Co-funded by the Erasmus+ Programme of the European Union

Methodological framework for the definition and development of training material for STEM teachers

(Ref. Result 1 // Project)

FULL STEAM AHEAD: De-gendering STEM through STE(A)M and creative thinking in secondary education

Project Number: 2021-1-HR01-KA220-SCH-000027733

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https://fullsteam-ahead.eu/the-project/

To the loving memory of Svenja Pokorny

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INTRODUCTION

This document demonstrates the **"Methodological Framework for the Definition and Development of Training Material for STEM Teachers"**, corresponding to the foreseen Result No.1 of the Erasmus+ project "FullSteamAhead - De-gendering STEM through STE(A)M and creative thinking in secondary education". The document is organised in two chapters. In the **first chapter "Combined research findings" we present the findings of primary and secondary research** carried out by the project partnership in the first half of 2022 in Croatia, Greece, Italy, Spain. The objective of both research activities was to **collect information on how STEM subjects are pedagogically approached by secondary education teachers in their teaching practice**, to eventually lead us to the development of the methodological framework to be deployed in organising and offering the FullSteamAhead training provision of the project for teachers, connecting thus this project activity with Result No.2 "Development of digital training and pedagogical modules for a de-gendered STEM teaching approach". The first chapter contains **summarized findings of main points** from teacher's questionnaire, along with supplements of desk research (secondary research data), students' questionnaire, as well as qualitative interviews with teachers and parents.

Research indicators:

- ✓ 121 teachers responding to online questionnaire
- ✓ 53 secondary school students responding online questionnaire
- ✓ 23 teachers responding to qualitative interviews
- ✓ 15 family members responding to interviews and 2 members responding on behalf of the Association of parents at IES la Cala (secondary school in Spain)
- ✓ 11 examples of good practices in STEAM education

Main points of **collective results in first chapter serve as ground base for second chapter the "Methodological Framework for the Definition and Development of Training Material for STEM Teachers"**, which is extended to R2 in the way that provides topics, common templates, and guidelines for development of educational materials. The **second chapter** provides an **outline for development of educational materials in English language**. After the materials are developed, project partners will translate and adapt the materials to the needs of teachers and students in their respective countries, to be eventually offered in an online training and learning space.

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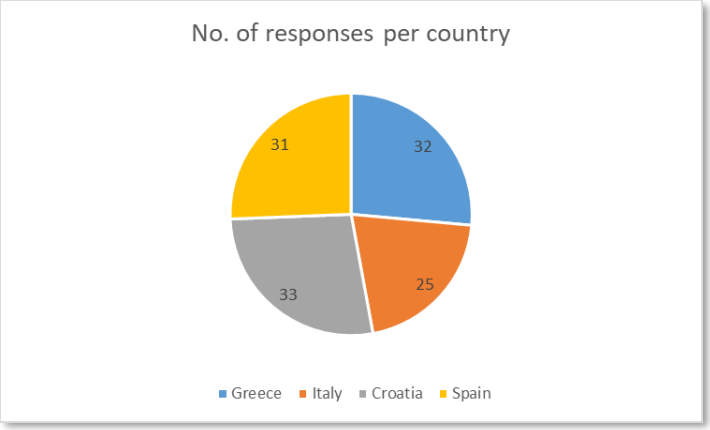
1. COMBINED RESEARCH FINDINGS

Below you can find combined research findings drawing from **primary research data (questionnaires for teachers and students, and interviews with teachers and parents)**, and **secondary research data (desk research)**.

STEAM awareness, application, preferences (teachers)

Figure 1: number of responses per country



Source: own elaboration

69 of the respondents were female and 51 were male, while 1 respondent chose the answer other.

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As to the question **Do you teach any STEAM integrated classes/project/programs in your school?**

Table 1: Steam integrated classes of respondents

	No. of responses	Percentage
Mathematics	16	9,6%
Art	8	4,8%
Engineering	6	3,6%
Nature and Environmental science	7	4,2%
Literature and language	17	10,2%
Chemistry	7	4,2%
Music	2	1,2%
Computer science	8	4,8%
Biology	9	5,4%
Physics	17	10,2%
Design and technology	4	2,4%
Information and communication technology (ITC and IT)	13	7,8%
Geography	8	4,8%
Economics	9	5,4%
No, I don't teach STEAM classes	27	16,2%
Other:	9	5,4%

Source: own elaboration

In addition, if the teachers are not teaching one of the STEAM subjects, or if their subject was not listed in the questionnaire, they were able to specify which subject do they teach. 9 teachers added additional classes: Agriculture; Electrical Engineering; History; Physical activity; Veterinary; History Graphic and visual communication; Support teacher for disabled students

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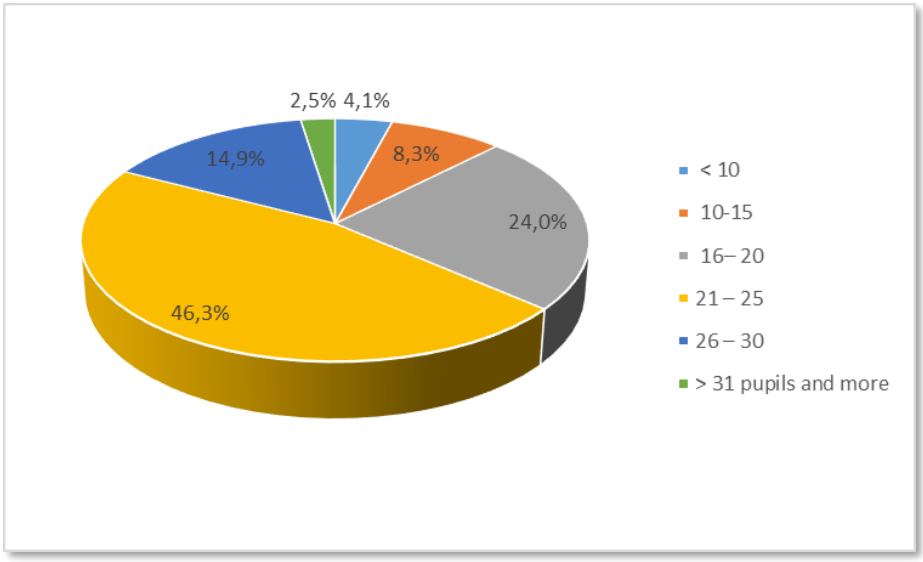
As to the size of the classes, figure 2 shows the results:

Figure 2: Size of the class reported by the respondents



Source: own elaboration

Figure 2 shows that 46,3% classes have 21 – 25 students, followed by 16-20 students and then 26 – 30 students.

Following the results, when developing educational materials preferable number of students in working group would be around 20 students.

Regarding the grade in which the respondents teach most hours during the 2022 school year, all grades have been represented in questionnaire.

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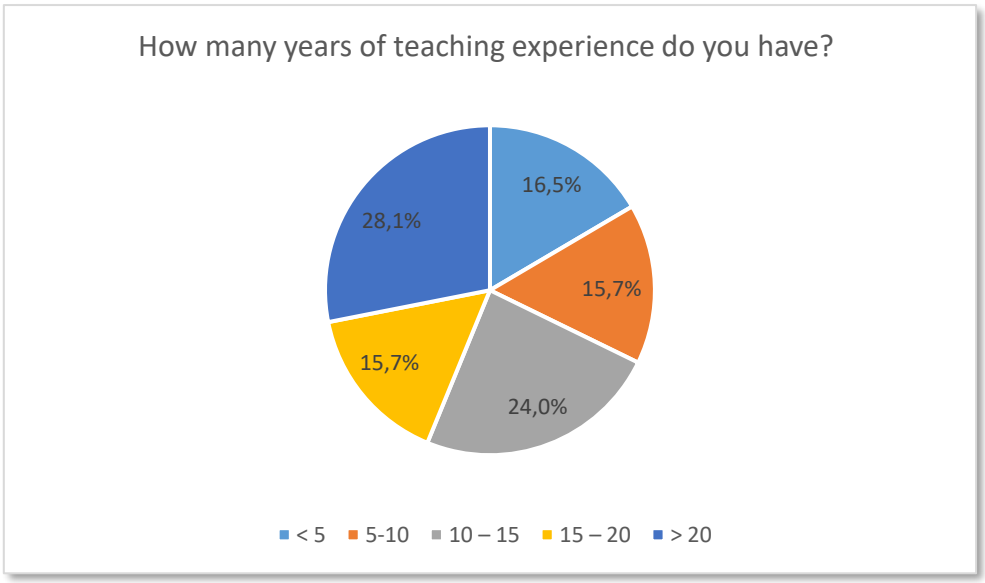
As to the years they have been teaching, the most teachers that participated in the questionnaire have been teaching over 20 years and from 10 to 15 years.

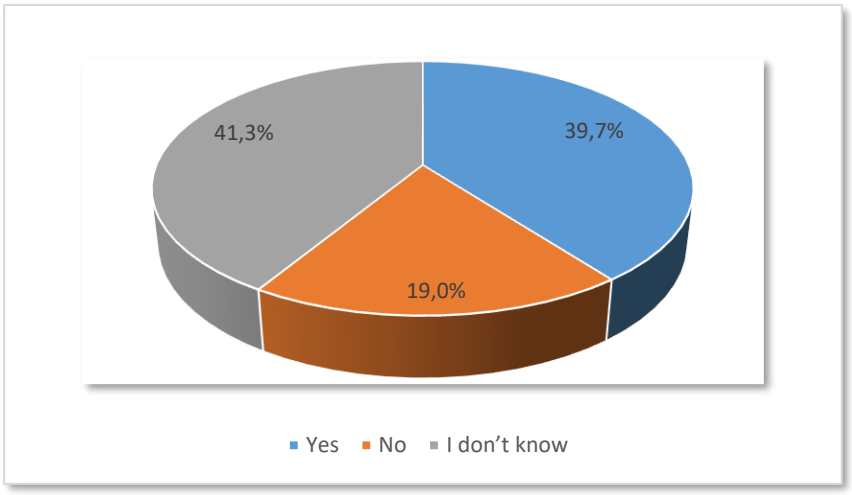
Figure 3: Years of teaching experience



Source: own elaboration

As to whether there are **opportunities in partners countries for teachers to participate in professional development relevant to STEAM education** (seminars, programs, projects, courses for teachers etc.), the following figure shows the results:

Figure 4: Opportunities in partners countries for teachers to participate in STEM professional development



Source: own elaboration

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Figure 4 shows that **41,3% of the teachers are not sure or don't know if there are any STEAM professional development opportunities** in their countries and 19% stated that there are no training opportunities in their country.

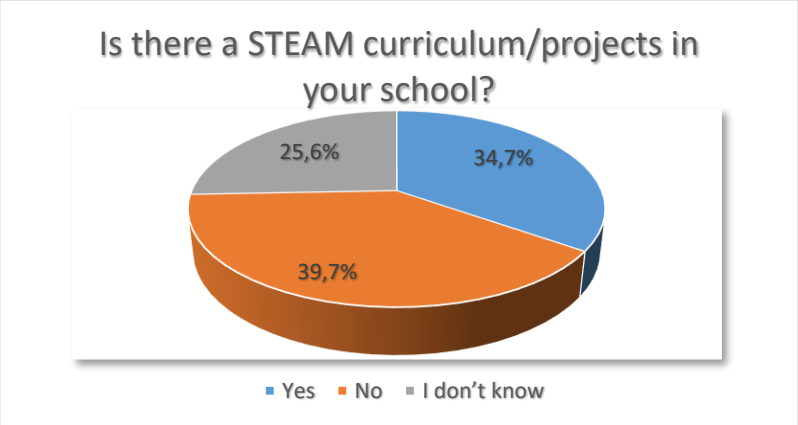
Additionally in interviews, teachers were asked: *Which factors are currently most critical in your country regarding training for teachers in STEAM education*.

These are the key words from the interviews:

- Lack of time for teachers to participate in training
- Lack of training with innovative methods (a lot of trainings are still based on frontal teaching)
- Lack of general interest
- Lack of skills of STEAM teachers to transfer knowledge to other non-STEAM teachers
- Lack of finances for proper teacher trainings
- Lack of specific and practical instructions/examples for implementation of STEAM (most of the instructions are too general)
- Lack of methodological training.
- Trainings that exist are made based on one-dimensional logic depending and there are not have a multi-discipline character.

Regarding the question **whether there is STEAM curriculum/projects in their school**, the following figure shows the results:

Figure 5: Availability for teachers STEAM curriculum/projects in their school



Source: own elaboration

Figure 5 shows that **only 34,7% teachers have or are aware of STEAM curriculum in their schools**.

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As to which subjects' students are more likely to engage with (not necessarily in STEAM field) by gender, table 2 shows that the girls (colour green) are more attracted towards *Art, Literature and language and Psychology*. While the boys *(orange colour) gravitate more towards: Engineering, Computer science and ICT*.

In each subject from the list, level of student's interest by gender can be distinguished, but the subjects for which students have *the most equal interest are: Nature and Environmental science; Music; Biology and Geography.*

Table 2: Preferred subjects of students per gender

B.4. In your opinion, which courses/subjects' students are more likely to engage with (not necessarily in STEAM field)?	Boys No. of responses	Percentage	Girls No. of responses	Percentage	Equaly No. of responses	Percentage	Neither No. of responses	Percentage
Mathematics	31	25,6%	6	5,0%	79	65,3%	5	4,1%
Art	4	3,3%	63	52,1%	50	41,3%	4	3,3%
Engineering	82	67,8%	2	1,7%	30	24,8%	7	5,8%
Nature and Environmental science	8	6,6%	17	14,0%	95	78,5%	1	0,8%
Literature and language		0,0%	60	49,6%	56	46,3%	5	4,1%
Chemistry	22	18,2%	8	6,6%	84	69,4%	7	5,8%
Music	5	4,1%	24	19,8%	88	72,7%	4	3,3%
Computer science	60	49,6%	4	3,3%	53	43,8%	4	3,3%
Biology	3	2,5%	25	20,7%	90	74,4%	3	2,5%
Physics	44	36,4%	9	7,4%	60	49,6%	8	6,6%
Design and technology	31	25,6%	10	8,3%	74	61,2%	6	5,0%
Information and communication technology (ITC and IT)	49	40,5%	2	1,7%	68	56,2%	2	1,7%
Geography	12	9,9%	7	5,8%	94	77,7%	8	6,6%
Economics	19	15,7%	7	5,8%	83	68,6%	12	9,9%
Sports	48	39,7%	2	1,7%	67	55,4%	4	3,3%
History	13	10,7%	22	18,2%	81	66,9%	5	4,1%
Philosophy	9	7,4%	25	20,7%	71	58,7%	16	13,2%
Sociology	3	2,5%	37	30,6%	66	54,5%	15	12,4%
Psychology	4	3,3%	53	43,8%	52	43,0%	12	9,9%
Ethics	1	0,8%	24	19,8%	83	68,6%	13	10,7%
Religion studies	1	0,8%	13	10,7%	83	68,6%	24	19,8%

Source: own elaboration

STEAM preferences (students)

A questionnaire that was implemented with 53 students, shows similar results:

When asked **"what is their favourite subject in school?"**, students were able to choose multiple answers:

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Table 3: Students favourite subject in school

What is your favourite subject in school?	No. Of responses	Percentage
Mathematics	2	1,3%
Art	8	5,2%
Engineering	3	1,9%
Nature and Environmental science	2	1,3%
Literature and language	11	7,1%
Chemistry	1	0,6%
Music	14	9,1%
Computer science	8	5,2%
Biology	6	3,9%
Physics	1	0,6%
Design and technology	9	5,8%
Information and communication technology (ITC and IT)	12	7,8%
Geography	12	7,8%
Economics	3	1,9%
Sports	25	16,2%
History	15	9,7%
Philosophy	3	1,9%
Sociology	4	2,6%
Psychology	7	4,5%
Ethics		0,0%
Religion studies	2	1,3%
Other (Please specify)	6	3,9%

Source: own elaboration

Table 3 shows that student's interest is highly directed towards Sports followed by History, Music, IT/ITC, Geography and Literature.

Second most rated subjects are also Design and technology, Computer science and Art.

As to an open question in student's questionnaire: *What topics would you like to explore in school?* (Topics can be related to school subjects but they also can be related to your everyday interest. For example: movies, music, photography, philosophical topics, exploring emotions and human psychology etc.).

22 students stated that they would like to explore *psychology and human emotions, next highest rated topics were music and movies.*

Pedagogical methods

In the questionnaire for teachers, as to which pedagogical methods would be most relevant to motivate students towards STEAM education, the highest rated methods are Teaching with

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experiments and Problem based learning, closely followed by Inquiry based learning, Challenged based learning and Experiential Learning.

The lowest rated method is Frontal instructions.

Table 4: Most relevant methods

PEDAGOGICAL METHODS CONSIDERED BE MOST RELEVANT TO MOTIVATE STUDENTS TOWARDS STEAM EDUCATION	Average (Where 6 is N/A and 5 is completely relevant and 1 is completely irrelevant)
Frontal instructions	2,8
Teaching with experiments	4,5
Socratic dialog	4,2
Problem base learning	4,5
Group work (collaborative learning)	4,2
Peer to peer learning	4,1
Inquiry Based Science Education	4,4
Holistic approach	4,1
Experiential Learning	4,4
Integrated learning	4,1
Flipped classroom	3,7
Design thinking	4,1
Visual Thinking Strategies	3,9
Challenged based learning	4,3

Source: own elaboration

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As to the **skills considered most relevant for students to develop through STEAM education, table 5 shows that all the listed skills received a high rating.** If we would single out the most rated skills, they would be the following: *Problem solving* followed by *Critical thinking, Creativity; Innovation; Collaboration and Curiosity.*

Table 5: Skills students could develop through STEAM

SKILLS CONSIDERED MOST RELEVANT FOR STUDENTS TO DEVELOP THROUGH STEAM EDUCATION	AVERAGE (WHERE 6 IS N/A AND 5 IS COMPLETELY RELEVANT AND 1 IS COMPLETELY IRRELEVANT)
CRITICAL THINKING	4,6
CREATIVITY	4,6
INNOVATION	4,6
PROBLEM SOLVING	4,7
COLLABORATION	4,6
COMMUNICATION	4,4
CHARACTER BUILDING SKILLS	4,2
SELF-EXPRESSION	4,2
CURIOSITY	4,6

Source: own elaboration

Additional skills that were emphasized by teachers are:

- Advance in communication in foreign languages.
- Independence, justice, determination, courage.
- Mutual respect and acceptance.
- Self-confidence.
- Memorization.
- Perception of oneself as a member of society.
- 21st century skills and transversals skills.
- Hand skills.
- Kinesthetics.
- Self-knowledge and self-confidence.
- Empathy, use of digital media, digital literacy.
- Insistence and patience.
- Emotional Intelligence.
- Planning and homework organisation.

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Regarding the choice of media/materials/learning resources you think is most relevant to motivate students for STEAM education, table 6 illustrates that Hand on science experiments and Virtual labs are the preferred methods followed by STEAM software and Audio-visual materials.

Table 6. Choice of media

CHOICE OF MEDIA/LEARNING RESOURSES/MATERIALS CONSIDERED MOST RELEVANT TO MOTIVATE STUDENTS TOWARDS STEAM EDUCATION	AVERAGE (WHERE 6 IS N/A AND 5 IS COMPLETELY RELEVANT AND 1 IS COMPLETELY IRRELEVANT)
AUDIO-VISUAL MATERIALS	4,2
PAPER BASED MATERIALS	3,5
HANDS ON SCIENCE EXPERIMENTS	4,5
VIRTUAL LABS	4,3
WORD PROCESSORS (MS WORD, EXCEL, GOOGLE DOCS)	3,8
STEAM SOFTWARE (E.G. GEOGEBRA)	4,2
ONLINE COLLABORATIVE TOOLS (E.G. MENTIMETER, QUIZLET, KAHOOT, SCRATCH ETC)	4,0
POWER POINT PRESENTATIONS	3,7
MORSE CODE APPS FOR DECODING	3,6
3D DESIGN SOFTWARE	4,1
HANDS ON ARTS AND CRAFTS MATERIALS	4,0

Source: own elaboration

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Other media/materials/learning resources mentioned were:

- Measurements, estimates of the cost-effectiveness of work
- Constructions by themselves
- Augmented reality
- Musical instruments, human voice
- Photography, plasticine

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As to the approaches would be the most suitable to motivate (empower) female students in taking more interest in STEAM education the most relevant approaches were *Connecting STEAM to everyday life situations* followed by *Transdisciplinary teacher; Career panorama on possibilities valid for man and woman; Developing soft skills in science*, as shown in table 7:

Table 7. De-gendering approaches considered most suitable

MOST SUITABLE APPROACH TO MOTIVATE (EMPOWER) FEMALE STUDENTS IN TAKING MORE INTEREST IN STEAM EDUCATION	AVERAGE (WHERE 6 IS N/A AND 5 IS COMPLETELY RELEVANT AND 1 IS COMPLETELY IRRELEVANT)
ROLE MODELS / WOMEN PROFILES IN TECHNOLOGY AND SCIENCE, DRAWING FROM PRESENT AND PAST	4,2
HISTORY, PHILOSOPHY OF SCIENCE AND TECHNOLOGY AS ACHIEVEMENTS OF WOMEN AND MEN	4,2
CONNECTING STEAM TO EVERYDAY LIFE SITUATIONS	4,6
ENCOURAGE CHARACTER BUILDING SKILLS AND SELF-EXPRESSION	4,2
TRANSDISCIPLINARY TEACHING – COMBINING STEAM AND OTHER SUBJECTS	4,4
CAREER PANORAMA ON POSSIBILITIES VALID FOR MEN AND WOMAN	4,3
DEVELOPING SOFT SKILLS IN SCIENCE AND ENGINEERING SUBJECTS	4,3

Source: own elaboration

In interviews the teachers were asked *How might we motivate girls to have more interest in STEAM education?* Here are summarized answers:

- ✓ Choose case studies from various relative professions in which their gender is engaged
- ✓ Changing the general mentality that science and technology are more suitable for boys.
- ✓ Creating gender-neutral activities that interest both boys and girls.
- ✓ Changing the subjects of the activities to more appealing ones for girls.
- ✓ They usually participate in the discussions and different strategies are usually used with more active and participatory methodologies.
- ✓ Motivate them by giving them the opportunity to explore and explain the world around them instead of simply providing them with answers and to introduce Science in a different way because girls like biology and chemistry.
- ✓ Make classes more engaging.

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- ✓ Proposing projects to them.
- ✓ Offering them the opportunity to actively experiment with STEAM.

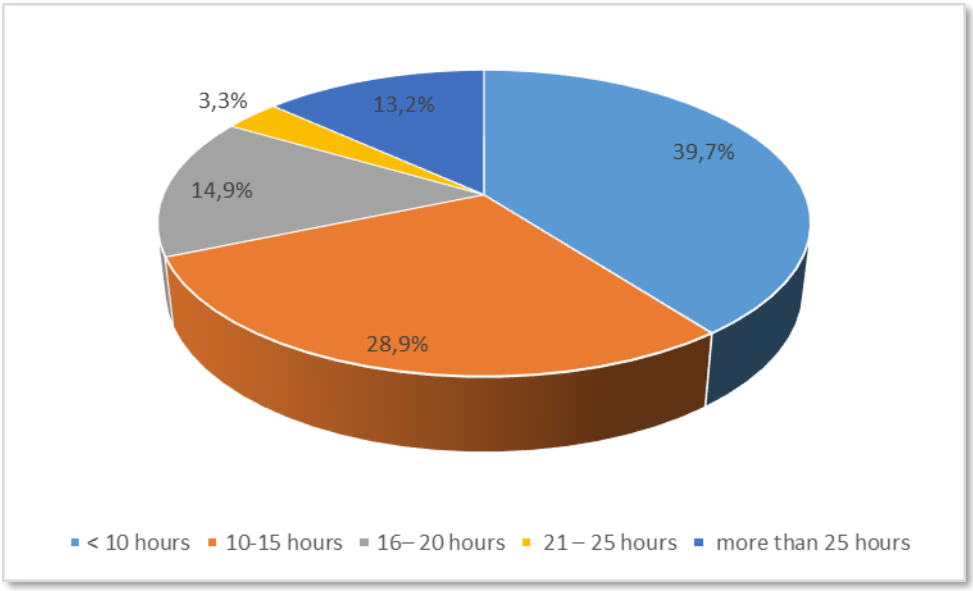
Students on the other hand, had an open question in the questionnaire: How would you make science more interesting to you and your peers?

9 students stated that they don't know how to make science more interesting. Rest of the students suggested more practical and interactive work, experiments, group and individual tasks, outdoor classrooms…

Furthermore, over 50% of students stated that they love tasks in which they need to find creative solutions and build something and that they would like to know more about woman in science.

As to the **total time you believe teachers could devote, if interested, to the open training platform for teachers which will be developed through the course of the project FullSteamAhead,** the following figure shows that the preferred duration would be from *10 hours* followed by *10 to 15 hours*:

Figure 6: Time that could be devoted by the teachers



Source: own elaboration

When asked if they had **further suggestions to our FullSteamAhead team to design educational resources for teachers in STEAM education,** these are the results:

- *Lots of education related to STEAM technology and procurement of appropriate applications and equipment*
- *Look for ways in which the role of women in society can be derived from instrumental to functional, which presupposes a way out of formal equality and creating conditions for education that will not be traditional gender conditioned. If we ask ourselves why there are no women in STEAM and only that, women will not find an easy path to a career in this field.*

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The intervention must be broader and aimed at creating social conditions for action that will not condition equal gender distribution but practice equal gender distribution.

- *Have the least possible theory and most possible hands-on activities (just like the STEAM approach!)*
- *Less is more. Simple formalities and the requirement of a short time for learning the material in order to attract the initial interest of the teachers.*
- *Information about steam not mainly through email and familiarization of educational media with organized training.*
- *The planning should be done taking into account the age groups of the students.*
- *To learn more (seminars, trainings) about this material, so that we can use it*
- *The most important thing in an educational material is the SPECIFIC examples, and not only the theoretical background.*
- *Design materials that are easy to adapt to different classes*
- *I think it is important not to stay within the theoretical framework but rather to favor the success of the project with sufficient resources (both personnel, technology, and training).*
- *Each person must freely choose what they want to study and work.*
- *Differentiate training between primary and secondary/high school teachers, with a common basis but training in specific resources according to the educational level of the students.*

When asked: ***What would be your main concerns regarding gender barriers/gaps if you were to implement STEAM education?***

One part of teachers didn't have any concerns. For the teachers that elaborated their worries, here are summarized answers that reflect overall concerns:

- A big concern would be to point out to boys and girls that the STEM area is not exclusively destined for men.
- Attitudes and desires of girls towards Steam education.
- Motivate girls to express their opinions and assumptions without hesitation.
- My main concern is a sexist approach that and women often encounter that.
- Sufficient motivation of the participants.
- Encountering resistance or disinterest.
- Lack of self-confidence in female students.
- I have no direct experience. On a theoretical level no doubts.
- Difficulties of integration with the mandatory ministerial program, which poses controversial but, currently, essential constraints.
- The number of students per class is excessive, not enough time to individualize and personalize teaching.
- the girls from my point of view really struggle in many cases to place themselves in a leadership role of the group.
- Ability to concentrate in boys. Confidence in girls.
- The main concern is the perpetuation of stereotypes by the educational community itself and the children's interlocutors.
- Gender stereotypes are hard to break, and many positive examples are missing
- Gender stereotypes and the so-called "hidden curriculum" not explained, which continues to affect the attitudes and values of our students.

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Good practices in STEAM

In the secondary research as carried out in Croatia, Greece, Italy, and Spain, we have identified several good practices. Some of them are on national languages, but some examples are also available on English. These examples can serve as an inspiration when developing educational materials for the FullSteamAhead project.

Table 8. Examples of good practices

Collective examples of good practices in STEAM education		
NAME	*TYPE*	*LINK*
GIRLS CODE IT BETTER	Training programme/Teacher training/Learning Platform	https://girlscodeitbetter.it/il-progetto/
STEAM UP ALLE RAGAZZE	Online Toolkit/Training Programme	https://www.scuoladigitaleliguria.it/risorse/kit-steam-ragazze.html
Community of Inquiry: from the science laboratory to philosophical practices	Training Programme	https://www.fondazionegolinelli.it/en/teacher-courses/community-of-inquiry-dal-laboratorio-di-scienze-alle-pratiche-filosofiche https://www.fondazionegolinelli.it/en
Masterclass for Steam	Training Programme/ Teacher Training	https://www.facebook.com/watch/?v=670269520768645
Code INTEF – ChicaSTEM (GirlSTEM)	Online space promoted by the Professional Development and Technology Institute (INTEF) is the National Agency for Educational Technology and Teacher Development funded by the Spanish Ministry of Education, Culture and Sport.	https://code.intef.es/chicastem/
Co-construction of rubrics for the assessment of STEM high school projects	Guidelines in the form of an academic article based on a co-construction model to create rubrics for the assessment of STEM high school projects	https://www.redalyc.org/journal/920/92064232001/html/
Repository of Good practices in Spanish	Repository of Good practices in Spanish to implement different activities related to women and girls in STEM.	https://organizaciondemujeres.org/category/materiales-didacticos/ https://organizaciondemujeres.org/category/campanas/visibilizacion/
GENERATION NEXT	Guidelines, videos and seminars for many different issues related to STEM as well as instructions for devices construction.	https://www.vodafonegenerationnext.gr
EQUAL IN EVERYTHING / SIDE BY SIDE, FEMALE AN MALE	Handbook/ Guidelines	https://edutorij.e-skole.hr/share/proxy/alfresco-noauth/edutorij/api/proxy-guest/4d99edf7-28e4-43be-81d7-92993cdf3227/index.html https://edutorij.e-skole.hr/share/proxy/alfresco-noauth/edutorij/api/proxy-guest/caa820db-ee3e-4ce7-8df5-8eaf41f01aee/index.html
RoboGirls: empowering girls in STEAM through robotics and coding	On line tools	https://robogirls.eu/en/
Gender4STEM – Gender aware education and teaching	An e-learning platform	https://www.gender4stem-project.eu/

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2. METHODOLOGICAL FRAMEWORK: TRANING MATERIAL FOR STEM TEACHERS

This output constitutes the milestone of the project, as it refers to the development of the actual educational materials, based on the findings of the study – desk research, questioners and interviews (R1).

The main aim of this Methodological framework is to outline the development of **21 educational materials** (3 per partner) to support teachers in motivating the students towards STEAM education as a de-gendered subject and to interduce students to STEAM as a de-genderesd option for personal and professional development.

Main target group in this process are **secondary school teachers** followed by **family members/parents of secondary school students.**

As indicatively planned, the development of the training material was divided in 3 main parts:

- ✓ THEMATIC PART 1 (STEM IN SECONDARY EDUCATION AS A DE-GENDERED TEACHING SUBJECT)
- ✓ THEMATIC PART 2 (STEM AS A DE-GENDERED OPTION FOR PERSONAL AND PROFESSIONAL DEVELOPMENT)
- ✓ SUPPORT MATERIAL FOR PEER GROUP DYNAMICS AND FAMILY/PARENTS/SIGNIFICANT OTHERS OF STUDENTS

THEMATIC PART 1 and THEMATIC PART 2 will be combined together in educational materials,

While SUPPORT MATERIAL FOR PEER GROUP DYNAMICS AND FAMILY/PARENTS/SIGNIFICANT OTHERS OF STUDENTS will be offered as separate/additional provision with materials; links; videos etc.

The materials will be developed first in English and **then translated in all partner languages** with specified parts of the material adapted to national circumstances (based on the National reports).

The materials will be accessible online on a landing page.

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Division of topics

The topics for development of educational materials were chosen based on the student's interest in school subjects and their interest outside of the school.

The materials will be developed for high school students from 1st to 4th grade. Since each country has different school systems and ages can be overlapping, the materials will be adapted for the following age range:

From 11 to 13 years old

From 13 to 16 years old

From 16 to 18 years old

Each partner will develop 3 materials which makes 21 educational materials all together (see Table 9)

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Table 9. Topics for development of education material

TOPICS FOR DEVELOPMENT OF EDUCATIONAL MATERIALS		
ART AND SCIENC		
TOPIC	**PARTNER**	**AGE**
Science through art-based activities	IES LA CALA	11-13
Scientists that were artists	MILITOS	13-16
Development of creativity and creative thinking	Moraitis school	13-16
Making zines	BR	16-18
NATURE SCIENCE AND BIOLOGY		
TOPIC	**PARTNER**	**AGE**
Hands on experiments	IES LA CALA	11-13
How science of nature affects human life	MILITOS	13-16
Energy balance and Metabolism	Moraitis school	13-16
Animal/human behaviourism and emotions	PP	16-18
Ecology	BR	16-18
TECHNOLOGY		
TOPIC	**PARTNER**	**AGE**
Nature based solutions for the symbiosis of humans with nature	MILITOS	11-13
Development of new technological ideas for everyday life and/or environment	Moraitis school	13-16
Design software's	IES LA CALA	16-18
MOVIES		
TOPIC	**PARTNER**	**AGE**
Making animated movie or short movie on smartphone	ITC	11-13
Movies with woman in science	STEPS	13-16
SELF-KNOWLEDGE, HUMAN EMOTIONS AND PSYCHOLOGY		
TOPIC	**PARTNER**	**AGE**
Emotional effect on human body	PP	11-13
Types of personalities by Jung	STEPS Using free apps as Kahoot	13-16
Psychological test conducted by student	ITC	16-18
LANGUAGE AND LITERATURE		
TOPIC	**PARTNER**	**AGE**
From abstract to literacy	ITC	11-13
Woman in literature under a pseudonym	STEPS	13-16
Neuroscience on language learning	PP	16-18
SPORT AND HEALTH		
TOPIC	**PARTNER**	**AGE**
Sport and Health	BR	16-18

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Educational materials will be developed in common template. To make materials more interactive, images, links and tutorials can be incorporated in template, especially in the Step-by-step section.

Table 9. Proposed template for learning materials

PROPOSED TEMPLATE FOR LEARNING MATERIALS	
TITLE	Name of the learning material
AGE	Age groups: 11-13/13-16/16-18
MATERIALS	List of materials needed to implement the activities
TIME	Time needed to implement the activity with students
GROUP SIZE	Number of students in the working group or if it is an individual season
OBJECTIVES	Learning objectives that should be achieved **(max 2 objectives)**
METHODOLOGY	Name of the methodology that is used to achieve the objectives (for example: Problem based learning)
CROSS – CURICULAR	Which school subjects can be combined (if any)
AUTHOR	Authors of learning materials could be signed as partner organization or individuals
STEP BY STEP IMPLEMENTATION	Step by step plan how to implement learning materials in learning surroundings. Suggestion would be that we develop flexible materials in order for teachers to adjust the according to the needs and abilities of the students they are working with.
FUN FACT or WOMAN IN SCIENCE	One fan fact or just a fact about real life woman in science.

Methods, materials, skills development

Following the topics presented, educational materials will combine different school subjects in order to create cross-curricular approach.

The keywords we have identified that would make the materials interesting to teachers and students are:

- ✓ Easley adaptable materials
- ✓ Hands on activities and experiments
- ✓ Specific examples
- ✓ Practical and interactive activates
- ✓ Connecting with real life and its situations
- ✓ Creative tasks

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✓ Group tasks

The following tables present **summary of teacher's choice of methods, media, approach and skills for students to develop**. Presented answers were rated above average of 3,5, but most rated ones are highlighted in red. More detailed description can be found in first chapter.

All proposed methods were highly rated, except for Frontal instructions which had average of 2,8. The red highlighted methods had the highest marks:

Table 10. Methods

METHODS	
Teaching with experiments	Subject matter is test through practical experiments
Problem base learning	Students learn about a subject by working in groups to solve an open-ended problem
Inquiry Based Science Education	Engaging students in designing and conducting their own scientific investigations
Experiential Learning	Entails the student to seek beyond academic pursuits. It encourages learning by doing – building life skills
Socratic dialog	Exploring students' thoughts, and evaluating the evidence regarding those and other possible thoughts
Group work (collaborative learning)	Collaborative learning
Peer to peer learning	Students are given the opportunity to learn from each other
Holistic approach	Learner's emotion, intellect, creativity, imagination and body are activated to bring forth a comprehensive and effective level of educational experience
Integrated learning	Students make connections across subjects
Flipped classroom	Students' complete readings outside of the classroom and work on live problem-solving during class time
Design thinking	Literative process that used to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test
Visual Thinking Strategies	Using art for student-centred facilitation method to create inclusive discussions
Challenged based learning	Learners are presented with a real-life problem or issue and then are asked to examine, research, and identify its main components
Frontal instructions	Delivery of content by teacher

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Table 11. Media

CHOICE OF MEDIA	AVRG
Hands on science experiments	4,5
Virtual labs	4,3
STEAM software	4,2
Audio-visual materials	4,2
Paper based materials	3,5
3D design software	4,1
Online collaborative tools	4,0
Hands on arts and crafts materials	4,0
Word processors	3,8
Power Point presentations	3,7
Morse code apps for decoding	3,6

Table 12. Approach

CHOICE OF APPROACH	AVRG
Connecting STEAM to everyday life situations	4,6
Transdisciplinary teaching – combining STEAM and other subjects	4,4
Career panorama on possibilities valid for men and woman	4,3
Developing soft skills in science and engineering subjects	4,3
Encourage character building skills and self-expression	4,2
Role models / women profiles in technology and science, drawing from present and past	4,2
History, philosophy of science and technology as achievements of women and men	4,2

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Table 13. Skills

CHOICE OF SKILLS FOR STUDENTS TO DEVELOP	AVRG
Critical thinking	*4,6*
Creativity	*4,6*
Innovation	*4,6*
Collaboration	*4,6*
Curiosity	*4,6*
Communication	4,4
Character building skills	4,2
Self-expression	4,2

When it comes to skills that are most relevant for students to develop, key words were also identify in National reports:

- ✓ Self-knowledge
- ✓ Self confidence
- ✓ Empathy
- ✓ Emotional intelligence
- ✓ Independence
- ✓ Determination
- ✓ Mutual respect and acceptance
- ✓ Perception of oneself as a member of society

This shows that character building skills and self-expression are much more needed than they are rated in the table. It also applies that development of self -knowledge, soft skills and ethical values are also very necessary and important for students to develop.

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Specific guidelines for material development

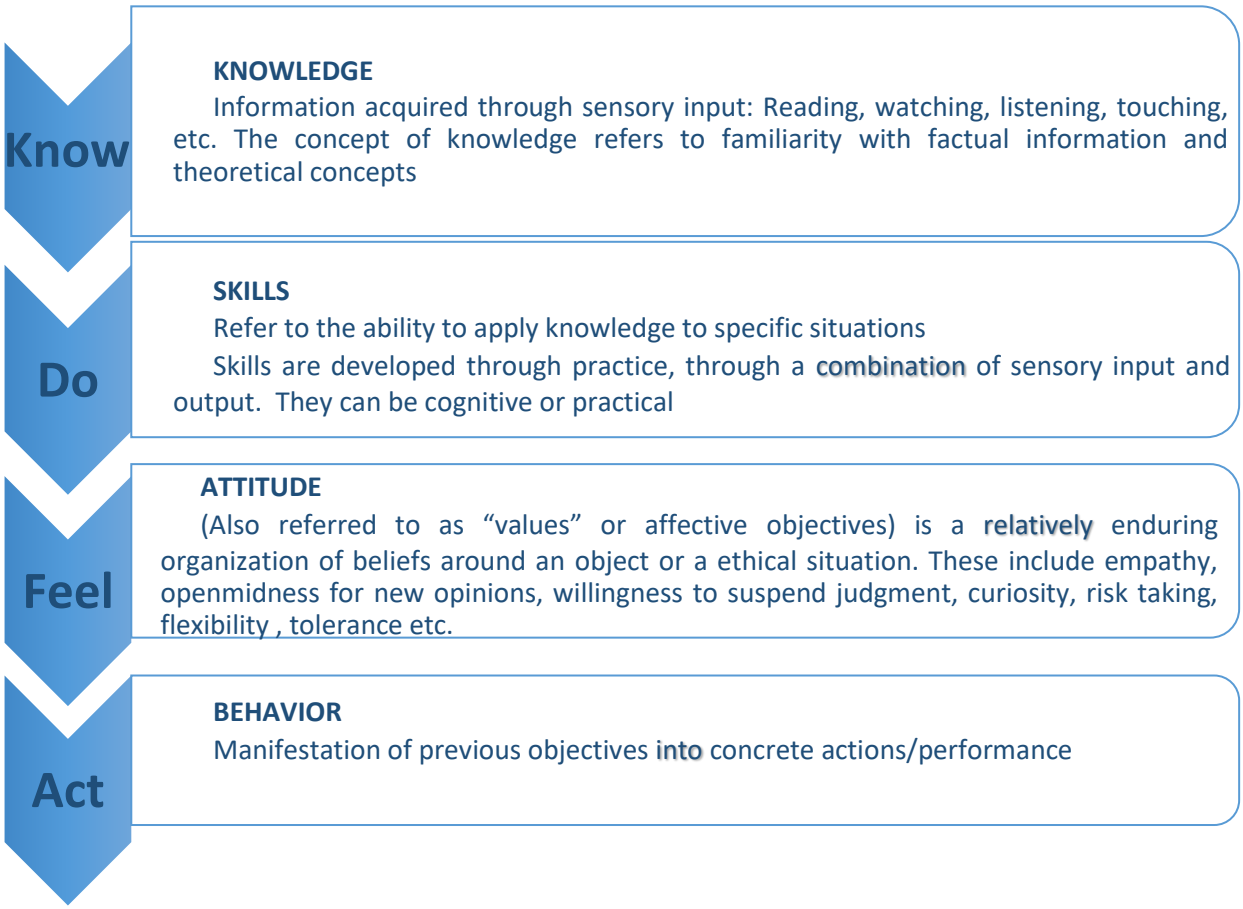
During the development of the training material, specific guidelines will provide clear instructions in order to equalize writing styles and reach specific goals listed in application form.

In development of educational materials the following elements should be considered:

1. Learning objectives: should focus on results of the learning experience in field of de-gendering STEAM education and in line with a topic that you are developing.

Examples of learning objectives depending on the field of development:

Figure 7. Learning objectives



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Learning objectives should be clear and in line with methodology that you will be used for a chosen topic. When defining an objective, the use of active verbs like presented in BLOOM'S Taxonomy of Educational Objectives Handbook, 1956 should be employed.

Table 14. Action Verbs

Category	Example Action Verbs	
Knowledge (Recall and Understanding)	Associate Compare Contrast Define Describe Differentiate Distinguish Identify Indicate List	Name Paraphrase Recognize Repeat Restate Review Show State Summarize Tell
Application	Calculate Demonstrate Draw Employ Estimate Give example Illustrate Locate	Measure Operate Perform Prescribe Record Set up Sketch Solve Trace Use
Problem-Solving (Analyzing, Synthesizing, Evaluating)	Advocate Analyze Assess Challenge Compose Conclude Construct Create Critique Debate Decide Defend Derive	Design Evaluate Formulate Infer Judge Organize Plan Propose Rank Recommend Select Suggest

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When writing a learning outcomes statement, focus should placed on the learner and start with an action verb, followed by the object of the verb as well as a statement specifying the depth/breadth of learning to be demonstrated.

Example of learning objective: Identify problems that arise in community when humans intervene in natural processes in order to create practical solutions.

Each educational material will have maximum two learning objectives.

2.CROSS – CURICULAR development of educational materials.

When developing educational materials, cross-curricular instructions should be provided, which is an instructional strategy that offers a way to plan lessons that incorporate more than one disciplinary area.

To take on more precise definition for cross-curricular:

"...a conscious effort to apply knowledge, principles, and/or values to more than one academic discipline simultaneously. The disciplines may be related through a central theme, issue, problem, process, topic, or experience." (Jacobs, 1989).

When combining disciplines, the following should be considered:

- ✓ Look for natural connections and links between subjects. When a connection is made between different subjects, the content becomes more relevant and applicable.
- ✓ Cross-calicular development can have more subjects combined, but keep 2 led subjects in focus and build the activities around them. If there are too many subjects or disciplines as a base for educational materials it can get too overwhelming for students.
- ✓ Choose methodology that benefits cross-curricular instructions (exp. Design thinking)
- ✓ Identify cross-curricular questions in order to set clear objectives for activates

Here is one popular example of combining math with poetry slam from Harry Baker (till 4:10 minutes in video): A love poem for lonely prime numbers
https://www.youtube.com/watch?v=O6jrLgvCUNs

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3. Active learning: learning materials should be student oriented in which participation becomes the most important condition for active learning.

When developing educational materials, the golden rule of learning should be applied: "I hear thus I forget, I see thus I remember, I do thus I learn".

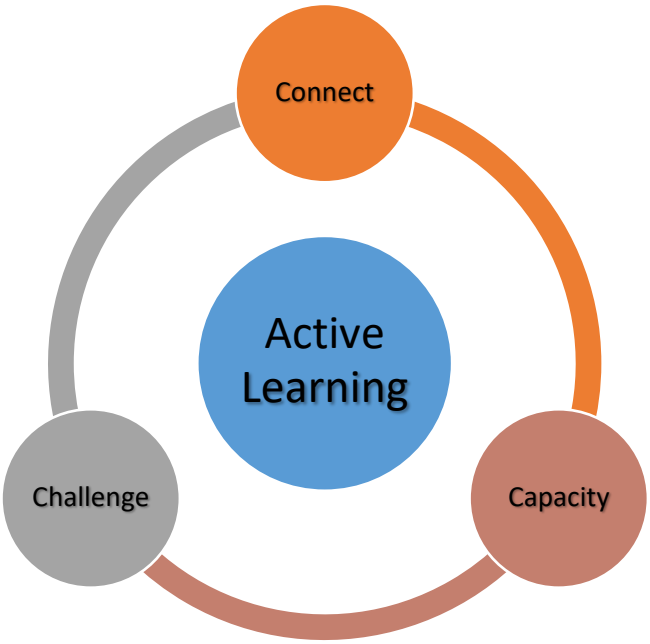
Active learning can be reached through appropriate methodology that puts the student in the centre of a learning process.
The 3 C's model and the correct balance of these three components will boost student's engagement in learning process:

Connection: learning material has a link with reality, hopes, everyday situations, and expectations…of the learner

Challenge: activity which represents the challenge for the learner

Capacity: the challenge should be balanced with capacity of the individual learner or the group to implement the task.

Figure 8. Active learning



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4. Materials and methods: should be in line with research findings– (see first chapter of this document).

   Materials are means that complement the method through which learning objectives are reached. Recommended materials are those directly related to everyday life problems and situations, everyday objects, technology that students use, students' surroundings in their community, ethical dilemmas and ethical values etc.

   Materials could be hands on: conflict/dilemma stories, newspaper, photographs, comic book, art crafts, case studies as well as audio-visual files, Power Point presentations, on line videos. Depending on methodology you will be using.

   Same principle should be applied for choice of methodology that encourages active learning. Here are the examples in case you want to use additional methods that weren't listed in R1 results: role playing, group discussion, storytelling, self-awareness exercises, reflective writing, brainstorming, concept mapping, self and group assessment/reflection, visual mapping…

5. Language:

   ✓ address the teachers directly in step-by-step section of materials template (ex: divide students in smaller groups and ask them to brainstorm about solution for given problem).

   ✓ be consistent in terminology and keep in mind that your guidelines should be clear also to a person that doesn't have didactical and pedagogical educational background in STEM education, as materials should be approachable for teachers in other disciplines as well.

   ✓ use short and clear sentences to keep the readers concentration and interest.

   ✓ do not repeat already stated, especially in step by step guidance. As the activities should lead/challenge students' development forward so should the language have a logical continuity in description of activities.

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Concluding remarks

The document at hand presented the findings of research activities carried out by the FullSteamAhead partnership to design the Methodological Framework upon which the training material for secondary school teachers will be developed in the next phase of the project. As documented, the findings have been analysed and exploited to come up with a clear training structure for teachers in pedagogical and methodological terms. Certain approaches as well as preferences from both teachers and students have been considered, and the topics of the training provision have been identified.

The development of the training material will follow the framework as designed and will be conditioned to be offered in an online space, ready to be used by school teachers in their didactic process. This document connects the three project phases which consist in training material development, online deployment thereof in English, Croatian, Greek, Italian, and Spanish, testing and validation as a follow up activity towards finalisation of both content and the FullSteamAhead online platform.

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