liceo Scientifico "Sensale (IT), Stichting Nationaal Centrum Voor Wetenschap En Technologie (NL).	secondary school students, teachers	2015	2017
3	HYPATIA https://www.ecsite.eu/activities-and-services/projects/hypatia	Horizon 2020	NEMO Science Museum	Netherlands	NEMO Science Museum (NL), Bloomfield Science Museum (IL), BureauQ (NL), Ecsite (BE), Experimentarium (DK), Fondation L'Oréal (FR) Museum of Science and Technology Leonardo Vinci (IT), PPG, University of Copenhagen (DK), Universcience (FR).	education authorities, industry, primary and secondary school students, teachers, trainee teachers	2015	2018

4	F.I.N.D: Future Inventors, New Discoveries https://erasmus-plus.ec.europa.eu/nl/projects/search/details/2016-1-UK01-KA219-024282	Erasmus+	Howes Primary School	United Kingdom	Gozo College Secondary School (MT), 49 Dimotiko Scholeio Patras (EL), Bagheria IV – Aspra (IT), Zespól Szkól nr 10 (PL), Lunde 10-årige skole (NO).	primary and secondary school student	2016	2019
5	GIGS: Girls into Global STEM http://www.gigsproject.eu	Erasmus+	University of Hull	United Kingdom	Practical Action (UK), Centre for Citizenship Education (PL), CARDET (CY), University of Boras (SE), de Ferrers Academy (UK), Gimnazjum im K. Baczynskiego (PL), The Grammar School, Nicosia (CY), Sandgardskolan (SE).	education authorities, policy makers, secondary school students, teachers, trainee teachers, other	2016	2019
6	GENDER4STEM – Gender-Aware Education and Teaching http://www.gender4stem-project.eu/	Erasmus+	LIST Luxembourg Institute of Technology, Luxembourg https://www.list.lu/	Luxembourg	Consulio (HR), Fundatia Professional (RO), Smart Venice (IT), VHTO (NL), Wide, Women in Digital Empowerment (LU).	education authorities, general public, policy makers, researchers, teachers, trainee teachers	2017	2020
7	FESTEM – Female Empowerment in Science, Technology, Engineering and Mathematics in Higher Education https://festemproject.eu/	Erasmus+	Cyprus University of Technology https://www.cut.ac.cy/	Cyprus	ARIS: A Really Inspiring Space (CY), CESIE (IT), Izobrazevalni center Geoss d.o.o (SI), Magenta Consultoria Projects SL (ES), University of Macedonia (EL).	education authorities, general public, industry, policy makers, teachers, university students	2019	2022

8	GE-STEAM – Gender Equality in Science, Technology, Engineering, Art and Mathematics https://erasmus-plus.ec.europa.eu/nl/projects/search/details/2020-1-RO01-KA201-080189	Erasmus+	Casa Corpului Didactic Mures	Spain	Fundatia Professional (RO), Future in Perspective Limited (IE), First Private School Leonardo da Vinci (BG), Academia Postal 3 (ES).	primary school students, teachers, trainee teachers	2020	2022
9	GEM – Empower Girls to Embrace Their Digital and Entrepreneurial Potential https://digital-strategy.ec.europa.eu/en/news/pilot-project-gem-empower-girls-embrace-their-digital-and-entrepreneurial-potential	EU Pilot Project and Preparation Action Grant	International Centre for STEM Education (ICSE), University of Education Freiburg http://icse.eu/	Germany	University of Nicosia (CY), Charles University (CZ), University of Jaen (ES), National and Kapodistrian University of Athens (EL), Vilnius University (LT), University of Malta (MT), Utrecht University (NL), Jönköping University (SE), Constantine the Philosopher University (SK).	education authorities, general public, industry, parents, policy makers, teachers, university students, university lecturers	2020	2022
10	AR4STEM – Augmented Reality for STEM Education https://erasmus-plus.ec.europa.eu/nl/projects/search/details/2020-1-LV01-KA226-SCH-094530	Erasmus+	Social Innovation Centre of Latvia https://socialinnovation.lv/en/	Latvia	GoINNO Inštitut (SI), Liepajas Raina 6. vidusskola (LV), Vilnius Joachim Lelevel Engineering Gymnasium (LT).	education authorities, general public, primary and secondary school students, teachers, trainee teachers, youth clubs	2021	2023

11	FemSTEM Coaching – Recruitment, Retention and Progression Coaching for Women in STEM https://erasmus-plus.ec.europa.eu/projects/search/details/2019-1-UK01-KA202-061528	Erasmus+	INOVA Consultancy Ltd.	United Kingdom	Centro Superior De Formacion Europa Sur (ES), CESIE (IT), Panepistimio Thessalias (EL),Women in Digital Initiatives Luxemburg ASBL (LU).	women and minority groups	2019	2022
12	Girls in STEM Career https://erasmus-plus.ec.europa.eu/projects/search/details/2022-2-IT02-KA210-SCH-000101114	Erasmus+	Liceo "Colombo" Marigliano, Napoli	Italy	Narva Pähklimäe Kool (EE), Yenisehir Ilçe MEM (TR).	young girls	2023	2024
13	Women Stem Up https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-SE01-KA220-HED-000086239 https://women-stem-up.eu/	Erasmus+	Linkoping University	Sweden	Digital Leadership Institute (BE), Norges Teknisk-Naturvitenskapelige Universitet Ntnu (NO), Panepistimio Thessalias (EL), Stimmuli For Social Change (EL).	primary and secondary school students, teachers, school leaders	2022	2025
14	FEMALES: Female Legends of Science https://erasmus-plus.ec.europa.eu/projects	Erasmus+	Bahçeşehir University Foundation	Türkiye	Asociacion De Investigacion De La Industria Del Juguete Conexas Y Afines (ES), Casa Corpului Didactic Teleorman-Ro Challedu (EL),	young girls and boys (age 13-18),	2019	2022

	/search/details/2019-1-TR01-KA201-074648 https://femalesproject.eu				Euphoria Net Srl (IT), Sukran Ulgezen Mesleki Ve Teknik Anadolu Lisesi (TR).	teachers in secondary education		
15	FemSTEAM: Mysteries: A Role-Model Game-Based Approach to Gender Equality in STEAM https://erasmus-plus.ec.europa.eu/projects/search/details/2020-1-CY01-KA201-066058	Erasmus+	European University Cyprus	Cyprus	Chelledu (EL), Douka ekpaideftiria AE – Palladion Lykeion Ekfpaideuthria Douka (EL), La Salle-Buen Consejo (ES), Technische Hochschule Koln (DE), The American Academy Nicosia Ltd. (CY).	young girls, boys (age 12-15), teachers	2020	2022
16	GE-STEAM: Gender Equality in Science, Technology, Engineering, Art and Mathematics https://erasmus-plus.ec.europa.eu/projects/search/details/2020-1-RO01-KA201-080189	Erasmus+	Casa Corpului Didactic Mures	Romania	Academia Postal 3 Vigo S.L. (ES), First Private School Leonardo da Vinci Ltd. (BG), Fundatia Professional (RO), Future in Perspective Limited (IE).	pre-school, primary and lower secondary education (students and teachers)	2020	2022
17	IN2STE(A)M: Inspiring Next Generation of Girls through Inclusive STE(A)M Learning in Primary Education https://erasmus-plus.ec.europa.eu/projects/search/details/2019-1-IT02-KA201-063173 http://in2steam.eu	Erasmus+	CESIE	Italy	Asist Ogretim Kurumlari A.S (TR), Astiki Mi Kerdoskopiki Etaireia Four Elements (EL), Centre for Advancement of Research and Development in Educational Technology Ltd. – Cardet (CY), Danmar Computers Sp. zo.o. (PL), Inova+ - Innovation Services, Sa (PT).	primary school teachers	2019	2022

18	PhysicsKIT4STEM https://erasmus-plus.ec.europa.eu/projects/search/details/2020-1-FR01-KA201-080433	Erasmus+	EPMI	France	A & A Emphasys Interactive Solutions Ltd. (CY), Asserted Knowledge Eterrorythmos Etaireia (EL), Atermon B.V. (NL), Pistes Solidaires (FR), Projeto Schole LDA (PT).	teachers of physics in primary and secondary education, students of 10-15 years of age, with special focus on female students	2020	2022
19	STEM#4TeenGirls Isn't She STEM? Break the Stereotype! Empowering Program in STEM for Teen Girls https://erasmus-plus.ec.europa.eu/projects/search/details/2019-1-IT02-KA229-063329	Erasmus+	C.E.F.A.- Associazione di Famiglie per l'Educazione e la Cultura	Italy	Promoción y Cultura SA (ES), Zakladni skola a materska skola Parentes Praha (CZ).	girls 11-16 years old	2019	2021
20	Improving Educators' Skills in Inclusive STEM Lessons Creation https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-BG01-KA220-SCH-000088580	Erasmus+	139 OU Zaharii Krusha	Bulgaria	Carlos V Sociedad Cooperativa De Enseñanza (ES), Cesie Ente Del Terzo Settore (IT), Instalofi Levante SL (ES), IS "Duca Abruzzi - Libero Grassi" (IT), S.C. Predict CSD Consulting S.R.L. (RO).	educators	2022	2024

21	E-STEAM on the Cloud https://erasmus-plus.ec.europa.eu/projects/search/details/2021-1-ES01-KA220-SCH-000032742	Erasmus+	Universidad Jaume I de Castellon	Spain	European School of Brussels IV (Laeken) (BE), Fundatia Professional (RO), Liceul Vocational de Arta (RO), Orizzonti Società Cooperativa Sociale (IT), VSI Inovaciju Biuras (LT).	secondary and upper-secondary education teachers, policy makers, students	2021	2023
22	She Chooses STEM for the Future https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-IT02-KA220-SCH-000086855	Erasmus+	Comune Di Narni	Italy	IIS Gandhi Narni (IT), Epralima - Escola Profissional do Alto Lima – Cooperativa de Interesse Público e Responsabilidade, Limitada (PT), Fundacion Universitaria San Antonio (ES), Gimnaziya s prepodavane na chuzhdi ezitsi "Simeon Radev" (BG), Association "Bulgaria Training" (BG), IES La Zafra (ES), Universitatea Nationala de Stiinta si Tehnologie Politehnica Bucuresti (RO).	high school level, involving teachers and trainers, students and families	2022	2024
23	Creating Conditions for the Application of STEM in General Education https://erasmus-plus.ec.europa.eu/projects/search/details/2023-1-RS01-KA122-SCH-000147957	Erasmus+	Srednja skola "Svilajnac"	Serbia	No partners	teachers and school coordinators, students	2023	2024

24	Promoting Interest in STEAM Subjects to Reduce the Gender Gap https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-IE01-KA220-SCH-000085941	Erasmus+	Gaelscoil na gCeithre Maol	Ireland	100.YIL Anadolu Lisesi (TR), Kossuth Lajos Gimnázium és Általános Iskola (HU), Menteşe Anadolu Lisesi (TR), Osnovna škola Bol (HR), Szkola Podstawowa nr 7 w Ostrowie Wielkopolskim (PL).	students, teachers	2022	2024
25	Empowering and Inspiring Higher Education Students in the STEAM Field https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-DE01-KA220-HED-000087805	Erasmus+	Fachhoch-schule des Mittelstandes (FHM) GmbH – University of applied science	Germany	EDEX – Educational Excellence Corporation Limited (CY), University College Dublin (IE), National University of Ireland, Dublin (IE), Centre for Advancement of Research and Development in Educational Technology Ltd. – CARDET (CY), Gospodarska Zbiornica Slovenije (SI), E.N.T.E.R. GMBH (AT).	higher education educators, industry leaders, students	2022	2024
26	Girls Go STEM https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-HR01-KA220-HED-000085120	Erasmus+	Sveuciliste u Zagrebu	Croatia	Sveuciliste u Rijeci (HR), Hacettepe Üniversitesi (TR), South East European University Tetovo (MK), Sojuz na istrazhuvachi na Makedonija – SIM Skopje (MK).	students	2022	2024
27	S-TEAM: Schools Team-up Using Hackathon for Girls' Inclusive STEM https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-	Erasmus+	Assoform Romagna Scarl	Italy	Osnovna skola Ivana Cankara (HR), Women Space Extremadura (ES).	students, teachers, schools	2022	2023

	IT02-KA210-SCH-000083848							
28	Scientific Investigations for Boys and Girls to Minimise the Differences https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-ES01-KA122-SCH-000069479	Erasmus+	IES San Telmo	Spain	No partners	students, secondary school	2022	2024
29	Empowering Girls in STEM https://erasmus-plus.ec.europa.eu/projects/search/details/2021-2-CY01-KA210-SCH-000049078	Erasmus+	Ministry of Education, Sport and Youth	Cyprus	EDEX - Educational Excellence Corporation Limited (CY), Univerzita Konstantina Filozofa V Nitre (SK).	10–14-year-old students and teachers	2022	2024
30	Promoting Gender-balanced STEM Education through DIY Kits for Teaching Physics in the Classroom https://erasmus-plus.ec.europa.eu/projects/search/details/2020-1-FR01-KA201-080433	Erasmus+	EPMI	France	Atermon B.V. (NL), Pistes-Solidaires (FR), Projeto Scholé (PT), Asserted Knowledge Eterrrythmos Etaireia (EL), A & A Emphasys Interactive Solutions Ltd. (CY).	teachers, physics and STEM educators and all organisations working in the different areas impacted by the project	2020	2022

31	Gender Equality in Science, Technology, Engineering, Art and Mathematics https://erasmus-plus.ec.europa.eu/projects/search/details/2020-1-RO01-KA201-080189	Erasmus+	Casa Corpului Didactic Mures	Romania	Academia Postal 3 Vigo S.L. (ES), Fundatia Professional (RO), Future in Perspective Limited (IE), First Private School Leonardo da Vinci Ltd. (BG).	teachers, policymakers, education professionals and decision makers, students from pre-school, primary and lower secondary	2020	2022
32	Engendering STEM https://erasmus-plus.ec.europa.eu/projects/search/details/2017-1-UK01-KA203-036834\	Erasmus+	City of Glasgow College	United Kingdom	Instituto Especofico de Formacion Professional Superior Miguel Altuna (ES), Stichting VHTO (NL), Edinburgh Napier University (UK).	employers and educators	2017	2019
33	Empowering Girls in STEAM through Robotics and Coding (RoboGirls) https://erasmus-plus.ec.europa.eu/projects/search/details/2020-1-HR01-KA201-077760	Erasmus+	Sveučilište u Zagrebu	Croatia	Regional Directorate of Primary and Secondary Education of Attica (EL), Centre for Advancement of Research and Development in Educational Technology Ltd. – CARDET (CY), Universidad Autónoma de Madrid (ES), The Rural Hub CLG (IE), Innovade LI Ltd. (CY).	teachers, primary and secondary school students, school leaders, school staff, academics, women in the ICT and digital technologies, education policy decision makers and other stakeholders	2020	2022

34	Improving Educators' Skills in Inclusive STEM Lessons Creation https://erasmus-plus.ec.europa.eu/projects/search/details/2022-1-BG01-KA220-SCH-000088580	Erasmus+	139 OU Zaharii Krusha, Sofia	Bulgaria	Sdrudzenie Znam I Moga (BG), CESIE (IT), IS "Duca Abruzzi - Libero Grassi" (IT), Instalofi Levante SL (ES), S.C. Predict CSD Consulting S.R.L. (RO), Carlos V S.coop. De Enseñanza (ES).	teachers and trainers	2022	2024
35	STEM for Girls and the Local Development https://erasmus-plus.ec.europa.eu/projects/search/details/2022-3-ES02-KA154-YOU-000097045	Erasmus+	Fundación Delegación Fundación Finnova	Spain	Ayuntamiento de Benaguasil (ES), Ajuntament d'Albal (ES), Ayuntamiento de Puçol (ES).	students, municipalities	2023	2024
36	Fostering Women to STEM MOOCs https://erasmus-plus.ec.europa.eu/projects/search/details/2019-1-ES01-KA203-065924	Erasmus+	Universitat Politecnica de Valencia	Spain	Conservatoire national des arts et métiers (FR), Universidade de Lisboa (PT), Politecnico di Milano (IT), Colégio do Amor de Deus (PT), I.I.S. Benedetto Castelli (IT), Kungliga Tekniska högskolan (SE).	students, teachers	2019	2022
37	FEMALES https://erasmus-plus.ec.europa.eu/projects/search/details/2019-1-TR01-KA201-074648	Erasmus+	Bahçeşehir University Foundation	Türkiye	Asociación de Investigación de la Industria del Juguete, Conexas y Afines (ES), Euphoria Net Srl (IT), Casa Corpului Didactic Teleorman (RO), Sukran Ulgezen Mesleki ve Teknik Anadolu Lisesi (TR), Challedu (EL).	students and teachers	2019	2022

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