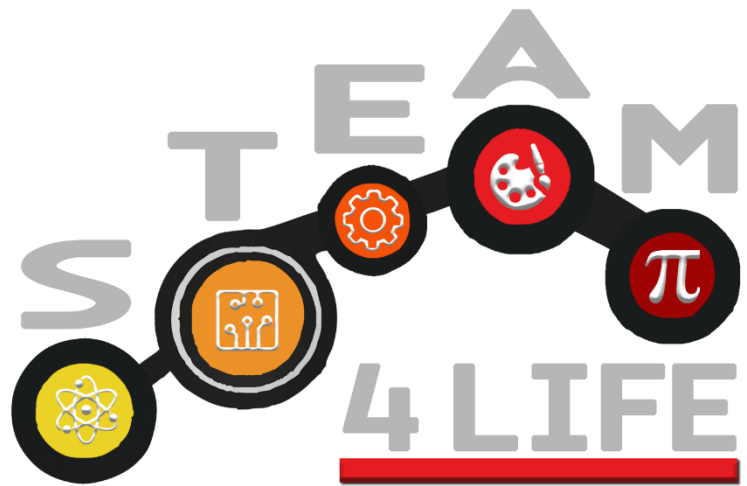


Empowering and Inspiring Higher Education students in the STEAM field

STEAM4LIFE Guide



Co-funded by
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July 2023



AUHTOR



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The creation of these resources has been (partially) funded by the ERASMUS+ grant program of the European Union under grant no. 2022-1-DE01-KA220-HED-000087805. Neither the European Commission nor the project's national funding agency DAAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.

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INTRODUCTION

The under-representation of women in STEAM has emerged as a significant focal point of concern in the European Union during the past decade. Despite the implementation of numerous initiatives aimed at addressing this matter, the problem persists, largely because of its complex and multifaceted nature, encompassing various stages of women's life cycles. A compelling body of evidence highlighting the limited engagement of women in STEAM disciplines can be discerned from university enrolment and graduation statistics, as well as from data pertaining to women's careers in STEM fields (STEM Women, 2021; 2022).

Women have a vital role to play in science, technology, engineering, arts, and mathematics (STEAM) fields and in the digital economy. However, they face many barriers and challenges in accessing, participating, and advancing in these fields (UNESCO, 2017). To address this gap and promote gender equality and empowerment, it is essential to encourage and support women in engaging in activities that involve the use of digital technologies in future occupations. One effective way to do this is through a mentoring programme that connects women with role models, mentors, and peers who can inspire, guide and empower them to pursue their interests and aspirations in STEAM and digital technologies.

This guide provides a collection of guidelines and best practices on how to design, implement, and evaluate such a mentoring programme. It also offers tips and resources for mentors and mentees to make the most of their mentoring relationships and achieve their goals. The guide is divided into three sections. The first section provides an overview of the current state of women in STEAM on European level, highlighting the achievements, challenges, strategies employed, and opportunities for women in these fields. The second section outlines the practical guidelines for educators, institute leaders, and other relevant stakeholders to gain the necessary knowledge to successfully engage women in STEAM activities and in digital technologies. It also introduces the STEAM4LIFE mentoring process and guidelines on how to mentor women efficiently to transfer their knowledge and engage in STEAM careers. The third section shows the best practice examples of how European higher education institutes have integrated learning activities and other STEAM initiatives to mobilise and empower women. The best examples include tips and strategies that educators can adapt and implement in their practice with students.

Section 1:

Current state of women in STEAM in European countries

1.1 Gender Disparity in STEAM fields

Women in STEAM (Science, Technology, Engineering, Arts, and Mathematics) are vital for the advancement of knowledge, innovation, and economic growth in the European Union (EU). However, despite progress in recent years, women still face many barriers and challenges that limit their participation and representation in these fields (United Nations, 2020). This section provides an overview of the current state of women in STEAM fields based on the latest statistics and research available at the EU level.

According to Eurostat (2021), in 2019, there were more than 6.3 million female scientists and engineers in the EU. However, this proportion varies significantly across sectors and countries. Women were underrepresented in manufacturing and overrepresented in services. Moreover, only five EU Member States had more female scientists than male scientists: Lithuania, Bulgaria, Latvia, Portugal, and Denmark. Similarly, the World Economic Forum's findings (2020) indicate a global underrepresentation of female students and employees in STEM fields, with women comprising approximately 30% of the world's researchers.

Looking at the undergraduate enrolment data over the last decade it appears that female students show a constantly lower proportion of entering STEAM programme at Higher education level in the UK and Ireland. According to the national enrolment statistics, the number of female students enrolled in STEM disciplines in UK and IE universities are increasing over the last years (Higher Education Statistics Agency, 2023; STEM Women, 2021; 2022) However, in the same context, females enrolled in ICT, computer and related disciplines constitute less than 20% of the student population (Berry et al., 2022). Looking at the subject choices of entrants to STEM education across all third-level institutions in Ireland, data for 2018-2019 reveals that women are well represented in life sciences and mathematics (Kiernan et al., 2022).

Despite notable progress in education, employment, and political engagement in Cyprus, women's representation in high-tech and STEAM-related industries remains limited, particularly in STEM occupations. Specifically, Deloitte's report of 2022 reveals that men constitute a significantly higher percentage of the STEM workforce (27%) than do women (4%). Austria also reflects a strong male dominance in the STEAM sector, as according to Haffner and Loge's (2019) report the share of women in STEAM professions is just 15%, which shows

that this area of the labour market is still strongly male-dominated. Despite some progress, female student enrolment in STEAM subjects in Austrian universities and universities of applied sciences remains comparatively low (Friedl, 2017). In a similar vein, in Germany, research studies emphasise that women are still underrepresented in the so-called “hard” fields of science, technology, engineering, and mathematics (STEM). One fact observed is that they step out of the field of study after university while men are more likely to stay in STEM. As a consequence, women are also underrepresented in STEM-related industrial or academic leading positions and boards. In addition to the tendency to leave research earlier than similarly qualified men, women in science are still paid less, promoted less, and win fewer grants (Nimmesgern, 2016).

Overall, the presented data underscores the persistent gender disparity in STEAM fields across various countries, signalling the need for continued efforts and targeted initiatives to promote gender equality and encourage more women to pursue and succeed in STEAM-related careers.

1.2 Challenges and barriers for women face in STEAM fields

The representation of women in STEAM professions remains low and various hurdles inhibit their integration into these fields. The influence of gender stereotypes is a recurring theme affecting female students in primary, secondary, and higher education (Zacharia et al., 2020). Women with similar personal and professional attributes and academic productivity as their male counterparts face lower promotion opportunities, indicating an inequality in opportunities and gender-based challenges (FeSTEM Consortium, 2022). Additionally, the lack of exposure to STEAM studies, media influences, and limited career guidance contribute to this underrepresentation (Schwarze, 2015; Friedl, 2017; Yates & Plagnol, 2022; Papafilippou & Bentley, 2017). The work-life balance issue remains a significant concern for women, particularly when they have children. Pregnancy is an additional barrier that requires attention and resolution within the work environment (Kouta et al., 2017).

The gender wage gap is prevalent in various countries such as Italy and Slovenia, impacting women's career progression and success. Women are more likely to start their careers in lower-level, lower-paying positions, and their perceived credibility is contingent upon male approval (Avraam 2020; FeSTEM Consortium 2022).

Moreover, female students in STEM courses in higher education often struggle with a sense of belonging and have low confidence compared to their male counterparts. Gender bias and

stereotypes persist, influencing women's career aspirations and choices (Batty & Reilly, 2022; Kelly et al., 2019; Devereux et al., 2022; Farrell et al., 2020).

In Germany, a study by Ertl, Luttenberger, and Paechter (2017) revealed that women studying STEM topics with low proportions of females must overcome barriers in school and family, impacting their academic self-concept. Negative gender stereotypes and family related influences lower women's self-concept, whereas positive school-related aspects have a beneficial effect. Measures such as providing opportunities for positive experiences and exposure to enthusiastic role models in STEM professions are crucial for enhancing women's interest in and self-concept of STEM subjects.

Overall, the data presented underscores the multifaceted nature of the challenges women face in STEAM. Deeply rooted societal attitudes and traditional role models still consider STEM/STEAM fields more suitable for men, which affects women's confidence and interest in pursuing careers in these areas. Women are underrepresented in both academic and industrial leading positions in the STEM/STEAM professions, and they tend to leave these fields after university, resulting in a lack of diversity. Gender stereotypes conveyed through literature, media, and educational materials further contribute to the perceived mismatch of women in the STEM profession. Limited access to STEM education and socio-economic conditions also pose challenges for young women in pursuing STEM/STEAM careers (Nimmegern, 2016). The aforementioned data highlight the necessity for targeted efforts to promote gender equality, enhance opportunities, and support women throughout their education and professional careers. Addressing gender stereotypes, providing support and opportunities for women in STEAM, and creating sustainable environments for their success are key areas that require further attention.

1.3 Strategies to successfully engage women in STEAM activities

To address these challenges and promote gender equality, various strategies are being implemented. These efforts include industry collaborations, community initiatives, mentorship programmes, and educational reforms. The overall aim is to attract and support women in their pursuit of STEAM careers and reduce the gender gap in these fields. Specifically, in Cyprus, partnerships with industry organisations are seen as a crucial step to engage women in STEAM activities. These collaborations provide opportunities for internships, research projects, and networking events, making STEAM fields more tangible and appealing (FeSTEM, 2022). Achieving gender equality in higher education and business requires comprehensive social justice initiatives that dismantle gender barriers and discrimination. Emphasis on action-

oriented approaches and societal impact is crucial for enhancing quality and excellence in universities and research-oriented institutions (Zacharia et al., 2020).

In the UK and Ireland, strategies are developed to support women's participation in STEM fields. Flexible career paths that reflect women's lives, peer-learning frameworks, and the use of role models are some of the approaches utilised (Donelan et al., 2019; Vasileiou & Haskell-Dowland, 2019; Taylor-Smith et al., 2022). Donelan et al. (2019) emphasise the importance of taking a life-span perspective in addressing IT skills shortages in the STEM industry. They suggest offering flexible career paths that accommodate women's lives, thereby improving the retention and return of female employees. Additionally, they stress the need for continuous efforts to challenge stereotypes, media influences, peer opinions, and teacher biases that impact the career choices of the next generation.

Vasileiou & Haskell-Dowland (2019) present a framework aimed at enhancing the sense of belonging among students pursuing STEM degrees. Their peer-learning framework promotes collaboration between students and teachers, fostering critical soft skills necessary for the workplace. This approach can help overcome issues of isolation, leading to improved retention and engagement with STEM studies. A participant-centred planning framework to encourage women and girls in computing is also suggested by (Taylor-Smith et al., 2022). With a focus on role models, the framework incorporates goals, participant inclusion, promotion strategies, activities, standards, and next steps. Their pilot program showed positive outcomes in participant retention and inclusion, indicating the effectiveness of the framework. Howe-Walsh et al. (2016) highlight the importance of supporting women with children in STEM careers in higher education institutions (HEIs). They advocate for institutions to offer return-to-work programmes and adequate mentoring opportunities to help women balance family responsibilities and professional development. Recognising women with children as role models and mentors within STEM fields can also positively influence the perception of women in HEIs. Herman et al. (2019) focus on blended learning approaches, emphasising the need for flexibility and adaptability to cater to diverse learner groups, including gender and other diversity characteristics. They present a model for community organizations that promotes engagement and collaboration within Blended Open Courses (BOCs), facilitating effective learning and creating an inclusive learning climate. Initiatives like the SUCCESS programme in TU Dublin aim to increase the number of female academic staff within computer science schools and create a supportive work environment (Lillis & McKeever, 2019).

Mentorship programmes and supportive policies are recognised as effective ways to address the underrepresentation of women in STEM. By providing guidance, support, and role models, these initiatives aim to create more diverse and inclusive workplaces, encouraging women to pursue and succeed in STEAM fields (Howe-Walsh et al., 2016; Kelly et al., 2020).

STEM projects and initiatives like Girls' Day, Girls and Technology, and Girls Digital Camps aim to sensitise girls and women to STEM/STEAM subjects, providing hands-on experiences and opportunities to explore these fields. Curriculum integration, making technology education compulsory for all students regardless of gender, helps engage children and young people early on and fosters responsible citizenship.

Out-of-school learning programmes, such as outreach labs and extracurricular activities, play a vital role in increasing interest and engagement among female students. Providing a supportive environment, where women have positive experiences, meet role models, and are exposed to enthusiastic STEM professionals, can positively influence their interest and self-concept in STEM/STEAM fields. Implementing work-life balance policies, including part-time work options and parental leave, can attract and retain women in STEM/STEAM careers. Encouraging highly skilled migrant women to pursue careers in these fields, addressing gendered conditions, and providing opportunities for social integration are also important strategies (Dönmez, 2021; UNESCO, 2023).

Addressing the gender pay gap and ensuring equal opportunities for women in STEM/STEAM fields are crucial for attracting and retaining talented women. The efforts in the partner countries, where collaborations with industry partners and organizations are being established to provide internships, research projects, and networking events for women in technology, are highlighted. The importance of mentorship, networking, and organisational support for women in STEM is emphasized, as well as the need for revised human resources policies and practices in higher education institutions (UNESCO, 2021; Fry et al., 2021).

Efforts are being made to support women individually through coaching or mentoring and to make the jobs themselves more flexible and adaptable in relation to family and private life. The media's role in shaping young women's choices of studies is mentioned, along with the need to reduce the gender pay gap and provide role models for interested women (Rockinson-Szapkiw & Wendt, 2020).

Overall, research studies emphasise the need for collaborative efforts between educational institutions, industry partners, and government organizations to promote gender equality, address challenges, and increase women's participation in STEAM fields. In conclusion, while there are some efforts to promote gender equality in STEAM fields in all partner countries, there is still a long way to go to achieve true gender parity in these fields.

Section 2:

Practical Guidelines to successfully engage women in STEAM activities through a mentoring programme

Women's participation in STEAM (and digital technologies) is essential for achieving the Sustainable Development Goals and advancing gender equality. Engaging women in STEAM activities and in digital technologies through a mentoring programme can be a powerful way to inspire, support and empower them to pursue and excel in these fields. However, designing and implementing an effective mentoring programme requires careful planning, coordination and evaluation (Council on Foreign Relations, 2018; UNESCO, 2023).

Mentors are considered as influential career role models that can shape students' attitudes and perceptions of STEM fields, bolstering their confidence to engage in related activities. Taylor-Smith et al. (2022) developed and evaluated a participant-centred planning framework to support initiatives encouraging women in computing, where the use of role models played a pivotal role. While mentoring was not the primary focus, their qualitative survey revealed that female students studying computing and related subjects at further or HE level regarded teachers as the most influential role models in their career aspirations. Notably, 17% of respondents credited a teacher as the source of their initial interest in digital technologies. The inclusion of female role models in mentoring programmes can challenge stereotypes and alleviate feelings of isolation among female students pursuing STEAM careers.

Furthermore, Howe-Walsh et al. (2016) shed light on the challenges faced by women with children in STEM in HE, emphasising the importance of female role models and mentoring support. Their study addressed that women with children had limited access to mentoring opportunities and that their perceptions of mentorship were influenced by their experiences as mothers. The authors advocate for proper guidance from female role models with children, as their experiences navigating careers with family responsibilities could be invaluable to other women. Consequently, HEIs are encouraged to offer mentoring support that considers the unique needs of women with children, ultimately benefiting all women in STEM fields within the HE environment.

The mentoring programme goal is to encourage and support women to engage in activities that involve the use of digital technologies in future occupations. It aims to connect women with role models, mentors and peers who can inspire, guide and empower them to pursue their interests and aspirations in STEAM and digital technologies.

The roles, responsibilities and commitment of the mentorship programme are based on the recommendations of MENTOR (2019), National Academies of Sciences, Engineering, and Medicine (2019) and UNESCO (2017), who have provided guidelines and best practices for effective mentoring in STEAM and digital technologies. According to these sources, the mentorship programme involves three main actors: mentors, mentees and programme staff. Each of them has specific expectations and duties to fulfil in order to ensure a positive and productive mentoring relationship and outcome. The following paragraphs summarize the roles, responsibilities and commitment of each actor. (Mentor, 2019; National Academies of Sciences, Engineering, and Medicine, 2019; UNESCO, 2017).

Mentors are experienced and successful professionals in STEAM and digital technologies who volunteer to share their knowledge, skills and insights with mentees. They are expected to:

- Provide constructive feedback, guidance and resources to help mentees achieve their goals and overcome challenges.
- Communicate regularly and effectively with mentees using the agreed mode and frequency of interaction.
- Respect the confidentiality, diversity and autonomy of mentees.
- Participate in training, orientation and evaluation activities organized by the programme staff.
- Report any issues or concerns to the programme staff as soon as possible.
- Commit to the duration and expectations of the programme.

Mentees are women who are interested in or pursuing STEAM and digital technologies as their fields of study or career. They are expected to:

- Identify their learning needs, interests and aspirations and set specific and measurable goals with their mentors.
- Seek feedback, advice and support from their mentors and act on their suggestions.
- Communicate regularly and effectively with their mentors using the agreed mode and frequency of interaction.
- Respect the confidentiality, diversity and autonomy of mentors.
- Participate in training, orientation and evaluation activities organized by the programme staff.
- Report any issues or concerns to the programme staff as soon as possible.
- Commit to the duration and expectations of the programme.

Programme staff are the coordinators and facilitators of the mentorship programme. They are expected to:

- Assess the needs and interests of mentors and mentees and match them based on compatibility.
- Provide training, orientation and resources to mentors and mentees on how to establish and maintain a positive and productive mentoring relationship.
- Provide ongoing support and supervision to mentors and mentees throughout the duration of the programme.
- Monitor and evaluate the progress and outcomes of the mentoring relationship and the programme as a whole.
- Resolve any conflicts or issues that may arise between mentors and mentees or within the programme.
- Recognise and celebrate the achievements and contributions of mentors and mentees.

The following section includes practical guidelines to successfully engage women in STEAM activities:

To effectively engage women in STEAM activities, it is essential to **promote positive role models and mentors who can inspire and support girls and women** in their pursuit of interests and aspirations in these fields. Role models can be female teachers, professionals, peers or celebrities who demonstrate the diversity and potential of STEAM careers for women (UNESCO, 2023; Empower Women initiative). To effectively promote girls' and women's engagement in STEAM education, it is crucial to **provide quality and gender-responsive educational approaches that are relevant, inclusive, and engaging**. This includes developing curricula, pedagogy and assessment methods that are competency-based, learner-centred and aligned with the needs and demands of the 21st century (UNESCO, 2023; Johnson, & Vega, 2019). It also involves addressing gender stereotypes and biases in the content, language and images used in STEAM education materials (UNESCO, 2023).

UNESCO (2023) also highlights the need to **enhance girls' and women's digital skills for learning, work and life**. Digital skills are essential for accessing information, communicating, creating and problem-solving in the digital economy. UNESCO works to empower girls and women in acquiring basic competences and digital skills to help close the gender digital divide. Through financial support from Intel and other partners, UNESCO is enhancing girls' digital skills for learning. UNESCO (2023) and Empower Women initiative underlines that **creating supportive and enabling environments**, encourage girls and women to participate and excel in STEAM activities and in digital technologies. This includes providing safe spaces, resources, networks and opportunities for girls and women to explore, experiment and express

themselves in STEAM fields. It also involves engaging families, communities, media and policy-makers to challenge gender norms and expectations that may discourage or discriminate against girls and women in STEAM.

It is imperative to **celebrate and showcase the achievements and contributions of women in STEAM and digital technologies**. By highlighting their accomplishments, the following strategies can effectively promote gender equality and inspire girls and women to pursue these fields. This can help raise awareness, visibility and recognition of women's role and impact in these fields, as well as inspire and motivate other girls and women to follow their footsteps. For example, UNESCO organizes an annual International Day of Women and Girls in Science on 11 February to highlight the achievements of women scientists and promote their full and equal access and participation in science (UNESCO, 2023). To support women in STEAM and digital technologies, it is essential to **provide comprehensive career guidance and opportunities that empower and enable their professional growth**. Many girls and women may not be aware of the range and diversity of STEAM careers available to them, or may face challenges and barriers in entering or advancing in these careers. Career guidance can help girls and women explore their interests, skills and aspirations, as well as provide information on education pathways, scholarships, internships, mentorships and job opportunities in STEAM fields (Frazzetto, 2021; UNESCO, 2023). It can also help them develop confidence, resilience and leadership skills to overcome obstacles and succeed in their chosen careers (Frazzetto, 2021).

Also, **fostering a culture of inclusion, diversity and equity in STEAM workplaces and digital spaces** is imperative. Women in STEAM and digital technologies often face discrimination, harassment, bias and stereotypes that can affect their performance, satisfaction and retention. To create a more supportive and enabling environment for women, employers need to adopt policies and practices that promote gender equality, diversity and inclusion in their organizations. This includes ensuring equal pay, benefits, opportunities and representation for women at all levels; providing flexible work arrangements, parental leave and childcare support; preventing and addressing sexual harassment and violence; and fostering a culture of respect, collaboration and innovation (Frazzetto, 2021; UN Women, 2023). Additionally, digital spaces need to be made safer and more accessible for women by addressing issues such as online harassment, hate speech, misinformation, digital literacy and affordability (UN Women, 2023).

According to Farheen (2021) & National Academies (2021), to **establish clear goals and expectations for the mentoring relationship** is a vital. Mentors and mentees would discuss and agree on the purpose, scope, duration, and frequency of their interactions, as well as the roles and responsibilities of each party. They should also set specific and measurable

objectives and outcomes for the mentee's learning and development, and monitor and evaluate their progress regularly. Providing **constructive feedback and guidance is crucial for the professional development of women** in STEAM and digital technologies. Effective feedback helps individuals identify areas for improvement, build on their strengths, and enhance their skills. Mentors should provide mentees with honest, timely and respectful feedback on their strengths, areas for improvement, challenges and opportunities. They should also offer advice, suggestions and resources to help mentees overcome obstacles, achieve their goals and advance their careers. Mentors must also encourage mentees to seek feedback from others and reflect on their own performance (Farheen, 2021; National Academies, 2021).

Furthermore, a practical approach according to Farheen (2021) & National Academies (2021) is the creation of **a supportive and trusting relationship**. Mentors and mentees should establish rapport, respect and mutual trust by communicating openly, listening actively, sharing experiences and perspectives, acknowledging differences and celebrating successes. They should also maintain confidentiality, professionalism and ethical standards in their interactions. Mentors should also create a safe space for mentees to express their concerns, doubts, fears and aspirations without judgment or criticism. **Expanding the mentee's network and exposure** is a valuable strategy to support the professional development of women in STEAM and digital technologies. By broadening their connections and providing exposure to diverse perspectives and opportunities, mentees can gain valuable insights, access new resources, and enhance their career prospects. Mentors ought to help mentees connect with potential collaborators, sponsors, allies and role models in their field of interest. They should also expose mentees to new ideas, perspectives, opportunities and challenges that can broaden their horizons and enhance their skills. Mentors should also advocate for mentees' visibility, recognition and advancement within their organization or community (Farheen, 2021; National Academies, 2021).

Garringer et al. (2019) & UNESCO (2023), note that the **evaluation of the needs and interests of the target group** is an important process. Before launching a mentoring programme, it is important to conduct a needs assessment to identify the specific challenges, gaps, opportunities and aspirations of the women and girls who will participate in the programme. This can help tailor the programme objectives, content, format and delivery to their needs and interests. **Recruiting and training qualified mentors** is essential for establishing a successful mentoring program. Mentors play a crucial role in guiding and supporting mentees, helping them develop skills, achieve goals, and navigate their personal and professional lives. A mentoring programme is only as good as its mentors, who should have relevant expertise, experience and passion for STEAM and digital technologies. They should also have strong interpersonal, communication and mentoring skills, as well as a commitment

to diversity, equity and inclusion. Mentors should be recruited from various sources, such as academia, industry, government or civil society, and should reflect the diversity of the mentees in terms of gender, race, ethnicity, culture and background. Mentors should also receive adequate training and orientation on the programme goals, expectations, policies and procedures (Garringer et al., 2019; UNESCO, 2023).

Another guideline that Garringer et al. (2019) & UNESCO (2023) suggest, is **matching mentors and mentees based on compatibility**. A successful mentoring relationship depends largely on the compatibility between the mentor and the mentee. Compatibility can be based on various factors, such as shared interests, goals, values, personality or learning styles. Matching can be done by the programme staff using a formal algorithm or questionnaire, or by allowing mentors and mentees to choose each other based on their profiles or preferences. Matching should also consider the availability, location and preferences of both parties. Another practical guideline is the **provision of ongoing support and supervision**. A mentoring programme should not be a one-off event, but rather a continuous process that requires regular monitoring and evaluation. Programme staff should provide ongoing support and supervision to both mentors and mentees throughout the duration of the programme. This can include providing feedback, guidance, resources, recognition and incentives; facilitating communication and collaboration; resolving conflicts or issues; and collecting data and feedback for improvement (Garringer et al., 2019; UNESCO, 2023).

Offering **hands-on experiences and practical application** of STEAM concepts is a key strategy to engage and motivate students in STEAM learning. Hands-on experiences allow students to explore, experiment and create using real-world problems and scenarios. Practical application of STEAM concepts helps students to see the relevance and usefulness of STEAM knowledge and skills in their lives and future careers. Research has shown that providing meaningful hands-on STEAM experiences for early childhood and elementary age children positively impacts their perceptions and dispositions towards STEAM (Bagiati et al., 2010; Bybee and Fuchs, 2006; DeJarnette, 2012). Hands-on experiences also foster the development of 21st century skills such as critical thinking, creativity, collaboration and communication, which are essential for success in the digital economy (The Edvocate, 2017). Hands-on experiences can be integrated into various STEAM activities, such as inquiry-based learning, project-based learning, design thinking, maker spaces, and digital storytelling (The Conversation, 2018; ERIC, 2018).

Raising awareness on the importance and benefits of women's participation in STEAM fields is a crucial step to promote gender equality and empowerment in science, technology, engineering, arts and mathematics. Women's participation in STEAM fields can bring various benefits for themselves, their communities and the society at large, such as enhancing their

personal and professional development. Women who pursue STEAM education and careers can develop their knowledge, skills, confidence and creativity, as well as expand their opportunities and choices for learning, work and life. They can also enjoy higher levels of income, satisfaction and recognition in their fields (McKinsey & Company, 2023; Go Science Girls, 2019). Also, contributing to the advancement of science and innovation. Women who participate in STEAM fields can bring diverse perspectives, experiences and insights that can enrich the quality and impact of scientific research, discovery and problem-solving. They can also address the needs and challenges of different groups of people, especially women and girls, who are often underrepresented or overlooked in STEAM fields (Council on Foreign Relations, 2018; World Economic Forum, 2020). In addition, by supporting the achievement of sustainable development goals. Women who engage in STEAM fields can play a vital role in tackling some of the most pressing issues facing the world today, such as climate change, health, education, poverty and inequality. They can also inspire and mentor the next generation of women and girls to pursue their interests and aspirations in STEAM fields (UNESCO, 2023; Her Culture, 2022).

Other important suggestions are the following:

Mentors can guide mentees in **expanding their networks** by introducing them to relevant contacts, encouraging participation in industry events, and providing guidance on effective networking strategies (Enekwizu, 2019; APA, 2012; Austin & Laursen, 2014). According to Rhodes & Beneicke, (2002) mentors can also help mentees **navigate the challenges of networking**, such as overcoming social barriers or building confidence in approaching new connections. Mentors also can assist mentees in **identifying** relevant industry organizations, professional associations, and community groups where they can contribute their expertise and expand their knowledge (Friedman & Phillips, 2002; Gisbert-Trejo et al., 2018). Balan (2021c) in her paper mentions that mentors can provide **guidance on how to get involved**, participate in initiatives, and contribute to the larger STEAM community, thereby enhancing their visibility and establishing their professional reputation. According to He (2022), mentors can **encourage and support mentees** in attending conferences and events by providing information about relevant gatherings, assisting with abstract submissions, and offering guidance on effective presentation skills. Mentors can also help mentees **navigate any potential challenges** they may face in these settings, such as imposter syndrome or feelings of self-doubt, by providing reassurance and sharing personal experiences (Ryan, 2023; Tulshyan, & Burey, 2021; LinkedIn, 2023).

Edwards (2019), in her paper highlights the topic of **empowering Resilience and Confidence**. Imposter syndrome and stereotype threat are common challenges faced by women in STEAM careers. Mentors play a crucial role in addressing these issues by helping mentees recognize and overcome self-doubt and negative beliefs about their abilities. Mentors can provide guidance on building self-confidence, reframing negative thoughts, and celebrating achievements.

Another important aspect is the **Monitoring and Evaluation of the programme**. According to Reeves (2021) mentors should schedule periodic meetings with mentees to discuss their progress, address any concerns or challenges, and provide constructive feedback. These check-ins provide an opportunity for mentees to share their experiences, seek guidance, and receive mentor feedback to enhance their professional development. Mentors can also use these sessions to assess the mentee's growth and make necessary adjustments to the mentoring approach. **Tracking mentees' progress** is essential to monitor their growth and recognize their achievements. Mentors can establish milestones and goals with mentees and track their progress over time. This tracking can involve assessing skill development, professional accomplishments, and milestones in the mentee's career journey (Reeves, 2022; Ryan, 2023). According to Montgomery (2017) & Landry & Lewiss (2021), a significant aspect is **Adapting the Mentoring Approach as Needed**. Mentoring is not a one-size-fits-all process, and it is important to adapt the approach based on the evolving needs and circumstances of the mentee. Mentors should remain flexible and responsive to changes in the mentee's goals, challenges, and preferences.

Ethical Considerations in Mentoring Women need to be also addressed. Palmer (2019) & Kow et al. (2020) underline that mentors should establish clear expectations regarding the confidentiality of information shared by mentees and take steps to protect their privacy. Also, mentoring programmes should actively promote diversity and inclusion to ensure equal opportunities for women from different backgrounds. Mentors should be mindful of their own biases and work to create an inclusive and supportive environment for mentees. Mentors should be aware of this power dynamic and take steps to mitigate its impact. This includes fostering an environment of mutual respect, encouraging open dialogue, and actively seeking mentees' input and feedback.

Section 3: Best practices

A range of projects and best practices have been carried out often in support of specific minority or marginalised groups across the EU. These have involved some national associations, NGOs, and charities, as well as other EU-funded projects that have been quite successful in how European HE institutes have integrated learning activities and other STEAM initiatives to mobilise and empower women. The following tables illustrate nine (9) best practices for engaging and empowering women in the STEAM field by each STEAM4LIFE project's partner countries and EU.

BEST PRACTICE 1: STEMAspire	
Topic/ Area	STEMAspire is a year-long mentoring programme by global technology giant Dell. The programme was created to help tackle gender inequalities in the technology sector. Throughout the next twelve months, participants will receive one-to-one mentoring, as well as attending various on-site events with Dell.
Target group	Undergraduate female students with female mentors at Dell
Type of Best Practice	Training/mentoring programme
Date released	2018-2022
Partners/ network	Dell EMC Glasgow
Description of the methods/ approach and/or theories used	1-1 support and guidance to help bridge the gap between education and employment.
Purpose/Aim	Developing students' skills and confidence to facilitate their education and career journeys.
Evaluation (results) of its effectiveness	118 students from universities in the UK, Ireland & France – 20 of whom have gone on to work at Dell Technologies, with a view to being expanded to other sites in the EU.
Evaluation (results) of its effectiveness	118 students from universities in the UK, Ireland & France – 20 of whom have gone on to work at Dell Technologies, with a view to being expanded to other sites in the EU.
Web link	https://www.strath.ac.uk/science/ourscienceblog/s_temaspire/

BEST PRACTICE 2: STEM for Her

Topic/ Area	Through direct exposure to hands-on experiences, mentors and role models and other programs, STEM for Her enables girls and young women to envision the path to an education and a career in STEM.
Target group	College students
Type of Best Practice	Mentor Programme
Date released	Founded in 2003 by Women in Technology (WIT)
Partners/ network	STEM for Her is a non-profit organization (USA)
Description of the methods/ approach and/or theories used	<p>Mentees will:</p> <ul style="list-style-type: none"> • Set actionable goals for the programme • Be accountable to meeting those goals through mentor sessions, reflection assignments and programme events • Network with other mentees and mentors • Leave the programme with actionable takeaways to advance the field of interest <p>Mentors will guide mentees by:</p> <ul style="list-style-type: none"> • Educating them about STEM-related careers and various paths to them • Providing them with real-life anecdotes • Growing their personal and professional networks through introductions where appropriate
Purpose/Aim	STEM for Her mission is to create awareness, excitement, and opportunities among girls and young women to launch successful STEM-related careers.
Overview of the lessons learned which are relevant to the project	Programs include: STEM for Her Day, Exploring Biosciences Opportunities, GEM Hunt and Drive Like a Girl. Mentor Program cultivates an opportunity for college students (Mentees) to be linked with professionals in STEM-related fields (Mentors). These programs enable girls to explore STEM topics they might not otherwise have an opportunity to discover. Through the mentor program, young woman have access to those in STEM-related fields.
Web link	https://stemforher.org/mentorprogram/

BEST PRACTICE 3: WiSTEM – Women in STEM

Topic/ Area	Matching high school girls with college students and professionals in STEM
Target group	Female university students & professionals with high school girls
Type of Best Practice	Mentorship Program
Date released	2021
Partners/ network	Women in STEM was founded at the University of Chicago Lab Schools
Description of the methods/ approach and/or theories used	<p>The mentorships vary on a case-by-case basis, so the advice can range. It is open-ended so that each partnership could find what worked best for them. Mentor/mentee partnerships generally meet in coffee shops, cafés, or other informal locations once to four times a quarter. This allows for a casual and mutually beneficial relationship to flourish.</p> <p>There is a variety of topics to be discussed during these meetings. Primarily, college/career advice, school advice, and a balanced social life. Essentially, through this program, we are fostering constructive dialogue between high school girls and their mentors, who serve as peer leaders/guides.</p>
Purpose/Aim	To gauge and increase interest in STEM fields to lay the foundation for representation.
Web link	https://womeninstem.org/mentorship

BEST PRACTICE 4: She.Can.STEM Program

Topic/ Area	Developing the future generation of female leaders in STEM
Target group	Female students in secondary education Female university students
Type of Best Practice	Internship Programme
Date released	2022
Partners/ network	Deloitte Cyprus
Description of the methods/ approach and/or theories used	<p>Separate sub-programs respective to specific educational levels</p> <p>1. Female students in secondary education will gain the follow:</p> <ul style="list-style-type: none"> ● Get to see the work that Deloitte teams do in the real world ● Build your confidence. ● Develop key business and technical skills, boosting your employability.

	<ul style="list-style-type: none"> ● Enrich the resume. ● Discover different career paths and understand first-hand the exciting opportunities we have for you at Deloitte. <p>2. Female university students will gain the following:</p> <ul style="list-style-type: none"> ● Gain work and career insights. ● Receive career advice and individual guidance from experts in the field. ● Improve communication skills and confidence in a professional sector. ● Be further connected to the local STEM community. ● Boost employability. ● Opportunity to be offered a place in Deloitte’s Tech-D Internship Program.
<p>Purpose/Aim</p>	<p>Enhancing workforce diversity and fostering inclusive growth</p>
<p>Overview of the lessons learned which are relevant to the project</p>	<p>Female students in secondary education:</p> <ul style="list-style-type: none"> ● Work experience across our STEM related service lines (specific departments depending on location) and personal development workshops ● Hear from our guest speakers, as well as our experienced professionals ● Individual coaching session with Deloitte professionals <p>Female university students:</p> <ul style="list-style-type: none"> ● This program connects university students with Deloitte professionals, through a mentoring relationship which: <ul style="list-style-type: none"> ○ Supports students along their skills building and employability journeys, addressing life, career and/or academic goals <p>Deloitte mentors exposes the mentees to the world of work, support them in setting and pursuing educational journeys or entering the job market, providing academic and career advice, and act as supporting soundboards to mentees. At the same time, every mentoring relationship will be different and tailored to each student.</p>
<p>Web link</p>	<p>https://www2.deloitte.com/content/dam/Deloitte/cy/Documents/careers/CY_Careers_She.Can.STEM%20Program_NoExp.pdf</p>

Best Practice 5: RoboGirls

Topic/ Area	Empowering girls in STEAM through robotics and coding
Target group	Teachers, Students (Education level: Primary education, Secondary, Adult education)
Type of Best Practice	EU+ Project
Date released	2020
Partners/ network	RoboGirls Consortium: Croatia, Cyprus, Greece, Ireland, Spain
Description of the methods/ approach and/or theories used	Building the capacity of teacher educators to organise and implement innovative hands-on STEAM activities and events (such as lesson plans, workshops, thematic school days) with the use of robotics and coding. By applying robotics and coding in school curricula, the project empowers girls and boost their self-esteem and enhance their confidence in relation to the use and capabilities they think they have towards digital technologies, making them consider following a relevant career in the future and be active in the future of the digital sector.
Purpose/Aim	Project aims at reducing disparities of girls' engagement in STEAM through the use of educational robotics, coding, and other attractive innovative online tools and activities by enhancing teachers' personal and professional development.
Evaluation (results) of its effectiveness	It has already been labelled good practice in the Erasmus+ results platform (received a score of 98/100). Also, the Robogirls project is a candidate for awarding this year's European Award for Innovative Teaching!!
Web link	https://robogirls.eu/en/

BEST PRACTICE 6: Women ReBOOT

Topic/ Area	Women ReBOOT Ireland is an initiative that specifically targets women who have taken a career break and are looking to return to work in the technology sector. The program focuses on supporting women who have previous experience or qualifications in technology-related roles but have been out of the workforce for a period of time.
Target group	Women on Career Breaks Technology Professionals Return-to-Work Women

<p>Type of Best Practice</p>	<p>Targeted assistance, training, and networking opportunities to help these women refresh their skills, build confidence, and successfully reintegrate into the technology industry.</p>
<p>Date released</p>	<p>2017</p>
<p>Partners/ network</p>	<ul style="list-style-type: none"> • Women ReBOOT has now enabled more than 100 women to rejoin the tech sector, stepping back into high-skilled roles in over 40 partner companies. Some examples of organizations that have been involved in supporting Women ReBOOT • Technology Ireland • Technology Companies • Higher Education Institutions • Professional Networks and Associations • Government Agencies
<p>Description of the methods/ approach and/or theories used</p>	<ul style="list-style-type: none"> • Career Development and Skills Training • Individualized Support and Guidance • Networking and Mentorship • Collaborations with Industry • Building Resilience and Confidence • Gender Equality and Inclusion
<p>Purpose/Aim</p>	<p>The Women ReBOOT program aims to provide targeted assistance, training, and networking opportunities to help these women refresh their skills, build confidence, and successfully reintegrate into the technology industry. By addressing the specific needs of women on career breaks in the technology sector, Women ReBOOT strives to facilitate their transition back into meaningful and rewarding technology roles.</p>
<p>Evaluation (results) of its effectiveness</p>	<p>Sample Program Outline</p> <pre> graph LR P1[Phase 1] --> P2[Phase 2] P2 --> P3[Phase 3] </pre> <ul style="list-style-type: none"> Phase 1 <ul style="list-style-type: none"> • eLearning: Pluralsight assigned learning paths to initiate professional development • Recommended reading, podcasts Phase 2 <ul style="list-style-type: none"> • 15 days classroom training • Instructor led • 60% Professional & Work Skills • 40% Tech Refresh • Two 1-2-1 Career Coaching Sessions • Companies Overview/Seminars • Psychometric Evaluation • Business Model Innovation Project Phase 3 <ul style="list-style-type: none"> • Career Action Plan • CV Preparation • Interview Preparation • Company Introduction • Two 1-2-1 Career Coaching Sessions
<p>Evaluation (results) of its effectiveness</p>	<p>Women ReBOOT supports women with tech sector skills and experience to return to work after a career break. Women ReBOOT has now enabled more than 100 women to rejoin the tech sector, stepping back into high-skilled roles in over 40 partner companies.</p>
<p>Web link</p>	<p>https://www.digitalskillnet.ie/about-women-reboot/</p>

Best Practice 7: DCU Women in Physics and “I WISH Initiative”	
Topic/ Area	Dublin City University (DCU) has established a Women in Physics programme that focuses on creating a supportive and inclusive environment for women studying physics
Target group	Female Physics Students Early Career Researchers Women in Physics Faculty: High School Students
Type of Best Practice	DCU Women in Physics can be considered a best practice in promoting gender equality and diversity in the field of physics.
Date released	DCU Women in Physics is not released or launched on a specific date. It is an ongoing program and initiative within Dublin City University (DCU) aimed at promoting gender equality and diversity in the field of physics.
Partners/ network	Collaboration with other departments, faculty members, and research centres within the university to promote gender equality and inclusion in the field of physics. Other Academic Institutions Women in STEM Organizations Industry Partners Professional Networks
Description of the methods/ approach and/or theories used	<p>Supportive Community: DCU Women in Physics provides a platform for networking, collaboration, and mentorship, allowing participants to connect with like-minded individuals, share experiences, and seek support. T</p> <p>Mentorship and Role Models: Pairing mentees with mentors who have navigated similar paths, DCU Women in Physics offers guidance, advice, and support to empower women in their physics education and careers.</p> <p>Tailored Support and Resources: The program provides tailored support, resources, and opportunities to address these challenges. This may include workshops, seminars, career development programs, and access to resources to enhance academic and professional growth.</p> <p>Outreach and Awareness: The program engages in outreach activities to raise awareness about the importance of gender equality and diversity in physics. By organizing events targeting high school students, DCU Women in Physics aims to inspire young women to consider pursuing physics and STEM subjects, promoting diversity from an early stage.</p> <p>Collaboration and Partnerships: DCU Women in Physics collaborates with other organizations, both within and outside the academic sphere, to further its goals.</p>

<p>Purpose/Aim</p>	<p>The overarching goal is to empower and support women at various stages of their physics education and careers. By targeting this group, the program aims to address gender disparities in physics, create a supportive community, and promote diversity and inclusion in the field.</p>
<p>Overview of the lessons learned which are relevant to the project</p>	<p>Importance of Mentorship: Mentorship programs play a crucial role in supporting and empowering women in physics. Establishing effective mentorship relationships and providing access to mentors who can share their experiences and offer guidance can greatly benefit participants.</p> <p>Building a Supportive Community: Creating a supportive and inclusive community is essential for the success of initiatives like DCU Women in Physics. Facilitating networking opportunities, organizing events, and fostering connections among participants can help them feel supported and valued.</p> <p>Tailoring Programs to Specific Needs: Recognizing the unique challenges faced by women in physics and tailoring programs to address those challenges is key. Designing initiatives that provide targeted support, resources, and opportunities can enhance the effectiveness and impact of the program.</p> <p>Collaborating with Partners: Collaboration with other organizations, both within and outside the academic sphere, can enhance the reach and impact of DCU Women in Physics. Partnering with industry, professional networks, and other academic institutions can provide additional resources, expertise, and opportunities for participants.</p> <p>Promoting Visibility and Representation: Highlighting the achievements and contributions of women in physics helps challenge stereotypes and inspire others. Showcasing successful female physicists as role models can encourage young girls and women to pursue physics and STEM subjects.</p> <p>Long-term Engagement: Sustained engagement is crucial for long-term impact. Initiatives like DCU Women in Physics may consider providing ongoing support, resources, and opportunities throughout participants' educational and professional journeys to ensure continuous growth and success.</p>
<p>Web link</p>	<p>https://www.dcu.ie/news/news/2019/11/dcu-led-initiative-aiming-to-improve-students-experience-of-stem-subjects-and</p>

Best Practice 8: FIT- FEM in Tech	
Topic/ Area	<p>The aim of FEM IN TECH (FIT) is to awaken and support the scientific or technical interest of schoolgirls. This collaborative initiative of tertiary education institutions is designed to help women to find their way into a future in science or technology.</p> <p>FIT offers summer courses and this initiative tries to raise awareness in schools via ambassadors. Here, female students and researchers report on how normal and fascinating a technical or scientific study can be and what experiences they have had as a woman in this domain so far.</p>
Target group	Schoolgirls and female prospective students between 16 and 19 years old.
Type of Best Practice	<p>Methods:</p> <ul style="list-style-type: none"> • Consultations • Establishment of a team of female ambassadors • Awareness-raising • Public relations • Events
Date released	01.10.2021-31.12.2022
Partners/ network	<p>The project was financed by the Federal Chancellery and implemented by the Technical University of Graz (TU Graz). Cooperation partners are:</p> <ul style="list-style-type: none"> • Klagenfurt University / Burgenland University of Applied Science/ Graz University Karl-Franzens/ Graz University of Arts/ Graz Natural Science Institute/ Graz Academy of Chemistry/ Ortwein School (public secondary/high school) / Higher Technical School Graz (secondary level) / Joaneum University of Applied Science Campus 02 / Montan University of Leoben
Description of the methods/ approach and/or theories used	<p>FIT works in different areas.</p> <ul style="list-style-type: none"> • FEM IN TECH-information days: During these information events, girls and young women can learn about scientific or technical studies and professions or deepen their existing knowledge. • Raising awareness in schools • Summer computer courses for girls and young women • T3UG-Teens Treffen Technik (Teens meet technology)
Web link	https://femintech.at/

Best Practice 9: FEMtech	
Topic/ Area	FEMtech is a programme of the Austrian Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (BMK)) to promote women and secure equal opportunities in research and technology.
Target group	Working women and (potential) career starters in companies and organizations in industrial and non-university research. RTI companies and non-university research institutions are the main target group for the funding section of the program.
Type of Best Practice	<ul style="list-style-type: none"> • Website and online newsletters • Network meeting • Expert of the month
Date released	2004
Partners/ network	<p>National cooperation partners:</p> <ul style="list-style-type: none"> • Austria Press Agency (APA)/ Federal Ministry of Labour and Economic Affairs (BMAW)/ Federal Minister for Women and Integration at the BKA/ Federal Ministry of Education, Science and Research /Federal Ministry of Agriculture/ Forestry Regions and Water Management (BML)/ Federation of Austrian Industry (IV)/ AMS - Public Employment Service Austria/ Vocational Information Computer of the Austrian Federal Economic Chamber (WKO)/ ERA Portal Austria/ Fact Atlas/ FFG - Austrian Research Promotion Agency/ FWF - The Austrian Science Fund/ IMAG GMB/ Central Association of Austrian Architects/ ÖGFA - Austrian Society for Architecture/ Federal Chamber of Civil Engineers/Chamber of Civil Engineers for Vienna, Lower Austria and Burgenland <p>International cooperation partners:</p> <ul style="list-style-type: none"> • Centre of Excellence Women and Science CEWS/ State Conference of Hessian University Women's and Equal Opportunities Officers
Description of the methods/ approach and/or theories used	<ul style="list-style-type: none"> • FEMtech expert database: More than 2.000 female experts from over 130 fields are registered here. • Cooperation with APA-Science • FEMtech Expert of the month • FEMtech publications • FEMtech network meetings
Evaluation (results) of its	In the period from August 2010 to the beginning of February 2011, the BMK commissioned the ARGE "3C" to evaluate the programme. The evaluation showed the following results:

<p>effectiveness</p>	<ul style="list-style-type: none"> ● Awareness was achieved ● Networking of interested persons is successful ● There is now a different way of talking about equal opportunities in research funding. ● Effects were mainly in the area of sensitisation and less in the organisational-structural area. ● Hardly any changes with regard to the proportion of women
<p>Overview of the lessons learned which are relevant to the project</p>	<p>There are some hurdles that could disrupt the work of the programme and also hinder its continuation.</p> <ul style="list-style-type: none"> ● FEMtech is very strongly associated with "women's empowerment", but companies and research institutions can be better reached through "equality of opportunity". It is therefore necessary to rebrand FEMtech. ● Companies are not reached enough ● FEMtech has reached too few cooperation and network structures. This must be expanded and developed in the future in order to achieve progress in terms of equal opportunities.
<p>Web link</p>	<p>https://www.femtech.at/</p>

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