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FEMST - Empowering girls with knowledge and confidence in STEM to become future STEM leaders.
2022-1-NL01-KA220-HED-000090191

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Work Package 2: FEMST Training Package Development and Validation
Activity 2.3: Integrated Pedagogical Framework
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FEMST

Contents

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1. Introduction

The project FEMST was born out of the challenges posed by gender stereotypes with regards to limiting women's potential and how these stereotypes contribute to the perpetuation of gender inequality within the STEM field. The project directly targets primary education teachers and students with an approach that involves innovative materials and tools in order to encourage more girls to become involved in STEM. As general objectives, the project aims to:

- Encourage gender-responsive training approaches for teachers and counsellors that focus on tackling gender biases in the classroom
- Train primary school teachers for the implementation of the Curriculum and the application of the tools contains therein in their own teaching, regardless of subject
- Disseminate the Animated Series of Stories and other activities/tools with children in the classroom through the teachers
- Facilitate the dissemination and sustainability of project results involving key stakeholders and policy makers at national and EU level
- Enable female students to develop their scientific capacities and inspire them to get involved in STEM-related activities overcoming gender prejudice in the field.

The results will be achieved by implementing thorough, rigorous and comprehensive management systems and processes, and maximizing partner cooperation, input and exchange through online platforms and pedagogical processes. In a world that is increasingly making creative use of innovative and technological tools, the need to further apply these tools in educational frameworks become apparent. The tools and deliverables that will be developed within the project activities will be free and easily accessed online, acting as Open Educational Resources (OER).

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2. Report's Objectives

The Integrated Pedagogical Framework (2.3) is under Work Package 2. FEMST Training Package Development and Validation.

The specific objectives of WP2 are:

1. To form local stakeholder forums in each partner country to strengthen connection with STEM providers, cultivate interest in project activities, and gain comprehensive feedback for FEMST concept.
2. To localize the needs, the perceptions, the challenges and the expectations of target groups and stakeholders and exploit existing good practices in the field of STEM.
3. To create a benchmarking index which will homogenise local needs in an Integrated Pedagogical Framework by translating local gaps in desirable learning outcomes, common across countries.
4. To develop instructional design of an informed and needs oriented training package for target groups, stakeholders and beneficiaries.
5. To finalize the Training Package through a feedback loop with the local stakeholder forums.

The activities of WP2 are predominantly those of a research and development phase of a project. Activity 2.1 is intended to establish a common ground for the contributions of all partners in WP2, establishing indications such as the timeline and scope of activities and providing tools (i.e. templates for questionnaires, consent forms, module development etc.) to be used during subsequent activities.

The Integrated Pedagogical Framework (R2.3) is an approach that structures and guides the design, the implementation, and the assessment of practices related to teaching and learning. Moreover, it provides coherency in organising educational activities capable of extracting learning outcomes. Therefore, the Integrated Pedagogical Framework for the FEMST project is the identification of the local needs that were gathered during Activity 2. Localisation Process along with a set of pedagogical methods, principles, and strategies, which will be used for the creation of 6 training modules, aligned with the European Qualifications Framework (EQF) level 6 (at least).

In light of the above, the target group for the Training Package, which will be designed following the Integrated Pedagogical Framework, is primary school teachers and HE students,

and it will contain a range of themes that will cover every aspect of the STEM field, but also the different pedagogical methods that will be used, considering the needs of the localisation process and the data gathered from the focus groups in the partner countries.

3. Localisation Process Findings

The focus groups were conducted in the partner's countries (the Netherlands, Portugal, Cyprus, Greece, Spain) and provided valuable insights regarding the local needs and expectations that have been set as an important stage before creating the training material. The target group of the focus groups had a variety of professions and societal positions of expected participants, and included:

- Career councilors in upper secondary education,
- School teachers/educators,
- Academic staff
- University recruitment officers
- Primary education, and secondary female students
- HE female students studying in STEM
- Wider stakeholders in the field of Higher Education such as Policy Makers in the field of Education, Educational Institutions, HE institutions, Gender-related institutions at a local, regional, national and European level who are also taken into consideration as participants in some project activities. The focus groups were organised with a total of 15 questions, to encourage open dialogue and receive different perspectives and suggestions related to the project's aims and STEM in general.

The findings report was structured according to the questions asked to the participants, integrating the common patterns and divergences between the countries of the partnership. Firstly, it is important to present the professional spectrum of the participants, who answered

the questions set during the focus group. The vast majority of participants are either university staff, or teachers in primary and secondary education, and some of them are teaching sciencesincluded in STEM. Other professions that were identified during the focus groups are psychologist, metallurgist, and software developing, showing a diverse academic background. However, all the participants, regardless of their profession or academic background, have concerned themselves with female students in STEM.

Throughout the focus groups, it is evident that the participants presented relevant needs and expectations across the partner's countries (the Netherlands, Spain, Portugal, Cyprus, Greece), and different perceptions deriving from the profile and background of the participants, the tools

that need to be put forward for the empowerment of female students to follow STEM related education and career, and the views on the educational systems of each country. Below, the similarities and differences on local needs and expectations are listed.

Another view regarding the Integrated Education in STEM defines it as "the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning" (Kelley & Knowles, 2016).

Similarities

- Girls by the age of 15 have some exposure to STEM, however the percentage of exposure does not match the one of boys of same age.
- Female students are less reinforced and supported to follow STEM education than male students, despite moving forward towards bridging the gap during the last decades.
- Responsible to raise awareness about STEM in female students is education, including teachers, educators, professors, and the family.
- All the participants, regardless of their profession or education, responded empathically that they are interested in STEM education and activities.
- Increasing interest in STEM education, while simultaneously supporting female students, will make them gain self-confidence, achieving more opportunities to build a career.
- STEM careers are the jobs of the future, however social sciences and humanities should evolve and develop accordingly.
- Creativity and Innovation are the basic elements of STEM.
- There is no big familiarity with career psychometric tests.
- Gaining knowledge and techniques through different types of training on STEM, is important to be able to empower female students and encourage them.
- Frequent training is necessary among the participants.

Differences

- The opinions and experiences of the participants was influenced mostly on their academic/working background. Professions, such as psychologist, metallurgist, content creator, academic staff, trainers, were introduced during the focus groups.

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- Some of the participants noted that education is the most important carrier of empowerment of female students to STEM, without including the family as an extension of encouragement. Other participants also included governmental and state policy, and the society per se as additives to education.

- The participants that have their expertise on STEM, have undertaken more training, than other participants, whose academic background is social sciences, or humanities. It is important to note, however, that all the participants, as is mentioned in the "similarities" section, are willing to be trained on STEM activities.

- The educational system of each country defines the opportunities, the potential and support to female students on STEM. In some countries, potential can be overlooked, due to overcrowded classrooms, and impersonal education.

- The participants proposed different types of training, such as workshops, courses etc., which could be valuable information for the creation of the training modules.

4. Integrated Pedagogical Framework

As Heikkinen and Tynjälä argue in the *Integrative Pedagogy in Practicum,* "In the Integrative Pedagogy Model, theoretical knowledge, practical skills and self-regulation (reflective and metacognitive skills) are merged" (Heikkinen & Tynjälä, 2011). The four main characteristics of an integrated pedagogical method are a) curriculum content, b) educational methods, c) assessment-evaluation, d) learning environment. These characteristics, or education components, operate in synergy to encourage active learning, which also can be effective for students to acquire knowledge and develop their skills. The Framework under Activity 2.3 of the FEMST project aims to be the main structure for the design, creation, and development of the training package. Moreover, the importance of the Integrated Pedagogical Framework lies on the focus on learning outcomes, as it encourages educators to define measurable goals and

outcomes, enables the observation on the progress made, and defines the learning environment in which the target groups will end up achieving the necessary knowledge acquisition.

This Framework can also be characterized as the outcome of the merge of the local needs that were identified during the 1st focus group in the countries participating in the FEMST project, and also as an index comparing educational methods against established standards or best practices.

Another view regarding the Integrated Education in STEM defines it as "the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning" (Kelley & Knowles, 2016). The graph below shows a conceptual framework dedicated to STEM learning.

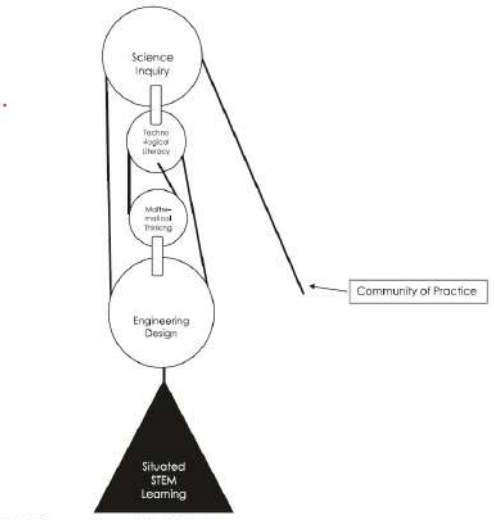

Fig. 1 Graphic of conceptual framework for STEM learning

(Kelley & Knowles, 2016)

As it is mentioned above, the Integrated Pedagogical Framework includes a set of educational components, one of which is the teaching methods. A prominent example of such method that

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has acquired a lot of supporters in the educational sector, is the **flipping the classroom** method. Bergman and Sams in their book, "Flip Your Classroom: Reach Every Student in Every Class Every Day", note that "students are often most in need of professor feedback while wrestling with homework problems" (Muzyka & Luker, 2016). Flipping the classroom often includes the use of video material, which allows students to focus "on work problems and other active learning pursuits while the professor is present to assist" (Muzyka & Luker, 2016). An interesting and relating with the FEMST project fact, is that flipping the classroom method offers significant benefits in STEM fields among "women and students with lower GPAs" (Muzyka & Luker, 2016).

5) Course Module Description

Training Module 1

COURSE MODULE DESCRIPTION		
1	**Thematic Area**	Problem Solving
2	**Course Module Title**	STEM Breakthroughs to Global Challenges
3	**Course Module description** **(aims & objectives)**	*This module aims to offer a holistic knowledge on multiple STEM disciplines to address societal challenges.* Aims and Objectives: ● Introduce foundational concepts in Science, Technology, Engineering, and Mathematics to provide students with a common understanding of the core principles. ● Encourage interdisciplinary thinking and collaboration among students from various STEM disciplines to cultivate holistic problem-solving approaches. ● Examine and analyze major global challenges, identifying their complexities and understanding the urgency of finding sustainable solutions. ● Explore and identify connections between different STEM disciplines and how their integration can lead to innovative solutions for global challenges. ● Showcase case studies and success stories of STEM breakthroughs, illustrating their impact on global challenges and inspiring students to think creatively. ● Develop the ability to critically evaluate the ethical, social, and environmental implications of STEM breakthroughs in the context of global challenges.

5	**Key words**	Global challenges, problem solving, interdisciplinary approach, breakthroughs, STEM.
6	**Learning outcomes (LOut)**	Upon completion of this module, the learners will be able to: • Develop a solid understanding of key Science, Technology, Engineering, and Mathematics (STEM) principles and how they contribute to addressing global challenges. • Investigate how interdisciplinary approaches within STEM fields can lead to breakthrough solutions for complex global issues. • Analyze and identify significant global challenges, such as climate change, healthcare disparities, or energy sustainability, and understand how STEM fields play a pivotal role in addressing these challenges. • Examine case studies and real-world examples of STEM breakthroughs that have made a substantial impact on addressing global challenges. • Apply critical thinking skills to evaluate the feasibility, ethical considerations, and potential societal impact of STEM solutions to global challenges. These learning objectives aim to provide a comprehensive framework for students to gain knowledge, skills, and a holistic understanding of how STEM breakthroughs contribute to addressing pressing global challenges.
7	**Contents**	Unit 1: Introduction to Problem Solving in STEM Unit 2: Interdisciplinary Approach on addressing societal challenges Unit 3: Current examples of Breakthroughs to Global Challenges through STEM
8	**Assessment method**	The assessment methods that will be used include multiple choice questions, quizzes, etc.
9	**Related Urls and Online Recourses**	

Training Module 2

COURSE MODULE DESCRIPTION		
1	**Thematic Area**	Digital Skills and E-Learning
2	**Course Module Title**	Bridging the Gender Division through Digital Knowledge
3	**Course Module description** **(aims & objectives)**	*This module aims to offer a series of digital sources which, could assist female students in STEM with more skills, empowering them to follow careers in the STEM field.*
5	**Key words**	Bridging the Gap, e-learning, digital sources

6	**Learning outcomes (LOut)**	Upon completion of this module, the learners will be able to: • Ability to identify and characterize the various domains that make up the eLearning area and their social impact; • Ability to discriminate concepts and issues in the area of eLearning as a transdiscipline; • Concerning emerging ecosystems. Ex: ChatGPT
7	**Contents**	Unit 1: Introduction Unit 2: E-Learning and essential digital skills Unit 3: Unique challenges and opportunities for female students in technology
8	**Assessment method**	The assessment methods that will be used include multiple choice questions, quizzes, etc.
9	**Related Urls and Online Recourses**	

Training Module 3

COURSE MODULE DESCRIPTION		
1	**Thematic Area**	Engineering and Sustainability
2	**Course Module Title**	Sustainable engineering and the role of women in STEM
3	**Course Module description** **(aims & objectives)**	*This module aims to offer a holistic knowledge on the correlation between sustainable engineering practices and environmental protection*
5	**Key words**	Sustainable engineering, sustainability, environmental protection
6	**Learning outcomes (LOut)**	Upon completion of this module, the learners will be able to: **UNIT 1:** By the end of this content the learners would: Ability to gain knowledge about existential risks for human security Ability to understand concepts about sustainable development and sustainable development goals (SDGs)

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		Ability to understand gender-climate nexus and relation between SDG 5 and SDG 13 **UNIT 2:** By the end of this content the learners would: Ability to understand effect of technology on sexual identity of women Ability to explain sustainable engineering and how engineering can be thought as a soft power Recognize the importance of women for climate solutions that work for entire world population **UNIT 3:** By the end of this content the learners would: Develop an understanding for deep connection between the speed of change, exponential technologies and environmental effects Ability to understand from example projects that are not only related to mathematics but also address human and environmental sustainability, all with the shared goal of making the world a better place
7	**Contents**	Unit 1: Introduction Unit 2: Sustainable engineering and the contribution of women engineers in the field Unit 3: Practices and projects in engineering, which promote environmental protection
8	**Assessment method**	The assessment methods that will be used include multiple choice questions, quizzes, etc.
9	**Related Urls and Online Recourses**	**sustain.org** **Women, SMEs and sustainable development – lessons learnt for the road ahead | UNIDO** **sdgacademy.org (35 online courses)** **world future studies federation** **The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services/www.ipbes.net/** **WFEO-WIE - WFEO** **Women, Peace & Security Explained - YouTube** **I'd Blush If I Could (unesco.org)** **Mathematics for action: supporting science-based decision-making - UNESCO Digital Library**

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Training Module 4

COURSE MODULE DESCRIPTION		
1	**Thematic Area**	Women in STEM
2	**Course Module Title**	Female Role Models in STEM Sciences and their Impact
3	**Course Module description** **(aims & objectives)**	*This module aims to offer a holistic knowledge on the impact of female role models in STEM*
5	**Key words**	Empowerment, role models, STEM sciences
6	**Learning outcomes (LOut)**	Upon completion of this module, the learners will be able to: **Upon completion of this module, learners will be able to:** ● Reframe the way they think about women in STEM by critiquing their own views and possible acquired stereotypes regarding science as a career path and scientists as professional role models (evaluate). ● Identify at least three (3) prominent female STEM scientists of the past and some of their thoughts (knowledge). ● Briefly describe the life, scientific discipline, and thoughts of at least one (1) female STEM scientist from the past (knowledge). ● Recognize the positive impact of women, both past and present, on the overall evolution of STEM fields (knowledge). ● Self-reflect and write down some of their core personal values, such as their passions, sources of inspiration, and causes (create). ● Identify the different STEM careers currently available in relation to their personal interests (knowledge). ● Defend the inclusion of more women in STEM fields in Europe by correlating inclusion with a positive social impact, both in terms of innovation and economic growth (evaluate).

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		• Identify the most important measures, programs, and platforms available within Europe to facilitate women's active participation in STEM fields (knowledge). • Categorize at least three (3) educational tools/platforms available in Europe with the aim of supporting female STEM students and professionals (analyze). • Correlate the benefits of lifelong learning and actively seeking opportunities as a path toward success (analyze).
7	**Contents**	Unit 1: Introduction Unit 2: Female Role Models who defined their STEM field Unit 3: Accessibility for STEM in EU
8	**Assessment method**	The assessment methods that will be used include multiple choice questions, quizzes, etc.
9	**Related Urls and Online Recourses**	

Training Module 5

COURSE MODULE DESCRIPTION		
1	**Thematic Area**	Data Science and Analytics
2	**Course Module Title**	Data Collection and Analysis Techniques

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3	**Course Module description** **(aims & objectives)**	*This module aims to offer a holistic knowledge on fundamental concepts, methodologies, and tools used in the field*
5	**Key words**	Data collection, analysis techniques, application of data in industries
6	**Learning outcomes (LOut)**	Upon completion of this module, the learners will be able to: ● Identify what is Data Science step by step ● Identify the set of skills a person needs to be data scientist ● Identify the ethics and the challenges that might arise ● Recognise the practical implications of data science to daily use of applications ● Understand the set of methods a data scientist that constitute the general approaches to collect data ● Identify the data collection tools, to narrow down the focus of the data collected
7	**Contents**	Unit 1: Introduction Unit 2: Concepts, methodologies, and tools in data collection and analysis Unit 3: Application of data in various industries
8	**Assessment method**	The assessment methods that will be used include multiple choice questions, quizzes, etc.
9	**Related Urls and Online Recourses**	

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COURSE MODULE DESCRIPTION		
1	**Thematic Area**	Emerging Technologies
2	**Course Module Title**	Artificial Intelligence is the Future (?)
3	**Course Module description** **(aims & objectives)**	*This module aims to offer a holistic knowledge on latest advancements in technology*
5	**Key words**	Emerging technologies, artificial intelligence, ethical and social implications
6	**Learning outcomes (LOut)**	Upon completion of this module, the learners will be able **to:** **UNIT 1:** By the end of this content the learners would: 1. Be able to define and explain the idea of artificial intelligence (AI), as well as its underlying ideas, purposes, and uses. 2. Be able to distinguish between Narrow AI (also known as Weak AI) and General AI (commonly known as Strong AI) after studying this material and be aware of their respective capabilities, restrictions, and potential ramifications. 3. Have a better understanding of how AI will influence both technology and society in the future, including its potential advantages and disadvantages, ethical issues, and the different fields where it is having a revolutionary effect. **UNIT 2:** By the end of this content the learners would: 1) Recognize and describe the most recent technological advancements, such as those in artificial intelligence, virtual reality, and other fields, while comprehending the underlying ideas and prospective effects on a variety of businesses. 2) Be able to discuss real-world use cases and applications of cutting-edge technology in a variety of industries, including healthcare, entertainment, education, and more, and to assess the possible advantages and drawbacks of each. 3) Possess improved critical-thinking abilities and increased ethical awareness in relation to contemporary technological breakthroughs. 4) Be capable of delving into the sociological, privacy, and security ramifications of these technologies, as well as their ethical implications, to promote a more responsible approach to their deployment and development. **UNIT 3:** By the end of this content the learners would be able:

		1) To recognize and discuss the key ethical considerations in artificial intelligence (AI). 2) To develop critical thinking skills to analyze complex ethical dilemmas and challenges related to AI. 3) To advocate for ethical innovation and policy development in the field of AI.
7	**Contents**	Unit 1: Introduction Unit 2: The Latest Advancements in Technology (Artificial Intelligence, Virtual Reality etc.) Unit 3: What are the ethical, economic, and social implication of technological advancements?
8	**Assessment method**	The assessment methods that will be used include multiple choice questions, quizzes, etc.
9	**Related Urls and Online Recourses**	

The Training Modules suggested above cover an extensive area of themes regarding STEM, taking into account the local needs, which were identified during the 1st focus groups of the FEMST project. The key result of FEMST is the design and development of an innovative learning and capacity training package that will address the needs of young girls in STEM in the partner countries that the project will be implemented. Addressing the local needs, the Integrated Pedagogical Framework provides the directives, the tools, and the learning outcome for the creation, and the development of the training package. More specifically, the IPF ensures:

- A coherent learning experience
- A focus on learning outcomes
- Continuous improvement
- Instructional strategies

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- Assessment methods
- Co-creation processes.

Specifications of the Training Modules

- EQF Level 6 (at least)
- Interactive content
- Language: English
- Expected Duration: 3 hours

Methodology for developing the Training Modules

Each module should include the following components:

- Unit: ....(title)
- Learning outcomes
- Learning objectives
- Keywords
- Training content
- References

Each unit should be the minimum 30 slides. The references should follow HARVARD reference classification in the end, as well as the footnotes that you intend to provide. Add at least 3 learning outcomes, 3 learning objectives per unit. Add at least 4 keywords per unit.

You should use Blooms Taxonomy Verbs for identifying the learning objectives and outcomes:

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1. Knowledge	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
Define	**Summarize**	**Solve**	**Contrast**	**Reframe**	**Build**
Identify	**Interpret**	**Change**	**Connect**	**Criticize**	**Animate**
Describe	**Classify**	**Relate**	**Relate**	**Judge**	**Adapt**
Recognize	**Compare**	**Complete**	**Devise**	**Defend**	**Collaborate**
Tell	**Contrast**	**Use**	**Correlate**	**Appraise**	**Compose**
Explain	**Infer**	**Sketch**	**Illustrate**	**Value**	**Devise**
Recite	**Relate**	**Teach**	**Distill**	**Prioritize**	**Podcast**
Memorize	**Extract**	**Articulate**	**Categorize**	**Grade**	**Write**
Illustrate	**Paraphrase**	**Discover**	**Conclude**	**Plan**	**Manage**
Quote	**Cite**	**Transfer**	**Take appart**	**Predict**	**Negotiate**

6. References

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