Instructional Guide on role-model education for promoting gender equality in STEAM

Intellectual Output 2

FemSTEAM Mysteries: A Role-Model Game-Based Approach to Gender Equality in STEAM

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Executive Summary:	*FemSTEAM Mysteries* is based on the values of gender equality and non-discrimination between men and women in the fields of Science, Technology, Engineering, Arts and Mathematics (STEAM), creativity and innovative entrepreneurship. Through the adoption of an innovative approach that integrates STEM and Arts, and combines Role-Model and Game-based methodology with a mystery story-telling digital game (escape room) that engages teenagers (age 12-15), *FemSTEAM Mysteries* aims to: (i) bring out the significant role of women in STEAM; (ii) fight stereotypes of students and teachers; (iii) inspire young girls through role-model game-based STEAM pedagogy to follow STEAM careers; (iv) enhance acquisition of key skills and competences for STEAM studies and careers of all students (boys and girls); (v) enhance teachers' skills in dealing with gender equality in STEAM. The present intellectual output includes the following parts: a) A literature review presenting theoretical and pedagogical approaches to role-model education, examples of educational interventions around the world aiming at promoting gender equality in STEM/STEAM, and a synthesis of research findings regarding stereotypes about the role of women and their consequences on students' academic choices. b) Main findings from field research that was carried out in three *FemSTEAM Mysteries* project partner countries (Cyprus, Greece, and Spain) examining teacher and student views about the social role of women and about gender-related classroom practices. c) A discussion of how role-model inquiry learning activities can contribute to students' development of global and key competences. d) A list of important personalities from Cyprus, Germany, Greece, and Spain who were selected to be utilized as STEAM role-models in *FemSTEAM Mysteries* learning activities and in the *FemSTEAM Mysteries* game. e) A collection of learning activities for fostering gender equality in STEAM, which are based on the principles of role-model education.

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1. Introduction

Equality of access to education has been identified by international institutions as an important global goal. One of the priorities of the United Nations 2030 Agenda for Sustainable Development has been to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, 2015). Nevertheless, results from international comparative studies on students' performance, such as TIMSS or PISA, point out that, to date, school subjects are still divided into gender-specific domains in terms of students' interests, motivation, academic self-concept, and preferences. While now girls and boys have nearly equal participation in primary and secondary education, there is a significant gender gap in STEM subjects, particularly in advanced coursework, higher education specialization, continuation into STEM research and professional careers, and leadership within STEM fields (UNESCO, 2017).

Gender-related differences in the preferences for academic subjects become apparent at the end of primary school, aggravate in the course of secondary education and become concrete later on, in the choice of careers and field occupation (Langfeldt & Mishchau, 2011). One of the major consequences of these gender-related differences is that women are underrepresented in STEAM (science, technology, engineering, arts, and mathematics) careers, and this poses new challenges at the dawn of the era of digital transformation (González-Pérez, Matos de Cabo, & Sáinz, 2020). The aforementioned gender differences have received considerable research attention in recent years (Sansone, 2017). For instance, several scholars have linked student performance and career decisions to the lack of female STEM teachers who serve as role models (Dennehy and Dasgupta, 2017), which may cause girls to believe that STEM fields are largely inaccessible (Solanki, 2017). The goal of this guide is to provide teachers with innovative tools and resources based on role-modelling for the implementation of STEAM education. It is expected that the guide will help teachers enhance their students' motivation to engage with STEAM studies.

The guide consists of four sections. The first section presents the main approaches to role-model education, along with international tools and resources that highlight the importance of role models in empowering and influencing the perceptions of young students to consider STEAM careers. The second section discusses the key competences that students can develop through each role-model approach, as well as the critical factors that can improve their potential to have better career prospects in STEAM. The third section includes biographies and short presentations of the work and life of famous women and men in STEAM, including their personal details, childhood experiences, fields of research and other details that could be useful for the promotion of gender equality in STEAM. The last section includes specific activities based on role-model education that aim at enhancing gender equality in STEAM and can be easily implemented in classroom.

2. Role-model educational approaches

In this section we discuss how role modeling can be used to increase students' understanding of and interest in STEAM studies and careers in the context of the STEAM education pedagogical approach. The STEAM paradigm emphasises the importance of STEM education, while also highlights the potential of arts to open up new ways of seeing, thinking, and learning (Psycharis, 2018). Learning through arts can trascend different disciplines and enrich learning in disciplines beyond the arts (Hetland, 2013). Moreover, arts can help students develop aesthetic values and creativity which are both needed in design and problem-solving STEM activities (Tsai and Wang, 2021).

2.1. Theoretical approaches to role model education

During adolescence, students shape their identify and envision their future self while making connections between their school experiences and the larger society. In this context, the role of the teacher has become an issue of investigation from a theoretical and experiental point of view.

Despite the fact that the term "role model" is widely used today, it was in 1957 that Merton coined the term to refer to individuals in specific roles who serve as examples of behaviours associated with this role. Although other terms can be used as synonymous, for example "exemplar" and "proxy" and there is a number of extended definitions of role models, three recurring and interrelated themes are found in the literature:

(a) They show us how to perform a skill and achieve a goal – they are behavioral models (e.g. a teacher).
(b) They show us that a goal is attainable – they are representations of what is possible(e.g. a Nobel Prize in STEAM subjects).
(c) They make a goal desirable – they serve as inspiration (e.g. an inventor).

Role models are often seen as a way of motivating individuals to perform novel behaviours and inspire them to set ambitious goals. Various factors may impact on the effectiveness of role models, such as shared group membership and similarity between role model and role aspirant, level of the role model's success, and level of attribute by the role aspirant (Mongenroth, Ryan, & Peters, 2015). Different theoretical approaches explain the nature of teachers's identity when they become a role model for their students. Three theoretical approches are presented in this guide: expectancy-value models, the motivational theory of role model, the identity-based motivational theory and gender impact in role model.

Expectancy-value theories of motivation argue that the degree to which a person is motivated to achieve a particular goal is the outcome of the person's subjective goal expectations and their goal values (Eccles and Wigfield, 2002). Expectancy refers to an individual's perceived subjective likelihood of success in a certain task or area, for example, the perceived likelihood of passing a difficult math test. Value refers to an individual's perceived desirability of said

success and its results (eg. enjoyment, pride, or financial rewards). In educational settings, ability perceptions (expectancy) predict enjoyment (value) of a subject for school students. This makes intuitive sense: we generally enjoy things that we are good at, or believe we are good at, more than we enjoy those things in which we experience or anticipate failure. Expectancy and value interact with one another to influence students' motivation, achievement, and choices (Nagengast et al., 2011).

Based on this expectancy-value theory, the motivational theory of role modelling establishes that the attributes of both the role model aspirant and the role model contribute to the perception of the role model by the role aspirant (Mongenroth, Ryan and Peters, 2015). Examples of these attributes are similarity between role model and role model aspirant, levels of role model success, and role aspirants' beliefs about whether abilities are fixed or malleable. The perception of the qualities of embodiment, attainability and desirability, in turn, influences a number of role modelling processess such as vicarious learning and identification.

The idea that the teacher's gender can contribute to a role-model effect for students is rooted in identity-based motivational (IBM) theory, which posits that identities are not stable, but rather dynamically constructed within contexts that help individuals interpret experiences and react accordingly (Oyserman, 2014). IBM theory helps us understand how a STEM course with a female instructor has the potential to change aspects of students' STEM identities. The IBM model posits that identity congruence (same gender and demographic group) has implications for action. If an action feels identity-congruent, individuals are more likely to further engage in the action, even in the face of difficulty. In fact, difficult tasks and challenging circumstances are less likely to be interpreted as impossible but rather more likely as important to one's identity. Studies have shown that improved identity compatibility is directly linked to improved academic performance and increased motivation for girls, while protecting against negative consequences that arise from stereotype threat (i.e. decreased performance resulting form the fear of confirming a negative stereotype) (Solanki, 2018). Female teachers serve as role-models and thus have the potential to improve female student academic and non-academic outcomes.

Female role models also show promise for inoculating women against the harmful impact of stereotypes impugning their ability in STEM (Dasgupta, 2011). Stereotypes about women's abilties in STEM can exist on both conscious (explicit) and non-conscious (implicit) level. Research on explicit stereotype endorsement has shown that both men and women endorse math and science stereotypes. People tend to automatically associate men with science and math and women with humanities to a greater extend than they associate women with science and men with humanities (Nosek et al. 2009). There are negative consequences for both implicit and explicit stereotypes about women's abilities in STEM. Stronger implicit STEM stereotypes among women are related to worse performance on standarized STEM tests, lower grades in STEM careers, and more STEM-related anxiety (Van Camp, Gilbert & O'Brien, 2019). However, there is evidence that the negative consequences of stereotypes about women can be mitigated

through exposure to successful female role models in STEAM. According to stereotype innoculation model, female STEM role models can serve as "social vaccines" who inoculate women in STEM against pernicious stereotypes even if they do not alter the sterotypes themselves (Dasgupta, 2011). Same-sex role models are capable of improving women's test performance, bolstering women's identification with STEM, and developing a sense of belonging and intention to pursue STEM (Van Camp et al., 2019).

The guidelines of the FemSTEAM Mysteries project suggest that it is important to diversify the images of STEAM fields and professionals, so that both female and male students do not feel that they need to fit a particular prototype in order to belong in these fields. Based on the guidelines, one way to break down gender stereotypes of STEAM professionals is to expose students to diverse role models.

Following the theoretical framework developed by Paredes (2014), teacher's gender may affect students in a variety of ways: teachers may act as role models, reinforce stereotype threats, and communicate their own gender biases. Paredes argues that students may perform better when assigned to a same-sex teacher in case that they have already identified with such a role-model. Students may react to teacher gender by internalizing an expected negative stereotype about their gender. The resulting anxiety may reduce their academic performance, with stereotypes being one of the main predictors of students' performance on STEM and STEAM subjects. Third, the teacher's gender may affect teacher behaviour. For example, female teachers could impact students' performances because they themselves may have higher math anxiety. Moreover, female teachers may structure their classrooms, select topics, and provide examples differently than their male colleagues (Sansone, 2017). Within this context, teachers may also have their own gender biases, which may affect how they treat and evaluate students , which may later impact their performance (Lavy, 2008).

The research on gender presented by Sansone (2017) concludes that students' (males' and females') interest and self-efficacy are substantially affected by teacher's ability to make the subject interesting and to create a positive learning environment. Beyond the role-model provided by the teachers (or the stereotypes threats), research highlights the role of effort that is placed in teachers' preparing their lectures and supporting the students as well as in their pedagogical choices. According to Sansone (2017), teachers with more experience, with advanced degrees, and with specific training in STEAM education are more likely to treat all students equally, to listen and value students' ideas, to have high expectations for all students, to make the subject interesting, and to have no gender-biased attitudes.

2.2. Teaching approaches in role-model education

When it comes to science, engineering, and technology, focusing exclusively on specific technical knowledge in isolation no longer provides learning advantages. There is a need for context-oriented STEM content and for teaching resources with a clear focus on trans-disciplinary learning. Indeed, a more holistic epistemology of STEM teaching embracing the ARTs (STEAM) is proposed, integrating arts subjects in the STEM curricula. The inclusion of Arts in STEM education consists of a learning process, which provides students with the instruments to creatively solve problems that they face in their daily lives (Pears et al, 2019). STEAM can be considered as an educational teaching and learning approach that can integrate a transdisciplinary epistemology of STEM disciplines with Arts, enhancing students' inquiry skills, problem solving skills and creative thinking, as well as offering new insights and new "vocabulary" in transdisciplinary thinking (Pychaus, 2018).

According to the FemSTEAM Mysteries project guidelines, students' motivational beliefs and understanding of STEAM research and professional activities can be enhanced with the use of authentic inquiry-oriented, problem solving and construction activities, that provide opportunities for collaboration and creativity and highlight the social benefits and applications of STEAM fields in real-life situations. Research also shows that learning preferences have consequences for student success, because students are more likely to be engaged in courses that employ their preferred instructional techniques and strong engagement can led to improved performance (Ferrara, 2012). According to the study of Wehrwein, Lujan and DiCarlo (2007), there are gender differences in student preferences in STEM, with males being more likely to prefer multimodal instruction and females showing preference for kinesthetic, "learning by doing" approaches. Also, female teachers are more likely to use interactive teaching techniques such as class discussions, small group discussions, and group projects, while male teachers tend to rely more heavily on lecturing (Solanki, 2018). The STEAM role-model learning activities of the FemSTEAM Mysteries project were developed based on the engineering design process, which can accommodate various learning preferences and allow their flexible implementation in class. This design process consists of 7 steps: define the problem, research background knowledge, propose solutions, choose the optimal solution, develop and built a model, testing and assessing, finalize the design and name the product (Van Long and Phuong, 2021).

2.3. International examples of role-model education

The following are examples of interventions from around the world that aim to promote gender equality in STEM and STEAM education:

- Hello Café Engineering Outreach Program for Girls in Early Secondary School in New Zealand (Goodyer & Soysa, 2017). "Hello Café" was designed to be a free after school club where participants collaboratively solved community-based problems in small groups. Young women engineers were recruited to serve as role models ("Ambassadors").

- The Australian School Innovation in Science, Technology and Mathematics (ASISTM) *"Attracting Girls to SET"* Project in Middle and Secondary Schools in Tasmania (Little & León de la Barra, 2009). The project sought to foster middle and secondary school girls' interest and engagement in engineering by changing student perceptions of engineering and emphasizing the ways in which engineering can be used to address real-world problems, through active and inquiry-based learning.
- Marketspace Hands-On STEM projects for Primary School Girls in Australia (Sheffield, Koul, Blackley, & Maynad, 2017). The aim of Markspace program was to provide girls with the opportunity to gain experience from female mentors and teachers through playful, hands-on collaborative projects centered around STEM topics.
- Project-based Learning for STEM in an All-Girls High School in Taiwan (Lou, Liu, Shih, Chuang, & Tseng, 2011). Project-based learning involves hands-on, long-term, interactive activities wherein students learn and acquire skills by engaging in problem solving and collaboration.
- Online Mentoring in One-on-One and Group Settings for High-Achieving Girls in Secondary School Education in Germany (Stoeger, Hopp, & Ziegler, 2017). Adult women role models provide, through mentorship, support, empowerment, and valuable career information to girls who are interested in pursuing STEM.
- Discover!: Careers Wales' and WISE's Informal Science Activity Club for Girls in UK Secondary Education (Watermeyer, 2012). The Discover! program was an informal extracurricular science club that was designed to inspire girls in early secondary education. Activities included role-playing as scientists, fun active and immersive learning projects, and "object-based learning" through activities that involved direct manipulation of materials and apparata.
- A STEM Career Exploration Enrichment Intervention in Lower Secondary Education in the UK (Archer, DeWitt, & Dillon, 2014). The program exposed girls to diverse possibilities of STEM careers by introducing students to a variety of applications and careers that utilize STEM specialization.
- BAMOT Mentorship Program for Girls in Secondary Education in Israel (Bamberger, 2014). The main goal of the project was to encourage girls to pursue STEM education and gain interest in STEM fields through mentorship and exposure to female role-models.

2.4. Impact on perceptions about the role of women

In this section we examine current perceptions about the role of women in STEM using four sources of information: review of relevant literature, national reports about women in STEM in the four partner countries of *the FemSTEAM Mysteries* project, and empirical research findings on students' and teachers' perceptions about the role of women in STEAM which are based on two surveys that were carried out in the context of the FemSTEAM Mysteries project.

2.4.1. Literature review on perceptions about the role of women

Historically, women have been encouraged to pursue languages and arts as school subjects because the later were stereotyped as more appropriate for their gender. These stereotypes regarding school subjects remain, with certain subjects, such as biology, language and psychology, being “feminine” and others, such as physics, math and economics being “masculine” (Institute of Physics, 2013). Also, women often consider that their role is associated with “helping” professions and interpersonal goals. The perception that STEAM fields are not relevant to these goals could be a reason that women tend to steer away from STEAM subjects. Overall, students view STEAM careers as less connected to humanitarian ideals and interpersonal goals (Wajngurt & Sloan, 2019).

Furthermore, the fact that girls are not frequently exposed to female role models in STEAM fields enhances the stereotype that STEAM professions are typically male (Marra, Peterson, & Britisch, 2008). Female students need STEAM role models who are inspirational and who can relate to their experiences. Research shows that women rely on and benefit form same-sex role models more than men do (Wajngurt & Sloan, 2019). Moreover, if educators start teaching female students about STEAM subjects at earlier ages and expose female students to more supportive female role models, it may be possible to increase STEAM-educated faculty in post-secondary institutions so that more female students enter STEAM careers.

Nevertheless, the existing situation concerning female participation in STEAM studies and careers depends on the national policies on gender equality and the integration of the gender dimension in education, as well as the on the adoption of STEAM pedagogical models by national school systems. An analysis of national policies in Cyprus, Germany, Greece, and Spain is presented in the Guidelines of *FemSTEAM Mysteries* document. In the next section we provide a summary of relevant findings

2.4.2. STEAM education in Europe

Although a general view of the STEAM education in Education cannot be presented due to differences in the educational systems as well as to socio-cultural differences among European countries, we describe the situation is in the four countries participating in FemSTEAM Mysteries consortium.

STEAM education in Cyprus

In Cyprus, a national policy addressing gender disparities particularly for STEAM related fields, where stereotypical perceptions about girls seem to be persistent, does not exist. More so, female representation in STEAM-related careers later in life remains low, regardless of girls’ high achievement in math and science at a younger age. There is no official STEM/STEAM related curriculum in terms of the national curriculum taught in public schools. However, it is noted that policy makers acknowledge the potential of STEM education, through the introduction of pilot courses

in primary education. Secondary schools are mostly introduced to STEM/STEAM through extra-curricular activities. Finally, it is easier for private schools to develop their own scheme for STEM/STEAM education.

STEAM education in Germany

Generally, in Germany there are various policies aiming at increasing female participation in education and research. Career choices often influenced by clichéd role models and cultural ideas of “typically male” and “typically female” professions, and women are underrepresented in many STEM areas. Concrete recommendations for action are provided by the inventory “Attracting young women to STEM occupational fields”. Also, it is recommended that gender disparities are addressed early in the educational process. At the moment, the German educational system focuses on STEM rather than on STEAM education, however, due to the federal structure of Germany, there is not a consistent way of adopting the STEM pedagogical model. Instead, there is a range of individual, regional, or state-wide initiatives, programs and resources that are available.

STEAM education in Greece

The National Action Plan for Gender Equality in Greece list several measures in the sector of studies and careers, including the examination and evaluation of the Curricula and the Interdisciplinary Unified Curriculum Framework with emphasis on language and content; the development of modern educational materials and updating of existing resources, so that they promote gender equality. Specific STEM or STEAM programs complement but are not part of the national curriculum for all levels of compulsory education. STEM is taught only indirectly through specific learning fields (physics, math, technology, chemistry, biology, geology, geography, art). Despite this situation, there are numerous private initiatives that develop comprehensive annual training programs for all beyond the school program.

STEAM education in Spain

According to the Spanish State System of Indicators of Education, the Spanish educational system is inspired by the principle of equity, which guarantees equality of opportunities, educational inclusion and non-discriminatory approaches, and aims at addressing personal, cultural, economic and social inequalities. To achieve this equality, teaching is adapted to guarantee access, permanence, and progression of girls in the educational system. The new Spanish reformed education law states that the regional educational administrations will need to the increase in the presence of female students in STEAM studies as well as in vocational training courses. The educational administrations shall ensure that curricula and textbooks and other educational materials promote gender equality and do not contain sexist or discriminatory stereotypes. In relation to STEAM education, two educational laws have considered the development of open learning environments and the the integration of individual subjects.

In conclusion, in these four countries there is a lack of a general policy that would promote STEAM education and a STEAM role-model education approach to reduce the gender gap. In the next two sections we present the main findings of the FemSTEAM Mysteries project survey regarding the perceptions of teachers and students about gender-related classroom practices.

2.4.3. Teachers' perceptions of the role of women

In this section we will present findings from a survey that was administered to the teachers of the three schools that participate in the FemSTEAM Mysteries project. In total, 39 teachers (28 women and 11 men) responded to the questionnaire. In the next paragraphs we will present teacher responses to the specific survey questions that focused on the role of women and on the teachers' own teaching practices. The purpose of these questions was to examine teachers' perceptions of how they may serve as role models for their students through their own classroom behavior.

Teachers' perceptions were analyzed according to the three major definitions of what a role model is: their behavior as a model for students and the presentation of models who demonstrate that a goal is attainable or desirable. In relation to teachers' behavior as a role model for students, 92% affirm that they ensure that all the students, regardless the gender, participate equally in classroom discussions and learning activities. The same percentage of the survey participants mention that they provide students with opportunities to take part in class by doing some activities in small groups. The percentage decreases somewhat when teachers affirm the use of a gender-neutral spoken language during discussions (82.1%) or the use of gender-neutral words in examples, images, and photos (74.5%). Moreover, the 87,9% of the teachers stated that they draw on examples from the lives of both girls and boys, although a lower percentage of teachers (69,2%) challenge traditional male and female stereotypes when giving examples to students. Also, not all participants (59%) agree on the need to examine all instructional materials (e.g. textbooks, handouts, workbooks) to determine whether they are gender-biased, gender-neutral, or gender-sensitive. Although they are not adopted by all teachers, all the above are good practices because research shows that those teachers who do not use a gender-neutral language and images could bias students' perceptions of role of women (Lavy,2008; OECD, 2018; Paredes, 2014; Wajngurt & Sloan, 2019) and that gender-stereotyped examples may have a negative impact on students by reinforcing gender-biases (Solanki, 2018).

We could consider that from a social point of view the classroom is not a neutral-gender environment, although from a cultural point of view, 92,3% of teachers argue that they want to create a classroom culture which supports the idea that males and females are equally competent in all fields, including male-dominated fields such as science and engineering. Seventy-seven percent of the teacher participants encourage students to engage in activities that may help them step outside their gender's comfort-zones. Considering that the examples presented in the survey (e.g. robotics, football for girls, dance or drama for boys, etc.) are not included in the national curricula of the teachers' countries, surpassing these specific stereotypes should be done outside the school.

Most teachers (89,8%) affirm that they talk to students about possible jobs or careers in math, science, engineering, arts, or technology that they could pursue. Those examples could be goals that are attainable or desirable and become examples of female and male role models (Merton, 1957; Mongenroth, Ryan & Peters, 2015). A smaller percentage of teachers implement role-model activities that fulfill the goal of attainance and desirability (Mongenroth, Ryan, & Peters, 2015). Such activities are: introducing the biographies of famous female mathematicians, scientitsts, engineers, or ICT professionals to their students (69,2%), introducing the biographies of famous female artists to their students (56,4%) and bring in female guest speakers to talk to their students about careers in science, technology, engineering or arts (53,8%).

2.4.4. Students' perceptions of the role of women

A survey was carried out to examine student perceptions and experiences regarding studies and carriers in STEM/STEAM. The participants were 361 students from the Cypriot, Greek and Spanish schools that are members of the FemSTEAM Mysteries consortium (52,6% boys, 42,1% girls, 5,2% did not respond or answered other). Students' ages ranged from 12 to 17 years. In this section we will present findings from survey questions that addressed students' perceptions of the role of women in STEAM as well as their experiences of classroom practices relative to gender.

Students' perceptions were analyzed according to the three major definitions of what a role model is: teacher's behavior as a model for students and the presentation of other models who demonstrate that a goal is attainable or desirable. (Mongenroth, Ryan and Peters, 2015). Based on student responses, teachers provide good behavioral models by acting in non gender-biased ways (Dasgupta, 2011). Almost half of the sudents (42,4%) agree that their teachers communicate high expectations for their abilities in STEAM subjects, 69,2% agree that teachers treat girls and boys the same in giving praise, offering help, setting tasks and asking questions, while 55,1% agree that teachers advise about gender stereotypes. Also, 74,5% of the students agree or strongly agree that their teachers and the school culture support the idea that women and men are equally competent in STEAM subjects.

In addition, based on student responses, teachers presented models demonstrating that the goal to become scientists, ICT professionals, engineers, artists, and mathematicians is attainable or desirable. Students reported that they had been taught the history of leading STEM professionals and artists. However, they were more likely to learn about male (65.9%) than about female (40.7%) STEM professionals. Also, more students responded that they had been taught the history of male (59.6%) than female artists (41%).

In the survey students were also asked about their intentions to enroll in specific courses in high school and their career interest in STEAM fields. The results show that 51.5% of the students intended to select math courses, 44.9% intended to select technology, 44.4% intended to select science, and 33% intended to select arts in high school.

In addition, 53.2% of the students expressed interest in careers that use technology, 48.5% in careers that use science, 46.3% in careers that use math, and 33.6% in careers that use the arts. Overall, students were more interested in STEM coursework and intended to pursue careers related with STEM fields instead of the arts.

3. Global and Key competences in role-model education

The term “global competence” has been developed in the 21st-century learning framework and relates to students’ competencies in facing challenges in their real lives. Global competence is a multi-dimensional construct that involves a combination of knowledge, skills, attitudes and values, successfully applied to global issues or intercultural situations (OCDE, 2018). Global competence is defined as *“*the capacity to examine local, global and intercultural issues, to understand and appreciate the perspectives and world views of others, to engage in open, appropriate and effective interactions with people from different cultures, and to act for collective well-being and sustainable education (OECD, 2018, p. 7). The education for global competence can contribute to the achievement of Sustainability Development Goals, and particularly to gender equality through the implementation of role-model education. Four dimensions of global competence are considered:

- Examine local, global and intercultural issues. This dimension refers to globally competent people’s practices of effectively combining knowledge about the world and critical reasoning whenever they form their own opinion about a global issue (OECD, 2018). A STEAM role model education approach will provide students with a mature level of development when using higher-order thinking skills, such as selecting and weighting appropriate evidence to reason about global developments done by men and women role models. Globally competent students can draw and combine the disciplinary knowledge and modes of thinking required to develop a position concerning to the role of women in STEAM education and vocations.
- Understand and appreciate the perspectives and worldviews of others. This dimension highlights that globally competent people are willing and capable of considering global problems and others’ perspectives and behaviors from multiple viewpoints (OCDE, 2018). As students will acquire knowledge about the nature of STEAM subjects, they will acquire the means to recognize that their stereotyped visions of the role of women are shaped by multiple influences. Presenting students with STEAM role-model scenarios with different perspectives and role views will help them examine the origins and implications of other people’s and their own assumptions on the roles of men and women.
- Engage in open, appropriate and effective interactions across cultures. This dimension describes what globally competent individuals are able to do when they interact with people from different cultures (OCDE, 2018). This dimension addresses appreciation for respectful dialogue and desire to understand the other that are key to the advancement of egalitarian and non-gender biased STEAM careers and vocations.
- Take action for collaborative well-being and sustainable development. This dimension focuses on young people’s role as active and responsible members of society and refers to individuals’ readiness to respond to a given local, global or intercultural issue or situation (OECD, 2018). Globally competent students are encouraged to build a more inclusive and environmentally sustainable world through a STEAM role model education.

Meanwhile, while the “global competence” concept is still developing in the national curricula, the European Council adopted and revised in 2018 the term “key competences”. Key competences are a combination of knowledge, skills and attitudes, where critical thinking, problem solving, teamwork, communication, creativity, negotiation, analytical and intercultural skills are embedded throughout the eight competences: literacy competence; multilingual competence; mathematical competence and competence in science, technology and engineering, digital competence; personal, social and learning to learn competence; citizenship competence; entrepreneurship competence and cultural awareness and expression competence (European Union, 2019).

The inclusion of role-model inquiry-oriented activities will provide students with the opportunity to develop their scientific thinking, that is, the ability to carry out scientific inquiry within a specific content area (Pears et al., 2019). Role-model activities based on the engineering design process will improve students’ creativity and critical thinking by developing their interdisciplinary competences and multiple literacies (Harris and Bruin, 2018).
Research illustrates how these methodologies could help to develop the key competences:

- A STEAM role-model education will directly emphasize the development of the integrated mathematical competence and competence in science, technology and engineering (Diego-Mantecon et al. 2020).
- Several components of linguistic competence are enhanced through the oral presentations required for students’ dissemination of their work, the STEAM content vocabulary, and the opportunities to interact and engage in dialogue (Diego-Mantecon et al. 2020).
- Students engaged in STEAM role-model activities will develop digital competence through the use of technological devices (computers, tablets and mobile phones), the use of information and communication technologies, the creation of media products (e.g., video editing), etc.
- A STEAM role-model approach that includes project-based learning including contruction and programming activities (e.g., writing code for a digital game) will help the development of computational thinking and digital competence, which are closely related. Although computational thinking can be conceptualized in many ways, common dimensions include decomposition, abstraction, algorithms and automation, modelling and simulation, data collection, data representation, data analysis, and parallelization (European Union, 2016).
- Brainstorming and decision making regarding the planning and organization of an investigation or a design project helps students develop learning strategies and entrepreneurial competence (Diego-Mantecon et al. 2020).
- The collaborative nature of the project, problem-solving and inquiry-based learning approaches reinforce the development of citizenship competence (Diego-Mantecon et al. 2020).
- STEAM role-model education develops students’ awareness and expression competence when Arts is included as a transdisciplinary engineering design element (Van Long and Phuong, 2021).

4. Famous women and men in STEAM

The previous sections have highlighted the importance of selecting STEAM role models to create scenarios and activities that could help students confront their stereotypes about STEAM subjects. The tables presented here summarize the information on female and male role-models in Cyprus, Germany, Greece and Spain. The following information is provided for each role model: era of birth, main subject of research and reasons contributing to their identification as role models in their country of birth. An extended version of these biographies can be found in the *FemSTEAM Mysteries* library. The extended version includes personal details of their life and childhood, fields of research and other details that could be useful in order to promote gender equality in STEAM. Eight of these men and women have been selected to be included in the *FemSTEAM Mysteries Game* which utilizes the gaming approach, one of the most effective approaches in role-model education.

4.1. Cypriot role-models

Name	Era of birth	Field	Contributions to STEAM
Alexia Vassiliou	1960s	Arts	Singer, Songwriter, Composer and Social Activist
Andria Zafirakou	1970s	Arts and Textile	Redesigned the curriculum to make it relevant to pupils
Christina Karapataki	1980's	Chemical Engineering	Investor in innovative companies that have the potential to significantly reduce greenhouse gas emissions
Lito Kattou	1990s	Arts and Sculpture	Questions traditional sculpture and volume through the flatness of her surfaces and expands on the Industrial and technological complexities of our present
Lourika Nicolaidou	1910s	Arts	A pioneer for women professional artists in Cyprus
Panayiota Poirazi	1970s	Biology	She is a member of AcademiaNet as an outstanding woman scientist
Sule Suha	1920s	Education studies	One of the first females to take action and defend the fact that a woman could contribute as well as any man in economic and social life
Theoni K.	1980s	Chemistry	Synthesis and characterization of polymers

Georgiou			
Toula Onoufriou	1970s	Civil Engineering	In 2020 she received the "Women in Energy Leadership" Award

4.2. German role-models

Name	Era of birth	Field	Contributions to STEAM
Christiane Nülsslein-Volhard	1940s	Biology	She established a foundation in her name which supports young mothers of all nationalities in their careers as researchers.
Emmy Noether	19th century	Mathematics	Noether decided to pursue Mathematics, which was then considered as a challenging path for woman.
Lena Flakenhagen	1970s	Novel	Lena's trademarks are stories and games that take a critical look at our own society.
Özlem Türeci	1960s	Physician	Since 2020, BioNTech has been conducting research on a vaccine against the infectious disease of COVID-19 in so-called Project Lightspeed under the leadership of Özlem Türeci and Uğur Şahin, making her responsible for the clinical trials area in the development of the vaccine BNT162b2, or in a more familiar term, the Pfizer–BioNTech
Susane Albers	1960s	Computer scientist	She became one of ten inaugural fellows of the European Association for Theoretical Computer Science

4.3. Greek role-models

Name	Era of birth	Field	Contributions to STEAM
Metrodora	200-400 CE	Physician	First female medical writer
Maria Petrou	1950s	Physics	Activist in organizations such as Women in Science and Engineering and the Women's Engineering

			Society.
Eleni Stroulia	1960s	Computer scientist	Founder of Ada's Team, a support group for women and people from other disadvantaged groups among computing students
Georgia Gina Tourassi	1960s	Physics	She is involved with the Oak Ridge National Laboratory women's' mentorship program
Efstratia Kalfagianni	1960s	Mathematics	She has participated in the workshop "Connections for Women: Quantum Symmetries"
Amalia Fleming	1910s	Physician	Fleming saw herself as a Greek patriot and defender of democracy and independence
Sophia Frangou	1970s	Psychiatry	She is co-author of the book "Women in Academic Psychiatry"
Linda Pisti Basile Katehi-Tserengounis	1950s	Engineering	In October 2012, she was included on the California STEM Learning Networks' list of twelve "Leading Woman in STEM"
Fotini G. Markopulou-Kalamara	1970s	Physicist	Fotini is co-founder and CEO of Empathic Technologies, an application in how complex systems science provides new perspectives on evolution of technology and guidance in creating future technologies
Iphigenia Photaki	1920s	Organic chemistry	Iphigenia was in 1965 the fourth woman overall to get an academic position in a scientific discipline in Greece, and the second to do so in the field of Chemistry
Georgios Papanicolaou	19th century	Physician	He was a pioneer in cytopathology and early cancer detection.
Alexander Fleming	19th century	Microbiologist	Discovered penicillin.

4.4. Spanish role-models

Name	Era of birth	Field	Contributions to STEAM
Georgia Gina Tourassi	1960s	Physics	She is involved with the Oak Ridge National Laboratory womens' mentorship program
Alicia Calderón Tazón	1980s	Physics	She works for the European Organization for Nuclear Research (CERN) and participates in initiatives such as Stem Talent Girl
Ángela Ruiz Robles	19th century	Educator	Precursor of the electronic book. At the International Exhibition of Inventions and New Technologies in Geneva in 1968, she was the only woman to receive an award among the Spanish inventors
Pilar Careaga Basabe	1910s	Industrial engineering	In 1929 she was the first Spanish woman to graduate in industrial engineering and to graduate as railway driver
Carlos Pacheco Perujo	1960s	Arts and biology	Best Spanish comic book artist and for a while he was a biology teacher.
Elena García Armada	1970s	Physics	She is the designer of the first prototype of the ATLAS exoskeleton that serves to decipher the child's intentions and to assist them in the movements that they wish to do.
Isabel Coixet Castillo	1960s	Arts	Her films are a reference when it comes to portraying both the reality of women and their achievements in a world run by men.
Julia Rodriguez Maribona	1950s	Technology	She is recognized for the invention of the mop, a technological breakthrough that facilitated household cleaning task
Margarita Salas Falgueras	1930s	Chemical Sciences	In May 2007, she was named a member of the National Academy of Sciences of the United States, thus becoming the first Spanish woman to join the institution

Maria Blasco Marhuenda	1960s	Molecular biology	She is member of AMIT (Association of Women Researchers and Technologists) and in 2016 she was awarded in Women to Follow in the category Special Award for Excellence in scientific dissemination
Marta Macho Stadler	1960s	Mathematics	She is member of the Equality Committee of the Faculty of Science and Technology of the University of the Basque Country and editor of the digital space Women with science of the Chair of Scientific Culture
Mercedes Siles Molina	1960s	Mathematics	She created the steMatEsElla programme to promote the talent of young women in STEM disciplines
Rosa María Menendez López	1950s	Biology	She is the first female president of the Consejo Superior of Scientific Investigations in Spain
Severo Ochoa de Albornoz	1910s	Biology	Nobel Prize and founder of Carmen and Severo Ochoa Foundation
Jimena Quirós Fernández	1910s	Oceanographer	She was a pioneer in marine sciences and the first Spanish scientist to board an oceanography campaign
Josefina Castellví Piulachs	1940s	Oceanographer	She was the first woman to run a scientific base in Antarctica

5. Activities based on role-model education

In the next pages, there are examples of learning activities to be enacted with students, which are based on the principles and purpose of role-model education that were described in previous sections.

Activity 1. I want to be like him or her!

Scope of activity

The activity is aimed at students in the first year of secondary education, aged 12 to 13.

Number of participants

A class of approximately 25 to 30 students, grouped in teams of four students.

Selection of Participants

There are no prerequisites for selecting the participating students. However, they will need to use some background knowledge of arithmetic.

Description of activity

The activity has three phases:

1. An introduction to the activity and its purpose.
2. The resolution of a problem posed by five scientists throughout the history of mathematics and who allow us to visualize the role of these scientists in the school curriculum. These scientists are:
    - Eratosthenes of Cyrene
    - Hypatia of Alexandria
    - Theanos
    - Sophie Germain
    - Leonardo of Da Vinci
3. An assessment of what a scientist's attitude should be when solving a problem.
4. Reflection on whether students want to be like her or they want to be like him.

Specific materials needed to implement it

Drawing materials (ruler)

Writing materials

Electronic device to enable students search for and process information

Evaluation sheets for the teachers

The evaluation sheets for teachers are included in the next link. Teachers could use them all together as a research project on five historic figures, or each one separately for the following five research activities:

1. Eratosthenes of Cyrene and the Sieve of Eratosthenes in Prime Numbers
2. Sophie Germain and the patterns of Prime Numbers
3. Hypatia of Alexandria and Integer Numbers
4. Theano of Crotone and the Golden Ratio
5. Leonardo Da Vinci and the use of the Golden Ratio in Arts

All resources can be found at:

https://view.genial.ly/6024026cf027f70d93288781/interactive-content-femsteam-yo-quiero-ser-como-el-o-ella

Students will be involved in three kinds of activities:

 Research on Internet about the STEAM role-model

 Hands-on activities to act as the STEAM role-model

 Assessment of the dispositions of students and the importance of this role-model for them.

Evaluation sheets for the students

The link includes all the sheets of activities for students:

https://view.genial.ly/6024026cf027f70d93288781/interactive-content-femsteam-yo-quiero-ser-como-el-o-ella

Activity 2. Thanks to "her and her" we could live 120 years

Scope of activity

- To research on the role-model of Maria Blasco and her work to extend life expectancy
- To know what telomeres are and how they work in humans.

Number of participants

A whole classroom, between 25 to 35 students.

Selection of Participants

Ages 15-16

Description of activity

The activity is a problem-based learning activity that aims to answer how we can extend our life expectancy. Maria Blasco, a Spanish scientist, is a role model for the research on telomeres and how these help to extend life time. Students are involved in different storytelling activities, video analysis and reports on research to understand how telomeres work on humans and life expectancy.

Specific materials needed to implement it

- A computer with sound and 3D drawing affordances.
- The webpage of the activity: https://sites.google.com/lasalleandalucia.net/thnkstoherandherwecouldlive120/home

Evaluation sheets for the teachers

The activity has different phases that include:

- What we already know about …? That is a Kahoot to assess students' previous knowledge.
- Professor Sallaninsky presents himself. A storytelling activity with a questionnaire to bring forth students' prior knowledge preconceptions.
- Professor Sallaninsky's age. A storytelling and a questionnaire to research on the initial knowledge of evolution of telomeres with age.
- Professor Sallaninsky's "the key of living 120 years". A storytelling to understand the problem.
- Video Analysis:
    - El laboratorio del rejuvenecimiento de María Blasco (CNIO)
    - María Blasco nos explica - TELOMEROS, ENVEJECIMIENTO Y RESVERATROL
- Questionnaire analysis: Got it? Let's see... go to questionnaire 3
- Reading a research report: Telomere shortening rate predicts species life span
- Texts and reading strategies on cell life and ageing.

Questionnaires are self-administered. The information of all the activity can be found in: https://sites.google.com/lasalleandalucia.net/thnkstoherandherwecouldlive120/home

Evaluation sheets for the students

The evaluation sheet for the students can be found in: Texts and reading strategies on cell life and ageing

Activity 3. Female Science Journal: Interview a female scientist

Scope of activity

The scope of this activity is that students get to know in person a female in STEAM and learn all challenges, achievements, honours and awards and inspiring moments of this personality. It is especially important that students learn how this woman overcame the difficulties, challenges and obstacles she faced. After the interviews, students can publish their findings in a school journal to "spread the word".

Number of participants

Any number, preferably work in small groups of 5-7 persons

Selection of Participants

Ages 12-18

Description of activity

Task 1 (5 min) - Preparation: The teacher comes in contact with some women working in STEAM and ensures their commitment to respond to the interviews and interact with the students

Task 2: The teacher divides the students into working groups, either on his/her own or through the students. The teacher assigns groups with the task to interview a specific woman working in STEAM. The teacher also explains to the students some actions they can do before the interview in order to be prepared.

Task 3: The students prepare the questions of the interview and research references and resources about the scientist assigned to them in order to make the questions more targeted.

Task 4: The students take and record the interview (in person or online or written) and edit the answers.

Task 5: The students prepare a story for the Female Scientist Journal combining interview answers with their previous research.

Task 6: The students prepare the outline and final design of the Journal.

Task 7: Publish online (or print out) and distribute the journal within and outside the school if possible.

Specific materials needed to implement it

The students (or some of them) can use their personal computers to finalize the journal. Also, in case of online interactions with the person to be interviewed, a device with internet connection is needed. Recording or video shooting devices are optional. If the journal has a printed version, then a printer is needed.

Evaluation sheets for the teachers

1. Did you find the activity valuable for the students?
2. Was the activity easy to implement?
3. What was the most important drawback of the activity?
4. What was the most important gain for your students?

Evaluation sheets for the students

1. How was the experience of interviewing a woman working in STEAM?
2. Did you find that some of the answers were unexpected and interesting?
3. Has the activity changed your mind about women in science? If yes, in what way?

Activity 4. Her innovation!

Scope of activity

- Learning historical facts about the contribution of a woman working in STEAM, but also about the sexism and other forms of discrimination that she faced.
- Examples of women that can be researched under this activity are Marie Curie, Rosalind Franklin, etc

Number of participants

Any number, preferably work in small groups of 2-4 persons

Selection of Participants

Ages 12-18

Description of activity

Task 1 (5 min) - Preparation: The teacher decides about the woman who will be the personality under research.
Task 2: The teacher divides the students into working groups and tells them to do research on specific aspects of her contribution, obstacles she overcame, awards etc. The teacher also asks the students to make a story on a specific subject.
Task 3: The students are doing research on the topic and developing the story.
Task 4: The whole classroom discusses the results of each group's research.
Task 5: Based on the main contribution of the woman selected, students together perform with the teacher hands-on activities, e.g. build a 3D helix of the DNA, or draw the molecular form of an atom etc.

Specific materials needed to implement it

The students (or some of them) can use their personal computers to do research or just use printed resources from the teacher. For the hands-on activity they can use several materials depending on the final result, e.g., pipe cleaners, beads, paper, etc

Evaluation sheets for the teachers

1. Did you find the activity valuable for the students?
2. Was the activity easy to implement?
3. What was the most important drawback of the activity?

4. What was the most important gain for your students?

Evaluation sheets for the students

1. Did you find the life and achievements of the figure you investigated interesting ?
2. Do you think female scientists can cope with challenges like the ones faced by this figure?
3. Do you have a clearer picture of this scientist's contribution to the world and the history behind it after this activity?

Activity 5: Find the false fact!

Scope of activity

The scope of this activity is to engage students in searching information about a STEAM female role model, working in teams, while they are presented with other role models by other teams of students, being motivated by the introduction of some game elements.

Number of participants

15-20 students, separated in 3 teams

Selection of Participants

Lower secondary education STEAM class students

Description of activity

Students are asked to choose one of 5 female STEAM role models that are selected by the teacher. Each team briefly presents its chosen role model by briefly narrating her achievements story. The students are then instructed to share three interesting facts about the role model's career or achievements. Two facts must be true and one fact is false, made up by the team of students. The other two teams will have a few minutes to discuss and suggest what they think is the false fact. All teams, rotate to the role of the presenting team.

Phase A (5-10 minutes)
The teacher presents students with 5 chosen STEAM female role models. Students are divided into 3 teams. Each team chooses one of the role models suggested by the teachers. Teams split into their teams and prepare to work in teams.

Phase B (15-20 minutes)
The teacher asks students to write a small paragraph about the role model they chose in relation to her career and/or achievements. They will present, once finished, to the other two teams along with 3 interesting facts about their career. One of them will be false. One team member will be assigned the role of note taking and another will be assigned the role of presenting the team's role model. All team members have shared responsibility in finding the information they intend to use.

Phase C (15-20 minutes)

Each team has 3-5’ minutes to present their role model to the whole class (the other 2 teams) and share the 3 interesting facts. For each team that presents, the other two teams, following the presentation, have 2 minutes to discuss and think, before their chosen presenter announces which of the 3 facts the team thinks is the false one.

Phase D (5 minutes)

The teacher reflects on the information shared by the 3 teams and points out the importance of each role model’s contribution to humanity and science and encourages students to further explore such role models as an after school activity, by researching information for the other 2 role models that were not chosen at Phase A of this activity.

Specific materials needed to implement it

A3 paper sheets

Markers

Portable devices with internet access

Evaluation sheets for the teachers

1. Were students presented with adequate information for each role model? (Likert scale: 1=Do not agree, 2=Maybe not, 3=Maybe yes, 4=I agree)
2. Were students motivated by the features of this activity more than usual? (Likert scale: 1=Do not agree, 2=Maybe not, 3=Maybe yes, 4=I agree)
3. Was there a common level of interest to participate in the teamwork by all students? (Likert scale: 1=Do not agree, 2=Maybe not, 3=Maybe yes, 4=I agree)
4. Do you suggest any changes at any of the activity phases? (Open question - optional)
5. Any other general or specific suggestions? (Open question - optional)

Evaluation sheets for the students

Some indicative questions are:

1. Did you find this activity to be more interesting than being presented with information about each role model? (Likert scale: 1=Do not agree, 2=Maybe not, 3=Maybe yes, 4=I agree)
2. Did you enjoy working in teams for an activity that had some features that games usually have? (Likert scale: 1=Do not agree, 2=Maybe not, 3=Maybe yes, 4=I agree)
3. Were you motivated to search and find information about the other role models that were not presented today by any team? (Likert scale: 1=Do not agree, 2=Maybe not, 3=Maybe yes, 4=I agree)
4. Would you suggest any additions to this class activity? (Open question - optional)

Activity 6: Science Café with Susana Trasobares

Scope of activity

The activity targets students, aged 15, with previous knowledge on chemistry at a school level. The aim is to deepen their knowledge on the applications of chemistry and nanomaterials research. Also, the activity challenges students, boys and girls, to reflect on their future vocations as researchers through the first-hand experience of Susana Trasobares, a researcher in chemistry from the Faculty of Science in the University of Cadiz. An extended biography of her can be found at: ES_O2_Bios_Susana Trasobares

Number of participants

A class of approximately 25 to 30 students

Selection of Participants

Students with previous knowledge of materials chemistry at a secondary school level, according to a Chemical or Technological curriculum.

Description of activity

Science Café is a popular role-model science format that aims to promote knowledge of science in a fun and relaxed atmosphere, in front of a non-specialist audience. After the presentation of the guests by a journalist, each researcher is asked to explain his or her work, and finally a debate is initiated, with the aim to encourage the audience to talk to the scientists. This format allows for a 'one-to-one' debate with experts in the field in question, as well as among the participating scientists, who view this as an opportunity to bring scientific knowledge to the society in an entertaining way.

This well-known activity has been transformed into a virtual one due to the restrictions of COVID19 pandemic with the steps that follow. These restrictions have provided the opportunity for the transformation of “Science Café” in an activity that can be implemented internationally. Here, we present the relevant tasks, using researcher Susana Trasobares Lorente as an example.

Task 1: Teacher motivates students to participate in Science Café activity. (S)he informs the students about the topic and the name of the researcher.

Example: “What are nanotubes of carbon used for?” by Susana Trasobares Lorente from the University of Cadiz.

Task 2: Students research on the Internet about the topic and the researcher who is going to participate in “Science Café”.

Task 3: Students pose questions related to the research topic and to how the researcher became interested in the topic.

Examples of questions posed by the students can be found at: Science Café by Susana Trasobares.docx

Task 4: The invited researcher presents the topic of research

Example: A collection of videos recorded during the Science Café with Coffee by Susana Trasobares. The videos have been uploaded to YouTube and can be transcribed in any language.

- What a nanometer is?
- Where can we find the materials with a nanometric scale?
- Which are the applications of the nanoparticles of iron?
- What are nanotubes of carbon?

Task 5: The invited researcher presents his/her autobiography, pointing out how he/she discovered his/her passion to become an STEAM researcher and invites students to be one.

Example: A video with the autobiography of Susana Trasobares Lorente challenging students to have an open mind, a lot of curiosity to learn and to not forget to pursue their dreams despite the difficulties: https://youtu.be/Qma2z1Rpl-4

Task 6: An open discussion takes place where the researcher, the teacher and the students interact to answer the questions posed during Task 3.

Example: Questions posed to Susana Trasobares after the conference: https://youtu.be/KPcJjW6vRaQ

Task 7: Students summarize the knowledge acquired during the participation in the “Science Café” and reflect on how the activity has helped them develop their interest in science.

Specific materials needed to implement it

A computer connected to the Internet

Evaluation sheets for the teachers

The evaluation sheet for the teacher is the rubric included in the link: OQ_FemSTEAM_STL_Rubric of assessment.pdf

Evaluation sheets for the students

The evaluation consists of the following:

- Task 2: Students research on the Internet about the thematic topic and the researcher that is going to participate in “Science Café”.Task 3: Students pose questions related to the research topic and to how the researcher became interested in the topic. Task 7: Students summarize the knowledge acquired during the participation in the “Science Café” and reflect on how the activity has helped them develop their interest in science.

Activity 7: Musical chairs for Role models

Scope of activity

This activity aims at developing students' cooperation skills by playing a well-known game around the world. Through this game, the teacher will be able to understand those characteristics that are most important for students when thinking or making up their mind about a role model. Moreover, during the game students should stay concentrated and form their own opinion on role models. In the second phase of the game the teacher asks the students to find a figure that they admire in the field of STEAM. In this way, the game incorporates the STEAM dimension to role models and students are able to learn while playing.

Number of participants

15 students (each time that the music stops students form teams of 3)

Selection of Participants

Lower secondary education STEAM class students.

Description of activity

Phase A (5 minutes)
Join all students together and explain the game to them. Describe what they should do and turn on the music.

Phase B (10 minutes)
Music starts and students start to walk around the classroom. In this stage the students do not have to sit when the music stops, but they have to find the 2 classmates closer to them and form a team. The teacher asks: 'Do you have a role model in your life?". Students have 3 minutes to discuss among themselves. The same procedure takes place again and the teacher asks the students: "In your opinion, what is the most important characteristic a role model should have?" Students have 5 minutes to discuss and write down the answer and give it to the teacher.

Phase C (30 minutes)
Music plays again but this time students should sit in the closest chair. There are 3 chairs around a laptop. When the music turns off, students are asked to search for a figure that had an important role in the fields of STEAM. Each time that the music stops, students (in different teams) look for certain information that is interesting about the person that is on the particular laptop they randomly sat on and write down one or more characteristics that pique

their interest. Each time the music stops, students have 3 minutes to search and record. In the end, representatives from each team present their findings.

Specific materials needed to implement it

- 5 laptops
- 15 chairs
- 5 tables
- Speakers
- Markers
- A4 paper sheets

Evaluation sheets for the teachers

1. Did students participate in this activity?
2. Did they enjoy working in teams?
3. Did they enjoy the interchangeable teams?
4. What else do you want to add?
5. Is there anything else you wish to change?
6. Any other suggestions?

Evaluation sheets for the students

1. What did you like the most from this activity?
2. Did you learn something new?
3. Were you motivated to search and find information about other role models that were not presented today?
4. Do you have any other suggestions?

Activity 8. Raising awareness through storytelling. Cypriot women and their story

Scope of the activity

The objective of this activity is for students to actively engage and collect information about various women in their country and through storytelling to learn about the key roles these women have played in the past, are playing in the present, and will play in the future of STEAM. The ultimate scope is to raise awareness towards the recognition of Cypriot Female Role models and their achievements.

Number of participants

25 students

Selection of Participants

This activity is designed for lower secondary students (Grades 7,8,9)

Description of the activity

<u>First lesson</u>

Introduction - 10 minutes

The teacher initiates a discussion regarding important Cypriot women and their achievements, targeting STEAM. In this discussion it is expected for students to mention the gender inequality regarding STEAM and how women are underrepresented in this field. What can we do to celebrate more women in Cyprus? Let's create a survey to collect important role models and learn more about their story.

Activity - 25-30 minutes

Students are guided to create a short survey with the school's community in order to collect information about female role models and their lives. What questions should we use? What have the women achieved? Is there any bibliography about their work? Agree on a set of questions to be asked (template provided in the resources below).

Reflection/Sharing - 10-15 minutes

Finalize the questions of the survey and create a form as a class to share with parents, teachers, students and generally the school community.

<u>Lesson 2 and Lesson 3</u>

Introduction - 5 minutes

Together we look at the results collected regarding the important women in our country. At this point teachers have already seen the results and created small presentations of a few chosen female role models. Students and teachers go over the achievements and biographies of the chosen role models.

Prepare for story - 15 minutes

Students need to be broken down into groups of 3. Each group is given a Cypriot woman and her achievements, along with her background story. Taking turns, each student will prepare to narrate a story representing their role model. Teacher will provide the truthful version and students will need to prepare their version of the story. Only one of the students of each group will be truthful and their classmates need to vote which one it is. In smaller age groups the teacher may provide the fake versions too.

Narrate your story - 10 minutes per group (Few groups on Lesson 2 and few groups on Lesson 3)

When it is Group A's turn for example, Group A will step outside. Each member will come in and narrate their part of the story in turns. Only one student will represent the role model, the other students will contain fake elements in their story. The classmates vote which classmate represents the role model of the group.

Reflection 5 minutes:

Think about how women you thought had an impact in our world before this lesson and how this perspective has changed after this lesson! Email your teacher your thoughts!

Specific materials needed to implement it

Sample survey : https://forms.office.com/Pages/ResponsePage.aspx?id=oETa12VSV0eNwiy2CJzudcYlK-jwHDdLpR6sFnJMYHdUNkVQNUhaOVhQMVRXQUdUUU84VEw5MjFPNi4u&fbclid=IwAR0N49GnnCxqzk1WCwAPYIdVFBpbShilVVhxeY3RixSwEfr5NSlQMVb8HaI

Evaluation sheets for teachers

1. Were the students engaged in the whole activity?
2. Did students find the planning of the activity easy to follow?
3. Overall, were students surprised by the involvement of women in STEAM?

Evaluation sheet for students

1. Before today, how familiar were you with the achievements of women in Cyprus?
2. Which female role model stood out for you? Why?
3. What did you like most from this activity?
4. Were you motivated to search and find information about other role models that were not presented today?
5. Do you have any other suggestions for this activity to become even better?

Activity 9. Women in Computer Science and STEAM

Scope of the activity

The objective of this activity is for students to explore the key roles women have played in the past, are playing in the present, and will play in the future of Computer Science and Engineering.

Number of participants

25 students

Selection of Participants

These activities can be adapted for a range of age groups starting from upper primary (Grades 5 and 6) and lower secondary (Grades 7,8,9)

Description of the activity

Introduction - 10 minutes

Teachers will initiate a discussion through a presentation with important women in Computer Science. During this phase it is important to review the gender inequality regarding the field of Computer Science, and how women are considered underrepresented in this field. Let's discover if they really are.

Activity - 25-30 minutes

Students are guided to work on the following activity in groups of 3: Using the important figures you just learned about, design an original timeline that shows important women throughout Computer Science history but don't just stop there. We've included some of our favorite women featured in this lesson, can you fill in the gaps with 2-3 important female figures in STEAM history? You can use the template provided in the resources below.

Reflection/Sharing 10-15 minutes

Each group shares their timeline and emphasizes important events that stood out.

Additional element/Extension:

You can ask the students to use google earth and create a narrated timeline tour using the location of each important woman at the time of the discovery. Ask students to share these timelines with other classmates and test their knowledge!

Specific materials needed to implement it

All materials can be found in this website: https://computerhistory.org/activities-resources/women-in-computing-history/

This lesson can also be adapted in Greek language lessons. The activity described above can use Greek resources from this website:
https://www.mouseio.org/%cf%83%ce%b7%ce%bc%ce%b1%ce%bd%cf%84%ce%b9%ce%ba%ce%ad%cf%82-%ce%b3%cf%85%ce%bd%ce%b1%ce%b9%ce%ba%ce%b5%ce%af%ce%b5%cf%82-%ce%bc%ce%bf%cf%81%cf%86%ce%ad%cf%82-%cf%84%ce%b7%cf%82-%cf%80%ce%bb%ce%b7/

Google Earth for additional element: https://www.google.com/earth/outreach/learn/creating-a-narrated-tour-in-google-earth/

Evaluation sheets for the teachers

1. Were the students engaged in the whole activity?
2. Did students find the planning of the activity easy to follow?
3. Overall, were students surprised by the involvement of women in Computer Science?

Evaluation sheets for the students

1. Before today, how familiar were you with the role of women in Computer Science?
2. Which female role model stood out for you? Why?
3. What did you like most from this activity?
4. Were you motivated to search and find information about other role models that were not presented today?
5. Do you have any other suggestions for this activity to become even better?

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