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# NGSS CONCEPT PAPER

- *report on STEAM education and gender-inclusive education in primary school and preschool education in partner countries.*

ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
UNIVERSITY OF CRETE

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## Table of Contents

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# 1. Project presentation:

## A) Project main information:

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**B) Project`s goals**

NGSS project aims to promote STEM+Arts in early childhood education through the novel approach that will focus on Social and Emotional Learning concept (SEL), integrated with interactive approaches (e.g. drama, gamified learning, physical education etc.), involving social, emotional skills as well as cognitive skills. The main focus will be on the following four skills: communication, critical thinking, collaboration, creativity. Acquisition of the four skills mentioned above will help to remove emotional and conceptual barriers to science learning in early education, so that learners will feel confident to approach the subject in their later schooling. The secondary goals of the project will include:

- Promote a gender unbiased approach to STEM education;
- Increase the environmental awareness and sensitivity of young learners;
- Increase children's basic skills in STEM+Arts (creativity, critical thinking, problem-solving)
- Develop teacher`s competences to effectively teach interdisciplinary art and science concepts using a real-world context for fostering more creative and collaborative learning environments in schools.

## 2. Introduction - Context and objectives of the Concept Paper

**A )** Context of the Concept Paper

The Concept Paper is the first intellectual output of the project, having the purpose to set the frames of the NGSS project's basic concepts and processes, to establish common criteria for estimation of the good practices within the project context and to offer background in the development of the NGSS teaching resources for preprimary and primary school teachers. In order to ensure the successful accomplishment of the projects goals and to offer a ground base for teacher training activities and teaching resources that will be further developed in the project, activities as needs analysis and early education curriculum analysis in each partner country had to be done. So, in the first months of the project (February – July 2021), research activities were prepared and accomplished in all partner countries, under the

coordination of P6 –Valahia University of Targoviste. Based on the templates prepared by P6 and discussed with the partners in transnational online meetings, Focus Group interviews and desk research were carried out in each partner country. In the context of the Focus-Group Interviews, researchers from the project team organized and conducted three interview sessions, online or face to face, according to specific SARs-Cov 2 epidemic situation of their country. The data obtained from both types of research (Focus-group interviews and desk research) materialized in National Reports regarding the status quo of the STEAM frames and implementation in early education in each country. National Reports were organized in two main parts, each part reflecting the results of one of the two types of research conducted.

National Reports were subsequently (August-October) centralized and analyzed for the elaboration of the first project intellectual output – the **Concept Paper** - that *reflects the State-of-the-Art of STEAM and SEL implementation in partner regions*, based on the structure and regulations provided by their national curriculum, educational policies and previous research on STEAM and SEL, the experience and personal reflections of teachers, parents and STEM+Arts professionals. *The key findings that are reported in the Concept Paper will support the designing and conducting the teacher training sessions and training resources from six different national perspectives that will ensure the innovative character of NGSS project. Also, the Concept Paper reflects the values of STEAM and SEL integrated teaching approach for girl`s motivation and involvement in pursuing of scientific activities and careers.*

*The Concept Pape*r structure follows the National Report structure, and it is organized in five chapters:

- in the first two chapters it is offered brief information of the project and information on the context of the Concept Paper and research objectives,
- the third chapter is dedicated to desk research results, outlining **t**he framework provided by the national curriculum for science education; curriculum structure at primary and pre-primary schools of partner countries; previous STEM or STEAM experiences in national or regional pre-primary and primary education; results/outcomes of previous projects on STEM education/Arts education/Social and Emotional Learning related to science education; limitations on or opportunities for the engaging of girls and other economically or geographically disadvantaged groups in science learning in pre-primary and primary education.
- the fourth chapter is dedicated to Focus Group Interviews results, reflecting research methodes, study population and samples, subjects perceptions on adressed topics, and conclusions and recommendationes.
- the fifth chapter contain general conclusions regarding Stem+Arts approach in primary and pre-primary education and inclusive education in partener countries, outlining

**teachers training needs**, a **SWOT analysis of the STEAM implementation** in primary and preprimary education, and the **value of STEAM education in increasing the motivation, participation of young girls in STEM fields**

The Concept Paper will end with **bibliographic data and annexes**. The training/teaching resources like **Autodidactic Resources based on Steam and Social and Emotional Learning, Digital Toolkit for Teacher Training Course and STEM+Art Kit for pupils, Online Guidebook for students & teachers how to think and create STEM+Arts education projects, Policy Recommendation Paper for STEM+Arts Education are integrated parts (annexes) of the Concept Paper.**

By offering guidelines, the Concept Paper create the opportunities for transfer and application of best practices and methodologies to school learning environments as well as in all educational systems in the countries involved.

## 3. Desk research results

For the desk research parteners reviewed previous research findings, scientific literature, official or government documents from relevant available sites (like national education system website, national research institutes in education websites, relevant authors and opinion leaders - e.g. minister of education, university professors, nationally/internationally recognized researchers, important figures in civil society), officially published data by national institutes or education stakeholders etc. This research aimed to obtain a broader understanding of the following issues:

- **The framework provided by the national curriculum for Science Education**; for this issue partners were searching for existence and description of a specific science curriculum for pre-primary and primary education, even of a specific STEAM education curriculum; implied the presentation of the disciplines included in the area of sciences and arts on the two levels of education, of the number of hours allocated to each discipline, Expected Learning Outcomes, the main topics covered, and the proposed teaching strategies.
- **Previous implementation of STEM or STEAM approach in national or regional preprimary and primary education**; this implied identification of existing educational policies or formal guidelines (national or local coverage) for STEM or STEAM approach implementation.

- **Results/outcomes of previous projects on STEM education/Arts education/Social and Emotional Learning related to science education;** for this, each partner identified some project that were implemented in their country or region and their results and the way this results could affect future STEAM+SEL education in primary and preprimary education.
- **Limitations on or opportunities for the engaging of girls and other economically or geographically disadvantaged groups in science learning in pre-primary and primary education;** for this issue each partner searched and presented information about formal, structural limitation or opportunities of the curricula or other educational or social policies regarding inclusive education practices for both boys and girls and other disadvantaged children.

**Data obtained by each partner regarding issues mentioned above are presented below, considering the existing similarities and differences.**

## 3.1. The framework provided by the national curriculum for science education; Curriculum structure at primary and pre-primary schools of partner countries

### BULGARIA

**National Curriculum for pre-school education**

In Bulgaria children may be enrolled into kindergarten when they turn 3 years. The focus there is child care, play and development of social skills. When children reach the age of 5 they are obliged to attend a pre-school program. According to BMES, pre-school should help children develop their physical, learning, language, social, emotional, and creative skills and enable them to adapt to primary school education. The pre-school curriculum consists of the following subjects (*STEAM in **bold***): Bulgarian Language & Literature, **Mathematics, Surrounding Environment, Arts, Music, Construction and Technology**, Sports. All those subjects are covered briefly, and the aim is to prepare children to study them in more detail once they enter primary education. Pupils are encouraged to study through various types of games and playing. The curriculum is flexible, all teachers can expand and develop their content outside of the minimum guidelines. Overall, the curriculum focuses on the smooth introduction of children into the schooling system. The emphasis is making learning exciting and engaging. For this aim the learning activities at this stage often include music and singing, as well as physical activities and dance, which facilitate kids' learning.

The curriculum for the early years is very broad and gives freedom to the teachers. The obligatory pre-school education is supported by various didactic materials, which are ensured free of charge to the kids. However, most preschools have poor facilities for teaching STEM.

**National Curriculum for Primary Education**

In Bulgaria the primary education is with 4 years' duration and consists of grades 1 to 4. Most of the pupils are between 7 and 11 years old. The Bulgarian Ministry of Education and Science (BMES) requires all state schools to follow the same core curriculum as advised by the governmental regulation. Schools are allowed to expand the curriculum, but only if the core curriculum is fulfilled.

The key focus of the primary school education in Bulgaria according to BMES the is to develop the following competences in pupils *(the ones related to STEAM are in **bold**)*:

1. Understanding and knowledge of the Bulgarian Language.
2. Ability to communicate in foreign languages.
3. **Core Mathematical knowledge and skills and basic competence in the field of Natural Science and Technology.**
4. **Digital skills.**
5. Self-study skills.
6. Knowledge of social and civil responsibilities.
7. **Innovation and Entrepreneurship.**
8. **Cultural knowledge and ability of expression through art.**
9. Skills for sustainable development, personal healthcare, and sports.

BMES highlights that the curriculum develops links between different subjects and great effort has been put into evaluating the impact one subject has on another (e.g. Comprehension of *verbal mathematical problems* expands the ability of pupils to understand the *Bulgarian Language*).

1. Mathematics

The focus of primary level mathematics is for the pupils to develop an interest in the subject. This is done through learning the natural numbers, their comparison and the algorithms of addition, subtraction, multiplication, and division. pupils learn to distinguish between geometrical shapes, as well as how to measure their parameters and find lengths and areas. Furthermore, there is an introduction to practical application of mathematics to real life situations, thus the basic units of length, mass and time are also covered. Finally, the subject focuses on developing the ability of pupils to take a rational approach and logic when solving problems.

Throughout primary school Mathematics is the second most regular subject after Bulgarian Language and Literature, with around 20% of the curriculum being dedicated to it. The subject is expected to have a strong impact on all the core competences presented above, highlighting the impact of Mathematics on cross-domain knowledge. Teachers are advised to spend approximately 50% of the lessons teaching new concepts, while 47% is used for revision and 3% for testing of the acquired knowledge.

2. Surrounding Environment

Surrounding Environment is an integrated subject that covers topics from both Natural Sciences and Social Studies, thus teaching pupils the relationship between those subject areas. It is part of the curriculum during the first two school grades and is further succeeded by another two integrated subjects: Man and Nature (Natural Sciences) and Man and Society (Social Studies).

The key focus of the subject is to familiarize pupils with their immediate surrounding environment. They are presented with information about the social and natural world, incl. climate change and develop skills on protecting the environment. The aim of this subject is to develop interest in science, nature and society; therefore, pupils are shown existing scientific phenomena. Finally, pupils are to be introduced to societal norms and personal healthcare.

Primary school pupils normally have 1 hour per week dedicated to this subject. It is 5% of the school curriculum but is still linked to other subjects and helps pupils develop many of the competences primary education is focused on. Teachers are advised to spend approximately 66% of the lessons teaching new concepts, while 31% is used for revision and 3% for testing of the acquired knowledge.

3. Man and Nature (Natural Sciences)

Natural Sciences is the integral subject, which covers considerable part of the STEM thematic at the primary school level. It encompasses topics from the areas of Physics, Chemistry and Biology. The subject is focused on familiarizing pupils with the key chemical elements, biological organisms, and physical phenomena. Pupils are encouraged to develop interest in the natural sciences and are taught practical skills for protecting the environment. Natural Sciences form basic skills for the observation and study of natural phenomena, as well as exposing pupils to the basic forms of scientific research (primary and secondary).

Despite the boldly declared aims of integrated education in the field of natural sciences, the topics are presented in separated thematic cores belonging to one or another natural science, which interchange every 2-3 months. Thus the introduction of the topics is separated and the links remain obscure for the pupils.

The subject is strongly linked to all core competences that primary education focuses on, particularly the ability of self-study. In the third grade pupils normally have 1 lesson per week

(5% of the curriculum), while in the fourth grade they have 2 lessons per week (10% of the curriculum. Teachers are advised to spend approximately 47% of the lessons teaching new concepts, while 50% is used for revision and 3% for testing of the acquired knowledge. It is important to note that the subject continues into the 5th and 6th grade and is split into separate subjects (Physics & Astronomy, Chemistry and Biology) in year 7.

4. Technology & Entrepreneurship

The aim of this subject is introduction to different types of technology and its role in people's life. Pupils are getting acquainted with different professions and their impact on society. The course focuses on economic awareness and teaches pupils basic financial skills. Finally, the course aims at inspiring pupils to be driven by innovation and entrepreneurship. The subject which in previous decades had more hands-on elements gets more and more theoretical nowadays.

Normally pupils have 1 lesson of technology and entrepreneurship per week (5% of the curriculum). The subject is fundamental in developing the soft skills that are embedded in the primary education program. Teachers are advised to spend approximately 47% of the lessons teaching new concepts, while 50% is used for revision and 3% for testing of the acquired knowledge.

5. Information and Communication Technologies (ICT)

The focus of ICT at primary school is teaching pupils how a computer works and showing them what they can do with it. Pupils are introduced to the basics of electronic communication and gain basic skills in work with text processing applications like MS Office and the use of the Internet. The aim of the course is to build basic competences and computer literacy.

Normally pupils have 1 ICT lesson per week (5% of the curriculum). The subject is supposed to develop pupils into tech savvy youngsters. Teachers are advised to spend approximately 47% of the lessons teaching new concepts, while 50% is used for revision and 3% for testing of the acquired knowledge.

6. Digital Modelling

In line with current socio-economic trends the BMES has introduced a new subject that focuses on developing pupils' computational thinking from an early age. The scope of Digital Modelling covers types of digital devices and their safe use. Pupils are taught to work with data and files. In 4th grade Digital Modelling branches out into visual programming culminating in an animated project (video game) that pupils are supposed to create. Overall, it is supposed to be an entertaining and engaging process that encourages pupils to study computing.

Although in theory this subject is supposed to teach computational thinking (i.e. ability to recognize logical patterns, to break down complex problems into smaller size modules, to sequence long and complex processes in "steps", etc.), in fact the subject is heavily dominated by coding. This makes it difficult for some pupils to follow the curriculum. The subject is one of the new additions to the primary school curriculum (introduced in 2018), showing the progress towards more exposure to STEAM subjects in primary education. Digital Modelling is introduced in third grade and pupils have 1.5-2hrs per week (8-10% of the curriculum). Teachers are advised to spend approximately 50% of the lessons teaching new concepts, 30% for project work, 14% for revision 6% for testing of the acquired knowledge.

7. Visual Arts

The main purpose of fine arts is to develop one's creativity. Pupils are exposed to different genres of fine arts, which should create a sense of aesthetics and understanding of different painting techniques. Furthermore, teachers should try to develop the interest of the pupil's and recognize their talent.

In primary school pupils have 1.5–2 hrs of arts per week (8%-10% of the curriculum). Arts is recognized as fundamental for developing soft skills. It is strongly linked to other subjects such as Surrounding Environment, Digital Modelling and Mathematics, as pupils are often tasked to draw physical phenomena, nature or use geometric shapes in their work. Teachers are advised to spend approximately 42% of the lessons teaching new concepts, while 50% is used for revision and 8% for testing of the acquired knowledge.

8. Class hour

The Bulgarian educational system includes one additional lesson per week for the so called "class hour". The curriculum for this hour is formed by the class teacher on the basis of the characteristics of the class and has some aims, related to safety and health education, character building and civic education. In years 1-3 the focus of those lessons is safety (incl. traffic, bullying, cyber-bullying, first aid in case of disasters and accidents, etc.) and the development of the patriotic spirit. In year 4 there is some allowance for media and digital literacy and for career development discussions. Based on the importance of such topics to one's development and given that a class consists of 25+ pupils such topics should be covered in more detail

## GREECE

In Greece "compulsory education has recently become a two-year period, starting at the age of 4 years in pre-primary school (nipiagogeio)" (Eurydice, 2021). The national curriculum for pre-primary education, "New School" curriculum (2014), as it is entitled, includes

teaching and exploring the learning area of Natural sciences, it also mentions explicit of "scientific literacy" as one of the aims of *early years science education*. It develops a teaching methodology for science which utilizes elements of scientific methodology to construct teaching strategies. In addition, it attempts to link science with society and culture, and fosters elements of the nature of science.

It is structured with the following units:

- Living organisms (the study of living organisms in their environment).
- Objects and materials.
- Concepts and phenomena from the natural world.
- Planet Earth and Space.

The proposed **teaching strategies** are various and they follow an inquiry-based teaching methodology: systematic observation of objects and phenomena; data collection that will lead to the answers of the questions that are important to the children themselves; data recordings that are collected by children using strategies like systematic observation and others sources like using symbols, drawings, tables, models that allow comparison; analysis and interpretation of the data collected by the children, correlations, formulation/ formation of questions and design of the solution, making measurements, recognition of repetitive patterns and effort of formulating rules; formulation of assumptions and/ or forecasts; drawing conclusions or interpretations together; reflection of the way the team worked and its results. Contents, goals and activities from the learning area of "Natural Sciences" will always have a place in the daily and weekly educational program. They are addressed to all the children in the class, by recognizing each child's ability to participate and to approach the scientific world (regardless of gender, ethnicity or other differences).

For the compulsory program of public Pre-primary education, by decision of the Minister of Education and Religious Affairs, which is issued after a proposal of the Institute of Educational Policy, introduces an educational action entitled "Skills Workshops", consisting of a pilot addition of new thematic courses in primary school. The aim is to enhance the cultivation of soft skills, life skills and technology and science skills. More specifically, the pilot action introduces for the first time the implementation of **«Skills Laboratories» in Primary school, too.**

"The New Greek Science Curriculum (NGSC) for **primary school** was designed by taking into account two pillars: (a) the current trends in science, technology, society, and environment curriculum development (STSE), and (b) the research and practice tradition in science education of the last decades. In respect of the first pillar, the envision of the

curriculum developing group was making NGSC more consistent with the calls for scientifically literacy. In relation to the second pilar, the NGSC is based on the major pinpoints and recommendations of science education research. NGSC underpins the issue of high quality science education acting not only in formal but also in non-formal cultural settings" (Plakitsi, 2013). The NGSC promotes the opening to learning communities beyond the traditional boundaries of the typical school environment, which provide multiple learning contexts necessary for the development of students' scientific and technological literacy (Linking School with Society). The topics of the content of Science and Technology in Primary school are: Life around us, Energy, Electrical and magnetic phenomena, Sound phenomena (Phenomena based on the sound), Machines and dynamics interactions, Properties of materials, Thermal phenomena, Light phenomena, Chemical phenomena.

**Regarding STEAM education**, The Greek Educational Policy Institute in cooperation with E3STEM, (Hellenic Education Society for STEM) recommends a program that targets (aims at) "Computational Thinking Development and Practical Skills (skills and practices) that utilize computational science by focusing on the core ideas but also on transversal ideas" (NGSS, 2013). The recommended program comes to fill in, enrich and support the existing curriculum for preschool and middle school. In particular, it targets *the evolution of the teaching goals of the existing curriculum by focusing on activities that contain practices of scientists and engineers*. It is designed to adapt to the maturity level learning and development capabilities of children for the Early Years and Primary (pre-primary and primary). This is the *implementation of a **STEM-STEAM Activity Plan**, which begins with realistic problems that require resolution, so that students are involved in exploratory procedures similar to those followed by researchers.* They take initiatives, always working in groups in order to solve the problem, they learn to use digital technologies in a creative manner, they plan their next step, they learn, they adapt, they understand, and they invent their own scientific instruments, (made solely by everyday materials) using simple and daily materials. Among all the benefits resulting from the implementation of the STEM-STEAM program, the following abilities and goals are also being developed: **Learning Skills (** Critical thinking, Communication, Collaboration, Creativity), **Life Skills (** Adaptability, Responsibility, Organizational Ability), **MIT: Technology and science skills (** Modeling and simulation skills, ICT literacy, Digital literacy, Technology literacy, Creating and sharing digital creations skills( or skills of..), Combined digital technology, communication and collaboration skills, Analysis and content production in print and electronic media skills, Skills of interdisciplinary use of new technologies); **Mind Skills (** Strategic Thinking, Problem resolution (Matters resolution) Case studies, Constructions). Regardless of the learning, cultural and socio-economic

background of the students, the **STEM/STEAM** program enriches the educational process and aims at the active participation of all students. Specifically, the distribution of activities within the broad program is positioned as "skill labs": **ROBOTICS:** Hardware interconnection, Model construction; **STEM/STEAM:** Problem delineation, Solution design, Implementation / Control, Update, Presentation.

Regarding the educational strategies, *the activities within STEAM education follow the teaching approach of the engineering design process* (Engineering Design Process Massachusetts Department of Education). According to that, each teaching scenario includes six implementation phases. Through these scenarios, students are occupied in a context of experiential learning, they engage in exploratory processes, they implement research projects, they create, they present their ideas, and they reflect.

## LITHUANIA

In **Lithuania, preschool education is not compulsory. Compulsory education starts with preprimary education at 6 years of age.** The goal of pre-school education is to satisfy and develop a child's social and cognitive needs. The pre-primary education is designed to assist a child to prepare for school and to equalize the level of knowledge of all preschool pupils. The curriculum of this stage can be offered at schools of general education or by other education providers. The curriculum of pre-primary education is standardized, while the curriculum of pre-school education is more individualized, designed by schools. In preprimary and primary education the curriculum consists of compulsory subjects and optional non-formal activities; subjects offered: mathematics, arts, physical education, moral education that covers religion or ethics; social sciences, languages, music, and natural sciences. Both in pre-school and primary education STEAM education is an integral and complex cognition, application and problem solving of reality phenomenon, oriented to the recognition of the world, ICT, engineering, Arts and Maths. STEAM education is based on development of the main competences of students which are cognitive, social and emotional, healthy living, creativity, citizenship, cultural and communication. Participating in STEAM activities students learn in attractive environments and through individual and team tasks develop their critical thinking and creativity both communicating and collaborting and solving problems. The main studied *topics within STEAM subjects are*: Stories of the Items; Painting and Creation; Technics, Construction, Modelling; Astronomy. Architecture. Design.; Experience in the Nature and Forest; Construction, Sculpture and Creation. *The suggested teaching strategies* within the curriculum are: Learning to learn, learning by doing; Practical,

research activities and lessons outside; Research based learning, interest in scientific discoveries; Experiments, observations; Practical tasks in laboratories; educational programs; Practical lessons connected to life experience; Integral learning; Critical thinking; Practical activities with scientists; Stimulation of imagination and creativity; Project work; Educational excursions; Mobile technologies, programs; Thinking maps; Roleplays.; STEAM approach; Taks in groups, pairs; Creation of diagrams, schemes and thinking maps; Robotics.

## POLAND

In Poland, preschool education (kindergarten) target children at the age of 3 to 7 years old, and primary education target children at the age 7-15. **Compulsory education starts at 6 years with one year of preparation for school in a pre-school unit**. The education system in Poland is based on a document prepared by the Polish Government (Ministry of Education) in 2017. The whole education system and school activities and programmes are based on that document. The paper is included in Journal of Laws of The Republic of Poland.

***Preschool education***

The aforementioned document includes the specific tasks of pre-primary educational institutions, along with the objectives and expected results of this stage of education. The very beginning of the paper indicates the importance of exploring a child's abilities and gaining experience. The tasks of the institution (kindergarten), also highlight the importance of the cognitive aspect of a child's behaviour. In the document one reads that the kindergarten shall take care of the proper space and conditions which will encourage the experiencing process of the pupil. Furthermore, the kindergarten's responsibility is to support the child's independent process of exploration of the world, including the natural environment. There is one point which is connected to a child's technical skills only, which states that the education institution shall create "conditions enabling safe, independent exploration of technical elements in the environment, construction, DIY, planning and taking intentional action" (Journal of Laws of The Republic of Poland, February 2017).

The next section of the document is the description of the expected results of the education at the earliest stage and the achievements of the pupils. It is divided into: physical achievements, emotional development, social interactions, and the development of the cognitive skills. The last aspect mentioned (cognitive), focuses on perceiving the world by a child. At the end of pre-primary education stage pupils are expected to:

- Show their understanding of the world using non verbal communication (gestures, dance, artistic, technical and theatrical impression – using models and materials);

- Show their understanding of the world via verbal communication;
- Know letters (which is the effect of play and spontaneous exploring):
- Experiment with rhythm, sound and voice, sing songs and know melodies;
- Experiment with paints and pencils, creating simple signs and adding meaning to it;
- "experiment, estimate, predict, measure the length of objects, e.g. using a hand or a foot" (Journal of Laws of The Republic of Poland, February 2017);
- Know the basic numbers and able to count;
- Know the basic concepts which appear in natural environment (words like „rainbow" and „blooming");
- "undertake independent cognitive activity, e.g. viewing books, development of space with own construction ideas, the use of modern technology" (Journal of Laws of The Republic of Poland, February 2017).

The above mentioned expected results are connected to the cognitive and scientific world as well as the world of arts. The words "explore" and "experiment" occur many times in the document at this stage. This proves the fact that Polish schools should be a place where the child is encouraged to develop using cognitive skills and basic human senses – ***the ability to explore via everyday interactions is at the core of the programme.*** Thus, pupils are not expected to be taught but rather to explore the world around them via playful activities. The teacher is more of a guide and observer of the child's development process – he is there to support the cognitive process rather than to teach: "Teachers diagnose, observe children and creatively organize the space for their development, including the potential of children and their interest in the elements of the environment in preschool games and experiences". Thus, the time spent in kindergarten is a moment "filled with fun, which, under the supervision of specialists, creates a field of developmental experiences that build school maturity".

To sum up, the general idea is to let ***the child explore the world around him or her and make them ready for the next stage of education*** – which is school stage.

***Primary education***

Primary education in Poland is a very important stage for every single pupil. This is the time when a child visits school for the very first time. The main responsibility of the educational institution (school) at this point is to familiarize students with the institution, but also with their duties and their self-development path. Primary education in Poland is also divided into: classes 1-3 and classes 4-8.

The governmental document also includes the expected learning objectives of primary education. The file indicates the importance of one's identity and emotions, as well as ethical

values . Nevertheless, there's plenty of space given to cognitive skills as well. It is important to encourage students' creativity, critical thinking and drawing conclusions. Moreover, it is crucial to encourage innovation and entrepreneurship skills of the children, along with allowing "comprehensive personal development of the student by expanding his/ her knowledge and awakening the natural cognitive curiosity". There are ***seven major general skills being developed in primary schools:***

- Communicating (in national and foreign language);
- Using mathematic tools in everyday life;
- Searching, analysing and using information;
- Solving problems;
- Solving problems in a creative way, using IT tools;
- Teamwork and social activity;
- Taking part in the cultural life of the school, local society and country.

**Scientific subjects** (biology, technical skills, mathematics, geography), are introduced in the **4th class of primary school**. At the same time art and music is being taught, along with foreign languages (foreign language is introduced in the 1st class already). Art and literature are equally important subjects at this stage since they "stimulate the multilateral, harmonious and holistic development of the student". Moreover the importance of literature is highlighted in the programme document as well since "the ability to understand, use and reflectively process texts, including cultural texts, is one of the most important skills acquired by student in the learning process".

Each and every subject is described in detail in the document – there is no division in terms of range into „more" and „less" important subjects. Instead all the subject are considered equally important since they help children develop their talents and shape their identity. Nevertheless, some experts claim that the education system in Poland is too much subject-related.

In Poland the STEM and STEAM approach is getting more popular nowadays – it is known as innovative method of teaching. Since it is quite a new trend in Poland, there aren't any additional official documents prepared by the Polish government which would include this approach as part of the policy for educational system. Nevertheless, apart from the programme document prepared in 2017 by the Ministry of Education, every school in Poland has its own regulations as well. Since the governmental papers allow taking part in programmes and projects, it is the school's policy that matters here. The school can take part in programmes since such actions "help to develop entrepreneurship and creativity of students and enable the use of innovative program, organizational or methodological solutions in the education process". Thus, many schools in Poland choose STEAM and STEM approach to

develop students' skills and knowledge. It is worth mentioning that these projects and programmes are not included as obligatory in the official education programme prepared by the Polish Ministry of Education.

## ROMANIA

### Preschool education

The National Curriculum for Early Childhood Education, issued in August 2019, covers ages from 1 to 6/7 years old, and is organised in two major education programs for early ages: ante-preschool education services (part of the services provided in nurseries) and preschool education, offered in kindergartens.

***The curriculum for early education capitalizes on the paradigm focused on competencies,*** valuing the acquisition of behaviours that will later ensure the development of competencies. So ***the aims of early education are the development of behaviours and skills that are the premises of the future key competencies*** diversified and developed during the subsequent schooling programs***. The curriculum is developed as an annual study program and it is organized around six integrative annual themes***. One of the principles underlying the development of the Curriculum for Early Education is the principle of ***holistic and integrated development,*** which provides an integrated (multi- and inter-disciplinary) approach to activities. ***Integrated activities are carried out within five experiential fields*** (the language and communication field, *the science field*, the man and society field, the aesthetic and creative field and the psychomotor field). The activities carried out within these fields almost every day are aiming a holistic approach to child development, targeting five developmental areas:

- physical development, health and personal hygiene;
- socio-emotional development;
- cognitive development and knowledge of the world;
- development of language, communication and the premises of reading and writing;
- learning abilities and attitudes.

The STEAM approach is not mentioned in the curriculum, nevertheless, ***activities similar to this approach targeting cognitive development and knowledge of the world, are aiming behaviors and skills organised on three dimensions of development:***

- relationships, operations and logical deductions in the immediate environment;

- elementary mathematical representations, for solving problems and knowing the immediate environment;
- structural and functional characteristics of the surrounding world.

According to these dimensions, the expected results at the end of the preschool period are behaviors such as:

- doing experiments to observe the effects of one's actions on objects and on others;
- finds and describes the similarity or difference between two objects of the same type (eg: a ball is bigger than wide, my skirt is the same as Maria's, etc.);
- repeats / resumes behaviors based on previous experiences (eg: observes how the adult blows on food to cool it and blows on him / her at the next meal);
- uses trial and error exploration to solve problems;
- recognizes some quantities of objects (eg two books, three boxes, etc.); Identifies by comparison, the size (large - small) or quantity (many - few) of objects of the same type;
- selects objects of the same kind in a string (eg a string of cubes);
- identifies, with support, categories of objects, beings (eg cat, fox and dog are animals) and groups them according to a criterion,
- notices details or differences between objects, beings, phenomena they are interested in, when examining them;
- observe and understand that living things need water and food to grow and develop;
- describes some parts of the human body and some sense organs;
- maintains (orders) the close environment, assisted by an adult.

**Primary school education**

Primary education in Romania lasts five years, respectively 5 primary classes (preparation grade, first grade, second grade, third grade and forth grade) starting from the age of 6 years and reaching around 11 years old. The preparation grade is the first year of compulsory education.

The National Curriculum for primary education ***is structured on seven curricular areas:***

- Language and communication;
- Mathematics and natural sciences (in the preparatory classes, I and II, the subject Mathematics and natural sciences is studied in an integrated way);
- Man and society;
- Physical education, sports and health;
- Art;
- Technologies;

- Counseling and guidance.

According to the Law on National Education (Law 1/2011), Art. 68, the national curriculum for primary education focuses on ***8 key competencies that determine the training profile of the student:***

- communication skills in Romanian and in the mother language, in the case of national minorities;
- communication skills in foreign languages;
- basic skills in mathematics, science and technology;
- digital skills to use information technology as a tool for learning and knowledge;
- social and civic competences;
- entrepreneurial skills;
- awareness-raising and cultural expression skills;
- the learn to learn skills.

Teachers are responsible for choosing teaching methods for instructional and educational activities. Methods that can be used in teaching activities are the following:

• methods based on oral communication used can be classified into methods based on exposure (storytelling, description, explanation, etc.) and methods based on conversation (conversation, heuristic conversation, problematization, etc.).

• methods of learning and exploration through discovery: direct exploration of objects and phenomena (systematic and independent observations, small experiments, etc.) and indirect exploration (demonstration through images, films, etc.);

• methods based on children's voluntary action (exercises, practical activities, etc.) and stimulated action (teaching games, learning through dramatization, etc.);

During the first two grades of primary education (but also, to a smaller extend, in the next years), following the methods used in preschool education, play is used as an important way to stimulate students' cognitive and emotional capacity and to facilitate their adaptation to the requirements of formal education.

The national curriculum promotes values that each person has to internalize and demonstrates in personal, social and professional life:

- respect: for oneself, for other people, for human rights, for diversity, for the environment;
- responsibility: responsibility assumed for one's own behavior and actions, conscious assumption of social responsibility;
- innovative spirit and creativity: openness to change, to the implementation of creative ideas through innovative solutions, generation of new ideas and behavior;

- excellence: the aspiration for performance and results in accordance with the potential of each child;
- integrity: honesty, responsibility, ethical attitude;
- active citizenship: solidarity and participation for the common good;
- critical spirit: development of critical thinking, autonomy and reflexivity;
- perseverance: patience, perseverance and tenacity in work, in beliefs, in attitudes;
- resilience: adapting in a positive way to unfavorable situations and overcoming challenges.

Analyzing the educational policy document developed by the Institute of Education Sciences "Landmarks for the design, updating and evaluation of the National Curriculum", we identify the focus of the primary curriculum on competences. Thus, the Romanian Education Law no.1 / 2011 assumed as purposes of compulsory education the eight key competencies recommended by the European Commission, which generated the need to develop a new curriculum. Thus, in 2013 new school programs were outlined the development of specific competences through integrated activities. Also, the new curriculum provided a new framework in which one can observe the emergence of curricular areas (or disciplinary fields - fields created by joining two disciplines, for example mathematics is joined with natural sciences, forming the curricular area Mathematics and Natural Sciences), thus is offered an inter- and/or multi- disciplinary vision on the study disciplines. This competency-based curriculum facilitate ”the training for life” through teaching in classroom skills that can be transferred to real life.

***The general competences for curricular area Math and Sciences are largely similar in all grades***, and their development follows a gradual and circular model to ensure a healthy and solid personality development. For example, in the first educational cycle (including preparatory class, the first and the second class) the competences are:

1. Use of numbers in elementary calculations;
2. Highlighting the geometric characteristics of some objects located in the surrounding space;
3. Identification of phenomena / relationships / regularities / structures in the immediate environment;
4. Generating simple explanations by using elements of logics;
5. Solving problems starting from the sorting and representation of some data;
6. Use of conventional standards for measurements and appraisals.

For the next two grades (the third and the fourth), the general competences in Math and Sciences curricular area are:

1. Identifying relationships / regularities in the immediate environment;
2. Using numbers in calculations;
3. Exploring the geometric features of objects located in immediate environment;
4. Use of conventional standards for measurements and appraisals;
5. Solving problems in familiar situations.

Regarding the number of hours allocated to disciplines **specific to science education**, the framework plan for primary education shows the allocation of a total number of:

- 4 hours/week for the discipline called ”Mathematics and the Exploration of the Environment” in the preparatory, first grade and second grade;
- 4 hours/week for the 3rd and 4th grades for the Mathematics discipline and 1 hour for the Natural Sciences discipline;
- for the currcicular area ”Arts and Technologies” the plan offers:

- 2 hours/week for Music classes in the preparatory class, the first and the second grades, and 1 hour / week for the third and the fourth grade; and
- 2 hours/week for Visual Arts and Practical Skills discipline in preparatory classes up to the third grade and 1 hour in the fourth grade.

Thus, out of a total of 19 hours per week in the preparatory class, 20 hours in the first, second and third grades, respectively 21 hours in the fourth grade, in the common core, 8 hours are allocated for the specific disciplines of scientific education in the preparatory and first grades (, 9 hours in the second and third grades, and 7 hours in the fourth grade.

## TURKIYE

In Turkiye, the Ministry of National Education brings various changes and innovations to the science curriculum covering the years 2005, 2013 and 2018. The aims and objectives of scientific education have been determined by the national program in order to raise individuals who can “produce information, use it functionally in life, solve problems, think critically, be entrepreneurial, determined, have communication skills, empathize, and contribute to society and culture” (MoNE, 2018:4).

In recent years, primary and secondary school science courses include a learning process emphasizing that scientific knowledge is transformed into a product through engineering applications and thus future generations can contribute to the country's economy. Curriculums are designed for this purpose and students are encouraged to turn scientific knowledge into production with science festivals held at the end of the year.

Based on the ***basic principle of providing scientific literacy to the young generation*** (MoNE, 2013; MoNE, 2018), the national education program listed the ***objects and expected learning outcomes as follows (MNE, 2018:9)***:

1. Providing basic information about astronomy, biology, physics, chemistry, earth and environmental sciences and science and engineering applications,
2. In the process of discovering nature and understanding the relationship between human and environment, adopting scientific process skills and scientific research approach and producing solutions to the problems encountered in these fields,
3. Realizing the mutual interaction between the individual, the environment and the society; developing awareness of sustainable development regarding society, economy and natural resources,
4. Taking responsibility for the problems of daily life and ensuring that science knowledge, scientific process skills and other life skills are used in solving these problems,
5. Developing career awareness and entrepreneurship skills related to science,
6. Helping to understand how scientific knowledge is created by scientists, the processes through which this knowledge is created and how it is used in new research,
7. Raising interest and curiosity about the events that occur in nature and its immediate surroundings, to develop an attitude,
8. Raising awareness of safe working by recognizing the importance of safety in scientific studies,
9. Developing reasoning ability, scientific thinking habits and decision-making skills by using socio-scientific issues,
10. Ensuring the adoption of universal moral values, national and cultural values and scientific ethical principles

In the National Preschool Education Program published in 2013, *science activities that can be done in schools, science centers and open spaces* are listed as follows (GDBE, 2013:48-49):

- Observing, discovering and inventing living and non-living things in their natural environment,
- Examining the seasons or weather conditions,
- Recognizing and using simple tools such as magnets, magnifying glasses and compass, examining natural and unnatural materials,

- Examining the food materials in the kitchen,
- Reviewing books and magazines, taking photos, reviewing photos, watching documentaries,
- Inviting resource persons in related fields of science as guests,

In addition, the Ministry of National Education has published ***a guidebook covering science and nature activities for students with special educational needs*** (NMB, 2014). In this material that will guide the teachers, science and nature activities are designed according to the types and degrees of children's disabilities. Children are motivated to observe nature with a sense of curiosity, do research, focus on a particular object, perceive themselves and their environment, relate facts and objects, develop problem-solving skills, clarify their thoughts and ask questions. (MNE, 2014:4).

The curriculum prepared for the 3rd and 4th grades of primary school is as follows (MNoE, 2018:12):

| 3RD CLASS | | | | | |
|---|---|---|---|---|---|
| **No** | **Unit Name** | **Subject Area Name** | **Number of Achievements** | **Time** | |
| | | | | **Lesson our** | **Percent %** |
| 1 | Let's Get to Know Our Planet | Earth and Universe | 5 | 9 | 8,3 |
| 2 | Our Five Senses | Living and Life | 3 | 6 | 5,6 |
| 3 | Let's Know Forces | Physical Events | 4 | 15 | 13,9 |
| 4 | Let's Get to Know Matter | Matter and Its Nature | 4 | 17 | 15,7 |
| 5 | Lights and Sounds Around Us | Physical Events | 8 | 21 | 19,4 |
| 6 | Journey to the World of Living | Creatures and Life | 8 | 18 | 16,7 |
| 7 | Electric Vehicles | Physical Phenomena | 4 | 22 | 20,4 |
| **Total** | | | **36** | **108** | **100** |

| | **4RD CLASS** |
|---|---|
| | ***According to the instructions in the Science, Engineering and Entrepreneurship Practices section, students are expected to make applications during the year.** |

| Science, Engineering & Entrepreneurship | No | Unit Name | Subject Area Name | No of Achievements | Time | |
|---|---|---|---|---|---|---|
| | | | | | Lesson hour | Percent % |
| | 1 | The Earth's Crust and the Movements of Our Earth | Earth and Universe | 5 | 15 | 13,9 |
| | 2 | Our Food | Living and Life | 6 | 18 | 16,7 |
| | 3 | Effects of Force | Physical Events | 5 | 12 | 11,1 |
| | 4 | Properties of Matter | Matter and Its Nature | 10 | 21 | 19,4 |
| | 5 | Lighting and Sound Technologies | Physical Events | 12 | 21 | 19,4 |
| | 6 | Human and Environment | Creatures and Life | 2 | 6 | 5,6 |
| | 7 | Simple Electric Circuits | Physical Phenomena | 3 | 6 | 8,3 |
| | Total | | | 46 | 108 | 100 |
| | *Science, Engineering and Entrepreneurship Practices: End of Year Science Festival (Students are expected to present their product effectively during the year.)* | | | | | |

## 3.2. STEM or STEAM approach in national or regional pre-primary and primary education

***Greece***

As presented above, the Greek curricula for primary school has already included the STEAM approach and the STEAM class/lessons follow specific teaching methodology. This is the teaching approach of the engineering design process (Engineering Design Process Massachusetts Department of Education). According to that, students are occupied in a context of experiential learning, they engage in exploratory processes, they implement research projects, they create, they present their ideas, they reflect. These processes are applied by engineers to provide solutions to real problems and to design systems. Therefore, according to the educational approach of the technical design process, each teaching scenario includes the following implementation phases:

PHASE ONE: Identification of the problem

PHASE TWO: Research into the needs of the problem

PHASE THREE: Development of possible solutions

PHASE FOUR: Choosing the optimal solution

PHASE FIVE: Construction of prototypes

PHASE SIX: Evaluation of the results of the solution

PHASE SEVEN: Different proposals of possible solution of each group (brainstorming solutions)

PHASE EIGHT: Redesign

**A few words about E3STEM (Hellenic Education Society for STEM)**

E3STEM (Hellenic Education Society for STEM) is authorized for the development of the training framework for the operation of the Competencies Development Labs, a recent (2020) initiative of the Greek Ministry of Education, and E3STEM is already involved in the pilot phase of this initiative (September 2020). The operation of the Competencies Development Labs has been significantly affected from the pandemic. For this reason, E3STEM has a great interest to propose an innovative approach that could facilitate the continuation of operation of the Competencies Development Labs with the support of digital tools and applications. E3STEM members work also for the inclusion of Art in STEM in a interdisciplinary and trans-disciplinary approach as an approach to teaching in which learners are engaged in conceptual understanding through an art form(e.g. by developing robotic artifacts, narrative stories using WEB 2.0 tools etc. implementing the so called studio learning). E3STEM also offers accredited seminars in teachers' training for STEM and STEAM education for pre-service and in-service teachers and has the capacity to train teachers in large scale

programs. Members of E3STEM are also Professors of Education Psychology and they work alongside with people from STEM disciplines to study the effect of STEM epistemology on psychological issues like internal motives, self-esteem, self –efficacy etc.

***Lithuania***

General Curriculum Framework for Primary and Lower Secondary Education (2008), Lithuanian Innovation Strategy for 2010-2020 (2010), Pre-school and Pre-primary Education Development Programme for 2011-2013 (2011), The State Progress Strategy "Lithuania Progress Strategy "Lithuania 2014-2020" (2012), The State Progress Strategy "Lithuania Progress Strategy "Lithuania 2030" (2012) and documents ratified in 2013 (Guidance for Diversity of models of Pre-school Education (2013); Guidance for Providers of Non-state Pre-school and Pre-primary Education (2013); The National Education Strategy for 2013–2022 (2013)) aim to emphasize that educational institution has to adapt to fast changing needs of society and educate children capable to live in nowaday conditions.

The State Progress Strategy "Lithuania Progress Strategy "Lithuania 2030" (2012) claims that „in long term perspective it will be aimed to stimulate creativity of all the society and its every member, to concentrate on the ideas which would help Lithuania to become modern, open to the world but cherishing its own national identity country." *The strategy emphasizes that STEAM helps to solve problem of lack of specially important skills and encourages to develop versatile skills which encourage entrepreneurship, innovation and creativity*. The document aims to intelligent society where creative and free individuals easily adapt to fast changing environment, creats fresh impetus to new ideas and works, able to not only survive but also satisfy all the necessary needs.

The Description of the Achievements of Pre-school Age Children (2014), The General Curriculum Framework for Pre-Primary Education (2014) Guidance of Pre-school Education (2015) provide modern approach to quality of pre-school and pre-primary education which aims to ensure successful development of children and use the most attractive and most effective methods and ways of teaching. Teachers are suggested to implement innovations, create not traditional educational environments, activate children's curiosity demonstrating the way items work, use all the senses (smell, tectile, hearing, sight, taste) while exploring the environment. National General Curriculum Framework for Pre-Primary Education (2014) presents guidelines for development of STEAM education using learning by doing and experimenting; also foundation of laboratories, experimental areas and creative areas, where it would be possible to organize different activities to develop children's cognitive and communication competences, is encouraged. The Good School Concepts's (2015) main position is to learn by discovering and inventing, creating and collaborating. The concept

emphasizes education (development) based on dialogue, making assumptions for the implementation of new, innovative models both in state and non-state education.

The article "STE(A)M Non-formal Children's Education: Problems and Opportunities" in the series of publications "Analysis of Educational Problem" by the Ministry of Education, Science and Sport of the Republic of Lithuania (2015) introduces a new educational method and provides recommendations how to implement it in Lithuania. Also a project "Scientix" was introduced; it aims to encourage and support cooperation of science, technology, engineering and mathematics (STE(A)M) teachers, educators, politicians and other professionals in the field across Europe. This project had three stages: in 2009–2012 web portal for European STE(A)M projects and their results was created; in 2013–2015 the project served while creating national strategies intended to encourage wider use of inquiry-based learning and other innovative methods for STE(A)M teaching; in 2016–2019 it is funded by EU Research and Innovation program "Horizon 2020".

The publication "STEAM Education in Lithuania: establishment of Open Access Centres and cooperation" (2020) emphasizes essential changes in the field of modernization of curricula of STEM and the development of teachers' competencies. To ensure development of children's STEAM competencies in Lithuania, STEAM open access centres (future classrooms) have been established since 2016 in Vilnius, Kaunas and Klaipėda cities and Alytus, Marijampolė, Panevėžys, Šiauliai, Tauragė, Telšiai, Utena regions. EU projects "Design and Installment of Digital Curriculum" (No. 09.2.1-ESFA-V-726-03-0001), „Development of Research, Evaluation and Monitoring System for General Education: Evaluation of Students' Achievements" (No. 09.2.1-ESFA-V-706-02-0001), "Professional Development of Teachers' and Specialists' Providing Assistance to Pupils" (No. 09.2.2-ESFA-V-707-02-0001), "Continue" (No. 09.2.1-ESFA-V-727-01-0001) and "Maintenance of Schools with Means for Natural Sciences and Technologies" (No. 09.1.3-CPVA-V-704-02-0001) together with its activities "Foundation of STEAM open access centres", "Purchase of Special Education Supply and Means for Technical Support" (No. 09.1.3-CPVA-V-704-04-0001) are intended to improve quality of education system, to develop teachers' competence and to eatablish STEAM centres.

## *New Technology (STEAM tools) in Polish schools*

Polish educational institutions – schools, kindergartens and universities – choose innovative technologies nowadays. Every year one observes an "increase of teachers and institutions focusing on modern education" (Mentor). Teachers search for new innovative solutions which can help prepare the lesson and convey the knowledge in an attractive way.

According to a headmaster of a Primary School in Lubsko city the role of a teacher is different today than what it used to be in the past since a teacher "ceases to be an omniscient figure, threatening with quizzes and tests, and instead takes the role of a mentor, advisor who motivates to act, encourages to overcome barriers, makes new attempts and sets new challenges in the area of the student's closest development". (Rabenda, 2019). As a consequence, *teachers need new tools which will enable them to prepare projects that will provide "answers to real problems; refer to everyday life; study phenomena occurring in nature; or improve already existing solutions*". Moreover, in her article M. Dabkowska-Wilczek indicates that "in the current era of technological progress, there can be no effective education without the involvement of new technologies" (2017).

Teachers can choose between various options of introducing new technologies to schools: EU programmes, governmental programmes, private companies' support and more. A great and popular example is the "Active Blackboard" programme prepared by Polish Government. It is financial support offered to Polish educational institutions – both: private and public. Thanks to this programme a school is able to get whiteboards, interactive touch monitors, computers, 3D printers, robotics and more teaching aids. The estimated amount of funds for the programme between 2020-2024 was over 361 000 Polish Zlotych (which is around 80 000 EUR).

Specific data gathered by the Ministry of Education also proves that numbers of innovative teaching aids are increasing in Poland. In an article published on „Stawiam na Edukacje" online portal we read about the exact numbers of interactive boards distributed within Polish educational institutions. According to the data published on the portal, the number of sold interactive boards for Polish schools in 2010 was around 6000 while it increased to 10 000 in 2016. The advantages of such interactive boards are wide: an increased interest of pupils, engaging the students, effective learning process, a better understanding of the subject thanks to the colourful material. Thus, it is understandable that Polish teachers choose such interactive teaching aids more often.

***3D printing as STEAM tool in Poland***

Another example of using technology during STEAM classes in Polish schools is a 3D printer. Such technology makes the learning process attractive while it becomes "a form of interactive fun" (Fundacja Digital Poland, 2018). Some claim that " 3D printing is critically important for all students to learn, and the younger they begin, the better" (Scott, 2017). A Polish high school IT teacher from Kolobrzeg city – Jacek Kawalek – is a 3D Expert as well. His mission is to make 3D printing an official school subject since there is no official 3D printing curriculum in Poland. This solution could really help especially those students who

plan to apply to technical schools. More and more teachers at Polish educational institutions strive to use innovative teaching aids along with new methodologies and approaches - including STE(A)M. New technology, like 3D printing, is a perfect tool for STE(A)M methodology. Since the approach is based purely on experiments and the new role of the student (who becomes an explorer rather than a passive listener) the new 3D technology enables him/ her to challenge his/her self and learn by doing. Thus, they can discover the world around them thanks to the 3D technology.

As consequence Polish schools choose to order 3D printers more and more often nowadays. Two Polish companies are now working together in order to promote further the use of 3D printers within Polish schools and educational institutions. These companies are: Zortrax (a company producing 3D printers and 3D printing materials), and Skriware (a company developing innovative teaching aids for schools – including STEAM teaching aids). The two enterprises are now cooperating: "Zortrax M200 Plus 3D printers will become a part of Skriware range of solutions aimed at educators around the world. The first joint project of Zortrax and Skriware is going to be placing a bid to deliver fully equipped SkriLab workshops to over 4.5 thousand schools in Poland under the Active Blackboard program." (Anusci, 2021). The impact of Skriware on education in Poland (and global education) is also worth mentioning at this stage. The company has created original programme called "STEAM education in every school" which gives "the possibility to implement a modern educational laboratory based on 3D printing, robotics and programming adapted to the conditions of remote and hybrid learning in schools" (Skriware). The company offers not only 3D printers but more teacher-friendly technologies like educational robots, programming tools and online platforms for teachers.

Another example of using 3D printing technology in Polish school would be EU projects. This does not mean financial support only but more of a research and development support as well. An example would be an Erasmus Plus project in progress – the 3DP Teacher project. The project aims to develop the competences of teachers and promote 3D printing methods in EU schools. There is an international group of experts working on the development of the project's results – amongst them there is a school from Poland (primary school in Czudec city). The school's website provide examples of the work of the students who had a chance of printing their projects using 3D printing. This is a great proof that 3D technology can be used in primary education stage as well as high school.

***Robotics in Polish school***

An interesting STEAM teaching aid is robotics. The popularity of robots is still increasing – children and adults become more and more interested in innovative solutions offered by

robotics and augmented reality or artificial intelligence. Since technology is all around us it is also appreciated in the field of education and school environment. Polish schools are still places of traditional teacher-centred approach but they are evaluating rapidly. Robotics is an interesting and attractive solution for both – students and teachers. It gains popularity and it is used in Polish educational institutions. Robotics is widely used in STEAM model as well:

"Robotics in the classroom has positive results on students such as encouraging students to pursue more STEM career paths and develop the necessary 21st century skills that will enable them for success in the future. […] It has been proven that the use of robotics can help to encourage confidence and a positive attitude toward education in students, which helps to reinvigorate classrooms with cross-curriculum activities. STEM education proponents are looking for more ways to incorporate robotics classes into schools at the earliest of ages" (Grover, 2015). An example of a company offering support for Polish educational institutions in the field of robotics is TROBOT. The company has been operating since 2008 – its mission is to provide and develop innovative teaching aids for Polish schools, on every stage of education. The company offers e-learning courses for teachers and workshops (for children and young people) and prepare lesson plans which have become the basis for many schools in Poland. While visiting the website of the company's partners one can see many models of robots offered as educational tools for schools. Companies like TROBOT are key support for teachers who acknowledge the value of robotics used during classes and want to start their journey with new technologies at school.

Examples of robotics used in Polish educational institutions can be easily found online. An example is a Primary School in Bielsko Biala where children from different classes (starting at the age of 7) are able to test robots during classes. The actual task for the pupil is to create and test the specific programme which controls robots. An example of a robot used would be an "Ozobot" which is a type of a robot used in order to teach children how to programme. It starts with drawing colourful lines on a piece of paper and continues with colourful blocks in a special programme called "Ozoblockly". The use of colours enables the youngest pupils to use this tool which proves that even the youngest students are welcomed to use innovative technology in the learning process.

***STEAM education in Poland – project example and inspirations***

It is important to notice that STEM and STEAM approach is much more than new technology used at schools. The idea is that thanks to this new approach students are able to learn new competences that are crucial on labour markets nowadays such as abstract thinking and logical thinking. While it is true that technology is all around us today and students should learn it from the earliest stages of education it is not the technical skills that are crucial but rather

"creative thinking, allowing students to understand the processes of controlling devices and learn them" (Librus).

Despite the fact that STEAM method is not included in the official education programme in Poland the schools are interested in the approach. An example would be SteamPolska – it is a project aimed to promote the ideas of STEAM approach in Polish educational institutions. SteamPolska brings together enthusiasts and practitioners of STEAM approach not only in Poland but worldwide. The authors organise conferences and workshops which aim to develop STEAM competences of the teachers. There has been prepared an original model of creative training laboratories - STEAMLab and CREATIVELab. The authors offer support for teachers and institutions interested in introducing the new approach. Nevertheless, it is the student who is still at the core of the programme: "A student who experiences work in STEAMLab will be a problem-solving, creative person, able to use a variety of tools and aware of his/ her talents" (STEAMPolska). Students will gain new competences and skills and will manage to develop much more than digital skills. The work in STEAMLab was planned in detail and divided into S-T-E-A-M spheres. For instance, in S sphere (Science sphere) the students will be able to learn about climate while creating a form of a spectacle taking place in Italy, Verona – they will need to design a model of the theatre, including the costumes of the main characters and the set/ scenography. Thus they need to know about natural environment in Italy – is the climate hot or cold there?; what kind of clothes would their characters wear? etc. On the contrary in the M sphere (Mathematics) the students need to learn how to calculate in order to build characters' houses. They should remember that they need a detailed calculation in order for their theatre model to be properly prepared. Again, this is a kind of learning through experience where the student is the explorer and then the constructor of the model. All the teachers who want to take part in the SteamPolska project are welcomed to contact the authors via email address provided on the project's website.

A different source of knowledge about STEAM methodology – apart from IT companies offering innovative teaching aids and specialistic programmes like SteamPolska project – are the teachers themselves along with couches and education experts. An example would be Marlena Plebanska who is a Polish e-learning expert. In her online article Plebanska claims that we do not need the standard learning system which is based on learning by heart and completing tests which are then to be assessed by the teacher and result in marks and grades. According to her the education system today is "not sufficiently focused on teaching children to solve real problems; it is not interdisciplinary and confines itself to an artificial framework of standards and principles" (Plebanska, 2021). In her article the author encourages to use an interdisciplinary teaching method and gives STEAM approach as an example. Plebanska presents the advantages of STEAM approach:

- Inspired by real life scenarios;
- Based on observing the social life;
- Experience gained through experiments and role plays;
- Building students' motivation to learn;
- No age limit (children from kindergarten are welcomed to take part in STEAM classes);
- No time limits (STEAM classes can be conducted by the teacher once a week or every single day);
- STEAM classes are intuitive.

Such articles prepared by education experts and teachers become a great source of inspiration and knowledge for teachers and tutors interested in new teaching methodologies, like STEAM approach.

***Romania***

Although STEAM education is not formaly included in the national curricula, there are some private initiatives of public school or non-government educational institution focused on introducing STEM/STEAM education to Romanian pupils, begining from primary education. These institution are offering solutions for completing the national core curriculum through optional disciplines or extracurricular activities, that are providing a practical and interdisciplinary education within STEM / STEAM approach, to helps development of future adults capable of facing future challenges. CRESTEM ("we grow") is one of the associations that implements in Romania projects aimed for STEM education. Through such projects, this association has as main goal the creation of a STEM-type educational framework, the creation, adaptation and promotion of STEAM educational programs adapted to the Romanian education context, supporting the adoption of STEM programs by public and private educational institutions, creating extracurricular activities such as robotics clubs, computer clubs. The association joined the "Education for Science" Community from Măgurele, for the development of educational activities, by creating the CRESTEM Educational Center. Other partners involeved in their projects of promoting STEAM education are: LEGO Foundation, Evolutie prin educatie (Evolution through education) and Fondul Ştiinţescu (Mr.Science Fund). Their main activities for the 2021-2022 school year are: Supporting and organizing the FIRST LEGO League content at national level, the ROBOT Olympics, Robotic clubs in for children from Bucuresti Schools.

***Turkiye***

Although Turkiye does not have a direct STEM action plan, some strategic goals to strengthen the STEM education were defined in the 2015-2019 Strategic Plan. These goals are aligned with the outputs of Technology and Design courses. It can be said that more studies should be carried out on 7th and 8th grade Technology and Design courses that include STEM. It is important to discuss STEM education as a priority for the students in order to improve the results of exams such as TIMSS and PISA (yegitek.meb.gov.tr, 2016). In 2018, the revised science curriculum in 5th, 6th, 7th and 8th grade is aimed at the plan "Science and entrepreneurship for engineering applications" connected by defining a problem or need from everyday life, designing a tool by taking into account the material, time and cost criteria (MEB, 2018, p.10). In order to implement these in schools, it is essential to get the support of experts working in the field of STEAM. To be able to adapt the STEM education into the curriculum Science and Mathematics in primary and secondary schools must be decreased in order to have enough time for STEM activities on the other hand national exams should be updated. Students' inquiry, researching, developing products and inventing skills must be assessed and evaluated. Science labs in school should be modernized according to STEM education and essential resources should be provided to them (yegitek.meb.gov.tr). According to the primary and secondary school science and mathematics curricula revised in 2013, it is defined that the inclusion of STEM education into these curricula aim for students to be educated as scientifically literate individuals with knowledge, skills and positive attitudes towards science, technology, society and the environment (FTTÇ) (TTKB, 2013). This means that although science and mathematics curricula attribute importance to the interaction between science, technology and society, STEM integration and engineering skills are not given importance in these curricula (Kertil & Gurel, 2016).

Actions and deficiencies regarding STEM education in the renewed science education program are included in Figure 1 (MEB, 2017).

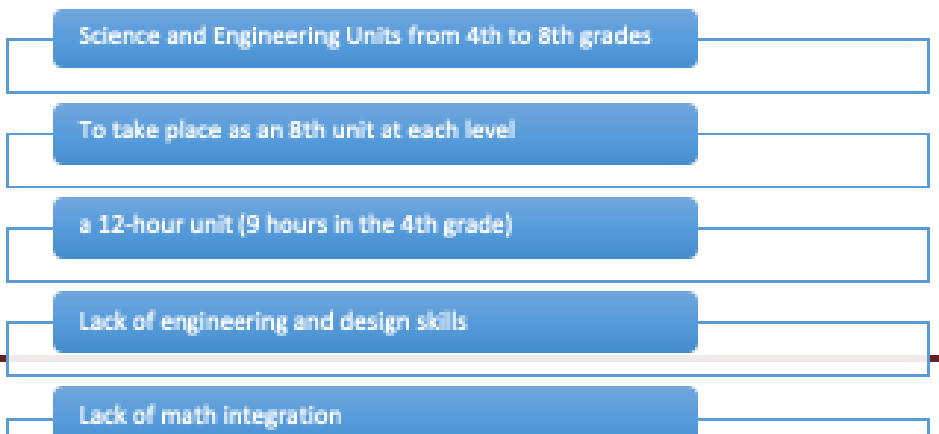


***Figure 1.*** *Actions on STEM Education in New Science Education Program (Aydın University)*

As seen in Figure 1, when examining the updated science program in Turkiye, it becomes apparent that the actions for STEM education take place from 4th to 8th grades under the name of science and engineering within the Next Generation Science Standards (NGSS). Although engineering design and science applications are planned from pre-school to university within NGSS, in Turkiye these actions are actually only implemented from 4th to 8th grade. In this program the engineering skills are highly emphasized but only emphasizing engineering skills does not mean the application of the STEM education approach in the science curriculum. As an approach, STEM education should be integrated into all science education curricula. Thus, students can acquire the skills of problem solving, design thinking, as well as the understanding of scientific and engineering methods (MEB, 2017).

When we look at the above definitions and the content of the MEB program within the scope of the STEM curricula, the skills that usually need to be developed in 2018 are related to life skills such as analytical thinking, decision making, creative thinking, entrepreneurship, communication, collaboration. In addition to this, and to the engineering and design skills (MEB, 2018), entrepreneurship and invention, the ability to gain self-esteem and to contribute to the economy of the country are factors that should be taken into account in STEM education.

## 3.3. Results/outcomes of previous projects on STEM education/ Arts education/ Social and Emotional Learning related to science education

***Greece***

In the last decade, in Greece, many Erasmus programs and e-Twinning programs are taking place at schools, mostly primary schools, that they target the STEM approach. One of the most important project was launched in 2017 (01/04/2017-31/03/2020). The Educational Policy Institute (IEP) as national coordinator for Greece of the European Project H2020, advanced in the call for interest of school units for their participation in the pilot phase of the OSOS project which has been implemented from the 2017-2018 school year.

The European project H2020: «Open Schools for Open Societies – OSOS» aims at formulating a framework for the "Open School". Its purpose was to prepare the introduction of the "Open School" innovation structured around natural sciences and STEM focusing on thematic areas linked to modern social challenges, in all education levels. 21 agencies (ministries, universities, research centres, museums, schools etc.) from Europe, the USA and Australia participated in the project.

Also, several non-profit organizations are active about STEM/STEAM approach. One of the most famous organizations is "STEM Education Organization" (since 2015) that conducts educational activities and aims for the STEM educational method to be inducted in the national education system. STEM Education is a non-profit organization and its purpose is:

- Create a proper environment where children of all age can develop their creativity, innovation and cooperation skill.
- Develop applications of natural science and new technologies, focusing on applying educational robotics.
- Develop knowledge in Technology and improve performance in school, mainly in practical courses, such as mathematics, physics and computer technology.
- Encourage an open exchange of ideas and cooperation between the participants in the fields of technology and educational robotics.
- Include Engineering in natural sciences (STEM).

### *Lithuania*

The report of the research "Innovative Pedagogical Practice and Pedagogical Innovations in Lithuanian kindergartens" (2018) claims that "evaluating the fields of achievements of pupils which require innovative ideas and means at a pre-school age most, it was recognition of environment, research, perception and expression of emotions, counting and measuring, oral and written language". The report of the research states that innovations are most

important for development of cognitive competence at the pre-school age and least important for artistic and health competences. (Monkevičienė, O., 2018, p. 104). The report emphasizes that mobile laboratories, temporary or permanent research spaces where pupils experiment, observe and research together with their teachers are founded for STEAM education in pre-school establishments. A lot of attention is paid to innovative activities outside (for example, a nap in the tent, outside area as a laboratory for reseach ans experiments), different natural experiments ( for example, use of microscope in the lab in the medical room), introduction of iinovative educational means (for example, there is a space of toys for STEAM activities). The analysis of the reseach results showed that STEAM education liberates pupils and teachers. STEAM encourages children to explore real problems playing and with pleasure. Besause of STEAM education children develop and gain knowledge sharing their explorations, discoveries, experiences and impressions. They become versatile personalities able to feel joy, improvize, elf confident, open able to act and make decisions.

### *Poland*

Despite the fact that STEAM method is not included in the official education programme in Poland the schools are interested in the approach. An example would be SteamPolska – it is a project aimed to promote the ideas of STEAM approach in Polish educational institutions. SteamPolska brings together enthusiasts and practitioners of STEAM approach not only in Poland but worldwide. The authors organise conferences and workshops which aim to develop STEAM competences of the teachers. There has been prepared an original model of creative training laboratories - STEAMLab and CREATIVELab. The authors offer support for teachers and institutions interested in introducing the new approach. Nevertheless, it is the student who is still at the core of the programme: “A student who experiences work in STEAMLab will be a problem-solving, creative person, able to use a variety of tools and aware of his/ her talents” (STEAMPolska). Students will gain new competences and skills and will manage to develop much more than digital skills. The work in STEAMLab was planned in detail and divided into S-T-E-A-M spheres. For instance, in S sphere (Science sphere) the students will be able to learn about climate while creating a form of a spectacle taking place in Italy, Verona – they will need to design a model of the theatre, including the costumes of the main characters and the set/ scenography. Thus they need to know about natural environment in Italy – is the climate hot or cold there?; what kind of clothes would their characters wear? etc. On the contrary in the M sphere (Mathematics) the students need to learn how to calculate

in order to build characters' houses. They should remember that they need a detailed calculation in order for their theatre model to be properly prepared. Again, this is a kind of learning through experience where the student is the explorer and then the constructor of the model. All the teachers who want to take part in the SteamPolska project are welcomed to contact the authors via email address provided on the project's website.

A different source of knowledge about STEAM methodology – apart from IT companies offering innovative teaching aids and specialistic programmes like SteamPolska project – are the teachers themselves along with couches and education experts. An example would be Marlena Plebanska who is a Polish e-learning expert. In her online article Plebanska claims that we do not need the standard learning system which is based on learning by heart and completing tests which are then to be assessed by the teacher and result in marks and grades. According to her the education system today is "not sufficiently focused on teaching children to solve real problems; it is not interdisciplinary and confines itself to an artificial framework of standards and principles" (Plebanska, 2021). In her article the author encourages to use an interdisciplinary teaching method and gives STEAM approach as an example. Plebanska presents the advantages of STEAM approach:

- Inspired by real life scenarios;
- Based on observing the social life;
- Experience gained through experiments and role plays;
- Building students' motivation to learn;
- No age limit (children from kindergarten are welcomed to take part in STEAM classes);
- No time limits (STEAM classes can be conducted by the teacher once a week or every single day);
- STEAM classes are intuitive.

Such articles prepared by education experts and teachers become a great source of inspiration and knowledge for teachers and tutors interested in new teaching methodologies, like STEAM approach.

### *Romania*

The previous research on STEAM education in Romania has also shown that the STEM / STEAM approach in school activities is not an approach provided by the national curriculum. A recent study conducted in Romania on the approach of STEM / STEAM in schools (Bărnuțiu-Sârca, Ciascai, 2021), investigated the perception of teachers in primary and preschool education on STEM / STEAM education, the opening of the school and the

curriculum to this type of education. The study data were collected through a questionnaire. The obtained results capture the need of teachers to acquire solid knowledge about the STEM / STEAM approach in educational activities. Also, in order to carry out activities based on the STEM approach, it is necessary that the schools are properly equipped so as to allow the development of the skills specific to the STEM / STEAM approach. 77.31% of respondents agree that STEM approaches should be cultivated. Although 56.7% of the teachers participating in the study state that they are not familiar with the STEM approach, teachers should successfully complete this type of approach in activities with students. Regarding the curriculum for primary and preschool education, the study finds that 82.47% of teachers believe that the curriculum should be redesigned to include STEM / STEAM skills and activities. The conclusions of the study show that STEM / STEAM approaches are perceived as difficult to implement in primary education due to the large workload and many required resources, but, despite these difficulties, this approach should be implemented and there for should be included in curricula for the training of primary and pre-school teachers.

Regarding the previous projects carried out in connection with or for the implementation of STEAM education in Romania, there were identified projects carried out by NGOs in the field of education with the support of the business environment:

- ”Solve for Tomorrow” is a project developed by JA Romania with the support of Samsung company, to promote *sustainable design thinking for solving problems*/ a challenge in the following areas of interest: Environment, Diversity and inclusion, Education, Sustainable development.
- ”Skills for Technology Professions” is a career guidance project for middle and high school students implemented also by JA Romania with the support of Honeywell company. It was developed as part of the international program Junior Achievement - Success Skills and includes a special educational module created for hybrid lessons - Jobs in Tech -, consulting and mentoring activities organized with the support of Honeywell volunteers and online training sessions, job shadowing type, for different professions in the company's field of activity (Aerospace; Control technologies for buildings and industrial spaces; High-performance materials and technologies; Solutions to ensure the productivity and safety of workers).
- SCIENTIX projects, developed in the frame of Horizon 2020 program; e.g. CONNECT – a project that encouraged young people to pursue a scientific career by giving students more opportunities, into the school curriculum, to see what scientists are doing and to appreciate the impact of science on the world. The project supported secondary schools to became an open school be integrating science-action in the

core-curriculum and using participatory-science with the community: families, universities and enterprises.

- STEM-STEP was an Erasmus + strategic partnership project for higher education, Solving environmental problems in the immediate vicinity in small steps is a big step in solving global environmental problems. The name of the project, STEP ("PAS"), was chosen as a metaphor to reflect this approach. Through this project, students developed basic skills and knowledge about STEM education, learning to identify environmental issues, set priorities, formulate solutions and put them into practice. An atmosphere conducive to the exchange of experience related to solving environmental problems will be created; also the project dissemination plan aimed for the creation of STEM school clubs.

***Turkiye***

Long-term and sustainable education policies are aimed at integrating STEM education into primary and secondary education programs. In order to achieve this, multifaceted action plans have been designed, such as providing STEM education for the needs of teachers and students, training STEM teachers, updating the curriculum to include STEM education and researching the course materials suitable for STEM education. With the transition to STEM education, it is expected that students will have a more qualified education and acquire skills suitable for 21h century skills such as problem solving, creativity, critical thinking, entrepreneurship and innovation. The STEM approach is desired to be adapted to the national education policies of countries for purposes such as sustainable economic development, raising individuals with the skills needed by the business world, and making each individual STEM literate.

After 2017, with the changes made in the Science Curriculum by MoNE, engineering and design chapters were added to the primary and secondary education curriculum, making the effect of the STEM program more evident (MoNE, Science Teaching Program, 2018). MoNE has published an online library that promotes STEM applications for preschool and private institutions (Acquisition-Centered STEM Applications, 2019). STEM and Coding Education Standardization (SOSACT) project in order to determine the quality standards of STEM and Coding Education carried out in Turkiye and to provide teachers with the STEM and Coding information needed, under the coordination of the Ministry of National Education- General Directorate of Innovation and Educational Technologies. The project still continues with the project partnerships of Gazi University, The European Schoolnet (EUN

Partnership AISBL), the University of Poland (Spoleczna Akademia Nauk) and the University of Barcelona (Universitat de Barcelona).

The HAREZMİ project, which is an educational model that reinterprets the interdisciplinary approach by integrating computer science teaching with Social Science, was implemented by the Istanbul Directorate of National Education in pilot schools of different levels and types in the 2016-2017 academic year. Between 2019 and 2020, it was implemented in 439 schools in 39 regions of Istanbul with approximately 10,000 students and 1,863 practice teachers. In addition, 33 in-service trainings are organized for 810 teachers in 27 provinces (IPDNE, 2019).

Hacettepe University established the STEM & Maker Laboratory in 2009 in order to support STEM practices in Turkiye, to increase the research, technological and scientific momentum of the country, and to contribute to the continuous development of the social and economic aspects.

BAUSTEM Center within Bahcesehir University organizes themes, content and applications for teachers who will implement the STEM program for primary schools. It also supports STEM practitioner teachers with face-to-face workshops and Webinar applications (BAUSTEM, 2021).

In addition to other initiatives, STEM education is organized in an integrated manner with social responsibility projects. One of them is the "Girls in STEM (GIS)" project for girls who will be women scientists in the future, led by Nobel Prize-winning scientist Aziz Sancar. In the project, girls discover both STEM education and their predisposition to scientific skills together with their peers living in other countries (GIS Project).

## 3.4. Limitations on or opportunities for the engaging of girls and other economically or geographically disadvantaged groups in science learning in pre-primary and primary education

***Greece***

Even though the curriculum for pre primary and primary schools include proposals and suggestions for differentiation learning, it doesn't seem to be practiced, both regarding to the participation of girls and disadvantages groups of students.

***Lithuania***

Educational strategies teachers are using do not exclude girls. Girls become involved into STEAM activities as active and willingly as boys, even more girls are more interested in STEAM activities than boys, there for they are not separated. Also, economical disadvantaged children are even more interested in STEAM activities than more advantaged children are, probably because those last are not able to resist computer games. For mentally disadvantaged students, teachers prepare tasks which are possible to do using simple everyday materials, for example, water, oil, sticks, etc., as there is always an opportunity to observe or explore something using the simplest materials. For all kinds of students teachers use methods that allow all students to try and find out, to prove or negate a certain hypothesis.

***Poland***

The official Polish education programme does not differentiate students based on gender. Nevertheless, the stereotype of a woman taking up humanistic career rather than the one connected to science is still present in Polish reality. In her work from 2016 Edyta Bombiak – a PhD from Siedlce University of Natural Sciences and Humanities – studies the career path realia in Poland. Bombiak points out that while it is true that certain social roles are assigned to women in Poland (taking care of the children and housework), they want to receive a proper level of education as they perceive it as a chance for their development. A different article by a Polish author – Justyna Tusinska – indicates that in Polish reality women choose humanistic career indeed and there is nothing wrong about it, with one exception: "the so-called female occupations are perceived as less prestigious and paid lower, while the so-called male occupations are valued and rewarder better" (2020).

As forementioned, the Polish education system does not divide students' tasks based on gender. Instead it focuses on the general development of the knowledge, skills, attitudes and behaviours of the children. Nevertheless, some experts notice that gender-based stereotypes are still present in Polish reality, including kindergartens and schools. Thus, they organise events which aim to develop the scientific interests of young girls. An example of such an event would be a project strongly connected to STEAM methodology. The project was called "STEAM-owe DZIEWCZYNY". It was a series of workshops for girls planned in Walbrzych city, Poland, in 2020 and organized by KidsTech company – an educational company which aim is to introduce new technology and methodology in Poland, including STEAM model. The company promotes the use of robotics, LEGO Education, drones, 3D printing and more.

They organize classes even for very small children (at the age of 2,5 and 3) which is part of their "SMALL EXPLORER ACADEMY". The planned workshops were strongly connected to all the spheres of S-T-E-A-M which included:

- Science – the green energy workshop (participants' task is to build and program wind turbines using LEGO elements and LEGO Education)
- Technology – using 3D printers to produce gel nails and nails' decorations, using recycled materials
- Engineering – inspiring young female engineers while building and programming robotics resembling the world of animals
- Art – a combination of artistic and technological workshops
- Mathematics – the colourful workshops which aim to inspire future math experts.

The workshops were designed for girls aged 6-12. The main objective was to break the stereotypes of STEAM activities interesting for boys only and engaging girls to take up a scientific career in the future. Furthermore, the most important task of the organizators was to make sure that the girls enjoy the event and that they feel confident while working with technology and learning subjects like mathematics and engineering.

***Romania***

Both the pre-school and primary school curricula are developed in an inclusive manner, taking into account all categories of vulnerable children and combating their exclusion or discrimination, regardless of the criteria considered. Also, the training at the bachelor's level of future teachers for primary and preschool education includes courses on inclusion at an early age and equal opportunities in education. Also, at national and local level, several socio-educational projects have been implemented by government or civil society dedicated to economically and or culturally disadvantaged groups, especially for the Roma ethnic category, for the prevention of school dropout, especially for girls in primary and secondary education.

Gender stereotypes in education are no longer found in the Romanian education system, but at the level of social perception, especially among the older population, there are still some prejudices regarding what kind of professions are more suitable for women or men. But, fortunately, these prejudices do not negatively affect the gender inclusive development of education, especially scientific education, for both girls and boys. Today's parents of preschool and primary school children make no difference between girls and boys in terms of learning activities or subjects they should learn.

***Turkiye***

In the ”The Turkish Republic Presidency of the Republic and the department of budget follow-up report” STEM subject should be considered on a preferential basis taking into consideration digital transition and the importance of Industry 4.0 revolution and the necessity of qualified education and also the impact of the Sustainable Development Aims (https://etkiniz.eu/wpcontent/uploads/2020/09/stem.pdf ). It is defined that applied concrete projects gave rise to the children's schooling rate. So these carried out projects lead to get rid of regional and social gender apartheid based inequalities in the education system via the impact of the contracts signed by Turkiye (ERG, 2019). The projects carried out with the cooperation of UNICEF and MEB like ”Glaonthus flowers”, ”Father please take me to school”, ”Let's girls go to school!” with the support of national foundations and entrepreneurs lead to progress the girls' sensibility for the schooling with good results in the society (Taş and Bozkurt, 2020).

According to the data of TUIK/ the State Institute of Statistics ‘’the questionnaire related to the use of time’’ in 2014-2015 the difference between the rates of ‘’ labour at home’’ and ‘’care labour’’ is getting bigger years by years on behalf of the boys dramatically in the questionnaire applied for the girls and the boys aged 10-17 (Taş ve Bozkurt, 2020).

In the last years, it is seen that many projects have been carried out by NGOs in order to eliminate the STEM and social gender based inequalities. My Madam Curie (2013-2015), STEM For Disadvantaged Students Especially Girls Project (2014-2015), STING (2014-2017), Honey Bees Become Engineers (2015-2017), STEM: Engineers of the Future (2015-2017), Turkiye's Engineer Girls Project since 2016, Aziz Sancar - Stem Camps Project for Girls (2016-2017), Science and Technology Seminar for Girls (2017), Girls in Science and Technology I and II (2017-2019), Girls Meet with Science since 2019, My STEAM Network since 2019, GirlCode since 2016 and STEM School Project for Girls since 2019 are some of the studies and projects carried out in recent years by Non-Governmental Organizations for the elimination of STEM and gender-based inequalities.

It is remarked in the report of ”the Success Difference Gender-Based in Turkiye” in which Batyra (2017) evaluated the 2015 PISA data; the female students stayed behind in the science and mathematics fields compared with the male students when the student, family and school features were kept stable in Turkiye. This situation is convenient with the biased choice of the female students. This work proves the gender gap in the student's success using the gender as a dummy variable in the regression.

In April 2014, Istanbul Aydin University launched a project called "STEM for Disadvantaged Students Especially Girls" to help socio-economically disadvantaged students

and especially girls be more interested in STEM to improve the students' scientific process skills, creativity, problem solving and higher order thinking skills and to help students form positive attitudes towards STEM related occupations (Istanbul Aydın University, 2019).

## 3.5. Conclusion regarding the general context (curricular and extra-curricular) existing in the partner states for the realization of inclusive STEAM-based education

As observed from the data presented above, all the partner countries have a national curriculum, both for pre-school and primary school education, focused on developing key competences for the 21 century, including scientific literacy competencies. The subjects or disciplines taught since pre-school cover knowledge in the field of natural and human sciences, physics, chemistry, mathematics and arts, according with the level of student`s development and with national regulations. These subjects are being studied in an integrated, inter- and trans-disciplinary manner, or as distinct disciplines. The differences between curricula are determinate by the number of hours allocate to each subjects/disciplines, the age entry and the level of education for compulsory education, the organization and implementation of the scientific classes (some differences between teaching activities, methods, resources etc.). There is no specific curriculum stated at national level for STEAM education, except for Greece, that has a new (since 2020) education policy aimed to implement STEAM approach in preschools and primary schools, respectively the ***STEM-STEAM Activity Plan.*** But all other partner countries curriculum offers a good frame for STEAM approach implementation in teaching science in early education. So, ***regardless of the lack of specific national regulation for STEAM education, in every partner country are found efforts to offer STEAM education in classroom or outside it, in curricular or extracurricular activities to promote specific cognitive abilities: critical thinking, problem solving skills, creativity, perseverance, team work abilities etc***. These efforts are mainly due to involvement of European educational programs and/or national NGO interventions and projects. In each partner are found previous experiences - activities of STEM or STEAM implementation- , from which they could conclude of what can work well and what could be the challenges for STEAM approach implementation.

Regarding socio-emotional learning related to science education, there was no evidence found for an integration of SEL with STEAM so far. Yet, all the curricula are focusing on socio-emotional skills especially as transversal and transferable skills that could be learned in science education classes as well.

Regarding gender inclusive education or other disadvantaged students education all the national curricula and other education regulations and policy papers offer the ground base for inclusive educational practices. There is no discrimination between the involvement of girls and boys in science education activities, or of the disadvantages pupils in primary or pre-primary education. Yet, some efforts still need to be done for equal participation of boys and girls to education in Turkiye.

# 4. Focus Group Interviews results

## 4.1.Methodology

In order to ensure the successful accomplishment of the projects goals and to offer a ground base for teacher training activities and teaching resources that will be further developed in the project, all partners carried out a needs analysis research during the first months of the project (February – May), under the coordination of P6 –Valahia University of Targoviste. For this, based on the templates prepared by P6 and discussed with the partners in transnational online meetings, each partner organized and conducted a series of Focus Group interviews targeting three type of stake-holders: 1) teachers for pre-primary and primary education and school management staff, 2) parents, 3) professionals from STEM+ Arts areas. The interviews were the structured type, following a list of questions (Annex 1) established by P5 (University of Creete) and P6 and agreed with the other partners. The questions aimed at identifying the knowledge about STEM and STEAM, as well as the difference between them, the difficulties that teachers encountered or consider they will encounter in implementing this approach in teaching activities, how these difficulties were overcome, what kind of support did they have/should they have in implementing STEM/STEAM, identifying the effects of teaching STEM on children, also the identification of types of strategies that could motivate students to get involved in STEM / STEAM lessons, as well as training needs in this regard. The interviews were recorded to allow the qualitative content analysis of the participant`s answers. This analysis followed a deductive approach, that it has involved analyzing qualitative data based on the interview structure (issues covered by the list of questions) predetermined previously to interview sessions.

The Focus Group interview sessions were held online (using platforms as Zoom, Microsoft Teams, BigBlueButton, or face to face, according to specific SARs-Cov 2 epidemic situation of their country. Each focus group interview lasted between one and two hours. All the participants expressed verbally or signed (in face to face matching sessions) their consent after reading and discussing the consent form. At the beginning of each interview the moderators introduced themselves, provided information about the project and requested the expression of consent for the use of participant`s data in the context of the project, after which they invited the participants to present themselves briefly. The moderators also considered creating an atmosphere of trust and good mood, so that participants feel comfortable and answer questions honestly.

### *4.1.2. Study population and samples*

For the research, population was targeted according to 2 main aspects important for the projects: occupational status in the area of education and STEM+Arts, parental status and children age covered in the project, respectively 4-11 years. So, the focus-group interviews subjects were: teachers in primary and preschool education and representatives of educational institutions interested in these levels of education, professionals in the field of STEM and Arts and parents. This empirical study has not been conducted at the national level, and is not representative of this level for any of the partner country. The geographical area covered for the recruitment of study participants was the residential area of the partner institutions involved in the project and nearby regions, except from Poland that had the teacher`s group representative for all areas of the country. All the participants of the Focus Group Interviews were selected according to the criteria requested in the project. Besides the criteria mentioned above, another aspect for the formation of the groups was a minimum number for each group (12 for teachers, 4 female STEM professionals, 3 female Arts professionals, 6 parents (and from them at least 3 parents with children of different gender) and subjects willingness for participating in the research. The interviews subjects come from different environments (urban or rural environments, most of them from urban areas, some from geographical or economical disadvantaged environments). The average teaching experience of all teachers groups was between 10 (Greece) and 25 years (Lithuania)

For the selection of the participants, each partner previously prepared a list of educational organisations – schools, kindergartens, colleges- and STEAM related institutions. Invitations were sent via open calls (which was distributed by the partner`s communication channels) or through a contact person from each organisation/institution from the list. Each subject's participation was based on free choice and availability in relation to the time lines and the online or face to face way of conducting the interviews.

**All t**he subjects (most of them are female) of the Focus-Group involved in the projects are presented in the table below:

Table 1. Subjects of the Focus-Group interviews

| Country | Teachers group | STEM+arts professionals group | Parents group | Total per country |
|---|---|---|---|---|
| **Romania** | 19 | 9 (8 female) | 9 | **37** |
| **Turkiye** | 19 | 14 (12 female) | 13 | **46** |
| **Bulgaria** | 18 | 5 (all female) | 7 | **30** |
| **Greece** | 41: 17 students, (teachers to be) + 24 in service teachers | 10 (8 female) | 9 | **60** |
| **Lituania** | 12 | 7 (4 female) | 6 | **25** |
| **Poland** | 20 | 8 (7 female) | 10 | **38** |
| **Total per group** | **129 teachers** | **53 professionals (44 female)** | **54 parents** | **236 participants** |

## 4.2. Results of the interviews qualitative content analysis

The data presentation is structured according to the issues that determined the creation and structure of the interviews questions list.

**The 1st issue: teachers and STEM+Arts professional`s previous experience and knowledge regarding STEM/STEAM approach**

Analysis revealed that most of the teachers and STEM+Arts professionals from all partners have a general idea about STEAM approach, they knew de meaning of the STEM/STEAM acronym (STEM comes from science, technology, engineering and math, and STEAM was obtained by the introduction of the arts), but only a few had the experience of implementing it. In general, they identified themselves as inexperienced in teaching based on STEM or STEAM approach. Except for Lithuanian primary teachers that have some experience in teaching STEM/STEAM, they can apply STEM/STEAM didactic strategies/methodes. Also, the greek group of student teachers appeared to be more informed about the approach, due to the fact that new younger teachers have/had more input about the STEAM approach during their undergraduate studies.

In general, there has need identified a small difference between teachers and STEM professionals regarding the knowledge of STEM philosophy and topics, in the sense that almost all STEM professionals and most of those in the Arts understood the need or benefits as well as the ways to combine science with art, which can be explained by greater access they have to up-to-date information related to science education or art education. Majority of the ART professionals agreed that there can be science through arts and vice versa, and could think of examples of how these domains can be correlated.

***The general attitude of teachers***, both from preschool and primary school education, ***and STEAM professional toward STEAM approach implementation*** is a positive one, highlighted by the openness and desire to know more and to try it in their own educational endeavors.

**The 2nd issue: difficulties they faced/they could face in implementing this approach** (difficulties related with their **infrastructure/logistics**, related with the framework provided by their national curriculum, **with the lesson plans design** etc.)

For most primary teachers and STEAM professionals that had previously experienced STEAM implementation or similar activities, the main difficulties mentioned were:

- School`s infrastructure (space and schedules) that makes it difficult to approach the integrated, trans - and inter- disciplinary approach of the topics /problems, to access the laboratories, etc.
- The lack of teaching materials/resources (like technology and substances needed for experimenting etc.) or proper spaces in the community (like Laboratories, botanical garden etc.) that can sustain proper STEAM implementation
- Big time consuming for designing and preparation of the lessons, and workload for teachers, mostly for the disadvantaged schools.
- Limitations due to curriculum frameworks;

- Lack of support or collaboration from science field experts/professionals/teachers,
- Lack of supporting educational policies.

For kindergarten/preschool teachers the lack of resources and curriculum limitation did not constitute difficulties, but rather challenges, mostly due to the fact that teaching resources for these ages are more accessible /affordable, they usually get more involvement from parents, and curriculum frames are more generous for a creative and customized approach to the needs of learners and subjects taught.

For teachers that did not experienced before STEAM implementation, besides the difficulties mentioned above, the first difficulties highlighted were:

- Difficulty in adapting to the level and specific needs of all and each children
- Lack of adequate information /models/ training and experience.

The 3rd issue: **Ways of overcoming of the difficulties, the support teachers have/could have in implementing STEAM approach, their strengths:**

All the teachers declared that they overcame the obstacles through:

- personal interest, study and effort to understand more and learn how to implement STEAM lessons,
- collaboration with a more experienced teacher or mentor, or with other colleague interested in this approach,
- consulting and adapting some examples of STEAM activities available on internet
- involving parents to obtain resources for the lessons, and some of them found material or financial support from other organization within the community (e.g. universities nearby, some economic entities etc.)
- some of the teachers declared having support from school management regarding teaching resources and school infrastructure difficulties.
- *only teachers from Lithuania received the necessary support from the policy makers , school management (the school has a team responsible for STEAM education and activities), and govermental training providers on methodology of STEAM. Therefore these training courses and collaboration allow teachers to work effectively. so the menbers.*

The 4th issue: **Teachers training needs, their own perceptions on their readiness for the implementation of STEAM approach,**

- Most of the teachers did not felt quite ready for proper use/implementation of STEAM activities, although they were willing and open to this type of education. Only teachers from Turkiye felt ready to implement STEAM.
- All teachers declared that they need more specific training on STEAM philosophy, concepts, methods, specific digital resources, lesson plans, didactic materials, mentoring and sharing experience trainings, practical seminars or fieldwork trainings in non-formal education providers such as museum.

The 5th issue: T**eachers opinion on the characteristics / attributes of a "good practice" in STEAM education:**

Analysis of teachers and STEAM professionals answers revealed four dimensions of a "good practice" in STEAM education:

- The capacity to fully engage all children, regardless of their gender, or other disadvantages, to be attractive and to motivate children to learn, to be inspirational and to increase children`s interest, especially girls interest and motivation, for science field of education and work.
- To be easy to implement, and it is not consuming big time and many financial resources;
- It allows creative, inovative and funny ways to do things, helps children, and teachers, to get "out of the box", allows students to put their theoretical knowledge into practice, develop their mind and socio-emotional skills alltogheter, and also digital skills both for students and teachers.
- It offers authenticity – children must work and use authentic tools and instruments, not just toy ones -, offers the posibility of obtaining meaningful artifacts that would be capitalize and promote all over the country or the world.

The 6th issue: **Expected effects of STEAM teaching on children:**

The STEAM approach value for children development depicted from teachers and STEAM professional`s opinions is:

- Value regarding cognitive development and learning potential or strategies: STEAM approach increase the quality of learning (children will find learning through STEAM easier, more fun, and more active), helps children aquaire scientific literacy and improve their critical thinking, inquiry thinking abilities, problem solving skills, creativity; STEAM can offer ways for extracurricular learning opportunities for all ages/educational level.
- Value regarding socio-emotional and language development: STEAM activities result in improved self-image, higher self-esteem, perceived self-efficacy, increased

resilience , tolerance end empathy, improved teamwork skills, improve assertive communication skills;

- Value regarding their intrinsic learning motivation and positive attitudes toward learning: increased children cognitive motivation, learning autonomy and engagement (students are much more comitted, more involved and more eager to learn).
- Value regarding digital skills: STEM education implies working with digital devices, use of the internet, computer programming, coding etc.

The 7th issue: pupils` **social and emotional learning process** (while doing STEAM or science lesson):

All teachers declared that they are aware of the socio-emotional learning importance and many of them admitted that socio-emotional abilities can be developed in science lessons, or STEAM lessons. However, some of the teachers don't seem to recognize how STEAM can contribute to SEL or, the opposite, that SEL is of primary importance in successful STEAM lessons. The SE abilities highlighted to be developed during STEAM or science classes by most of the teachers were: empathy, cooperation and collaboration, self-esteem, assertiveness.

The 8th issue**: How to make STEM/STEAM more attractive to girls and disadvantaged students,** and to get them become familiar with tools and other devices

Most of the participants from STEM professionals group didn`t encountered gendered differences while teaching science, especially regarding girls desire to learn and participate in activities. The differences between students are in temperament and aptitude, but are not influenced by gender, but by the attitudes of certain adults towards gender behavior. For example, they met older teachers who didn't ask too much of girls to do experiments or solve Physics/Chemistry problems. But this was in the past. In their current teaching experience, they did not had to differentiate methods or tools for girls to be involved and interested in the activity.

In Turkiye, there are some schools that still have to deal with girl`s school abandonment due to the early marriages and /or because of their parents attitudes towards the role of girls. Therefore they stated that the parents should be educated and trained first from the early school education of their children. Without their support, it is very difficult to keep the girls in the schools. They also propose strategies and solutions for the motivation and participation of girls and disadvantaged students: supporting collaboration among students, using appropriate role models, inclusion of genders and corresponding the needs and interests of the girls.

For economically disadvantaged children the situation is slightly different. Most of them do not have all the necessary supplies to carry out all the proposed exercises and activities.

Therefore they need support in this regard. Children in geographically disadvantaged areas could be supported by mobile teams of diacticians, or the development of summer schools, theater activities that took place in summer holidays and helped children learn different topics (from sciences, humanistics) through arts. They all agreed that STEAM -based activities would help children in these disadvantaged areas much more.

All the teachers and professionals believe that the STEAM approach makes a difference and is an opportunity for all children to develop better, deepen their knowledge and be better prepared for their future profession.

- The 9th issue: **parents biased perceptions of gender differences** in the use of toys, programs and activities specific to their children's age:

Almost all parents claimed that they do not have any problem in allowing both gender children playing or engaging in all type of games and activities. However, some parents declared that there are gender differences in the use of toys, programs and activities specific to their children's age. Boys are being considered as computer gamers, more active (prefer balls, Lego and cartoon characters), whilst girls are assigned to “calm” playing, such as mind and board games. The conclusion was that this could probably be due to stereotypical behaviors children observe and parochial ideas that might be passed on to them by their environment, from elder people or even from some younger too.

The 10th issue: **parents perceptions on the value of Science and Art in children education:**

Regarding the knowledge of the STEM/STEAM approach, most of the parents (except those from Lithuania, were STEAM education is a popular topic in nowadays), declared that Art helps their children express themselves better and natural sciences are useful for the future career of their children. mentioned that they had no previous knowledge and have not heard of this approach so far, so they can`t mention anything about the value of STEAM in child`s education. They understood during the interview what STEAM is and how will learn children in such an educational approach. There for they were able in the end to contour the value of this approach: they considered it perfectly adapted to today's children of early education years, because they learn by moving, playing, doing experiments, and that helps them to learn very quickly and much easier. All the parents outlined that STEM+ARTs approach facilitates to a greater extent the discovery of a child's talents and abilities.

## 4.3. Conclusions and recommendations from Focus-Groups Interviews

The respondents, in most cases (except the ones from Lithuania) only heard about STEM / STEAM concepts, but do not have enough information about it or they have a few information discovered on the internet or during the interviews. So, both teachers and parents did not have a clear and dipper understanding of the potential STEAM approach offers. But all the teachers, and STEM+art professionals, were entusiastic about the approach and eger to be trained and be prepared for implementing STEAM education. All the participants agreed that science can benefits from arts and viceversa, especially in teaching.

Also, most the participants declared that they did not noticed or think of any gender discrimination in teaching science or arts, but they did noticed some gender stereotypes and some trends in the context of children`s activities to guide or encourage the participation of boys and girls in activities traditionally considered specific to one gender or another.

All participants believed in the added value of art in the science learning process and in the importance of socio-emotional abilities development even through science lessons, or especially through STEAM lessons.

# 5. **General conclusions** regarding Stem+arts aproach in primary and pre-primary education and inclusive education in partener countries

## **5.1.** Training needs outline by the interview respondies

**Teachers training needs for STEAM approch implementation in primary and preschool education are the most important aspect needed to be addressed during this project. The outlined needs for training are grouped in three categories, as specified below:**

a) **Trainings content (what the trainings should be about):**

- specific training on STEAM philosophy, important STEAM topics and concepts, methodes, STEAM specific digital resources/softwares etc; for univeristy students - the need for more STEAM lessons in their initial training;
- innovative methodes, methodes suitable for working with vulnerable children, not only discriminated, but also abused or emotional disturbed.

- best teaching approaches in science/STEAM.
- how to define the needs and learning styles of the students, and how to link the lessons with the real life problems.
- how to improve their collaboration with parents, and to increase the awareness of the teachers being a role models and influencers for the future career choices of their students;

**b) Trainings resources:**

- open source digital materials, like lesson plans, methodological materials (newest methodologies, integrated lesson plans), examples of STEAM projects for different ages, non-formal or extracurricular education projects based on or including STEAM approach, ready-to-use school projects that are related to STEAM topics.
- acces to free use of digital platforms or application suitable for STEAM implementation.

c) **Trainings format:**

- practical trainings/seminars (to share experience), ”on the field” or blendeed learning trainings; some would like more international projects and activities where they could share their experience with teachers from other countries;
- mentoring,
- fieldwork in non-formal education providers such as museums.
- demonstration lessons and examples of the best teaching approaches.
- authenticity;
- the need for personal study in order to increase their knowledge of the subject.
- support from the academicians/ experts while designing the lesson plans.
- to have a ”learning hub” – could AuReSSel become a learning hub? (**a technology-rich learning environment with** both physical **and virtual components** that provide formal and informal opportunities for learners to come together with peers, teachers, and other experts in their field)

## 5.2. SWOT analysis of the STEAM implementation in primary and preprimary education

Taking into account the specific conditions existing in partner countries for STEAM implementation, we developed a SWOT analysis:

| Strengths | Weaknesses |
|---|---|
| • Awareness of the existence of this approach and a minimum understanding of it.<br>• Teachers openness and enthusiasm for implementing STEAM approach, and availability for the trainings on STEAM approach.<br>• Good collaboration:<br>-between teachers and STEAM professionals or academics from education area or sciences area,<br>- between schools and other relevent comunity stake-holders (e.g. educational directorates or non-formal education institutions).<br>• Previous experinces in using methodes/teaching methodologies suitable or specific to STEAM approach (like research, exploration, experiments, working in groups, critical thinking etc.).<br>• Some previous experience with STEAM approach or previous training on STEAM (LI and TR).<br>• There are many national and regional science, coding and STEAM projects that will support the NGSS project.<br>• There is a new statutory curriculum focused to STEM/STEAM for pre-primary education (in Greece).<br>• Some schools which have been participatig in the research since 2020 have become valuable | • Teachers lack of experience with implementation of STEM/STEAM approach in different education level<br>• Difficulties related to curriculum infrastructure limitations (in Turkiye, Poland, and secondary cycle of primary education in Romania)<br>• Poor school or comunity facilities related to science learning,<br>• Lack of teachers time and resources/funds.<br>• Lack of teaching material for STEAM activities.<br>• Lack of more academic support from the universities and experts.<br>• The pre-primary and primary science curriculum should be revised according to the STEAM approach.<br>• Lack of projects, science festivals and competitions that could encourage STEAM implementation<br>• The workload for teachers, mostly for the disadvantaged schools.<br>• Teachers did not use specific SEL methodes in teaching science, they did not took into consideration the fact that science education could focused or allow focuse on SEL.<br>• Some parohial and outdated teacher-centred perceptions are still |

| | |
|---|---|
| members of STEAM network. (in Lithuania)<br>• Some STEAM specific activities (research, exploration, experiments) already implemented (in Lithuania).<br>• Plenty of projects promoting STEAM education at schools. (in Poland). | very much evident in teachers' thinking about STEAM. (in Greece) |
| **Opportunities** | **Threats** |
| • Generous framework provided by the early education national curricula for STEAM implementation in some countries (Greece, Lithuania)<br>• Good training opportunities or experiences offered through ERASMUS projects or some other European projects or other civil society organizations projects (all partner countries).<br>• The existing national projects for the gender and disadvantaged students can be linked with the NGSS project. (Turkiye)<br>• The national and regional education coordinators/ managers/ stakeholders can contribute to the implementation of STEAM education through delivering the workshops and disseminating the project.<br>• The skill and design ateliers of the schools can be used for the workshops and students' events.<br>• New teaching approaches are tested often at Polish kindergartens and | • Limitation due to no education policies regarding STEAM implementation.<br>• Lack of educational materials, schools infrastructures can decrease the impact of the project in disadvantaged schools and involvement of students.<br>• Lack of a STEAM educational programs makes the integration of the STEAM in the lessons more difficult.<br>• The lack of formal assessment procedures and processes of professional appraisal leaves it up to the teachers to implement whatever they want at the time they want.<br>• The format of the national exams don't match the STEAM principles, that can make it difficult to implement and evaluate the children progress.<br>• Some gender stereotypes and gendered parents attitudes toward |

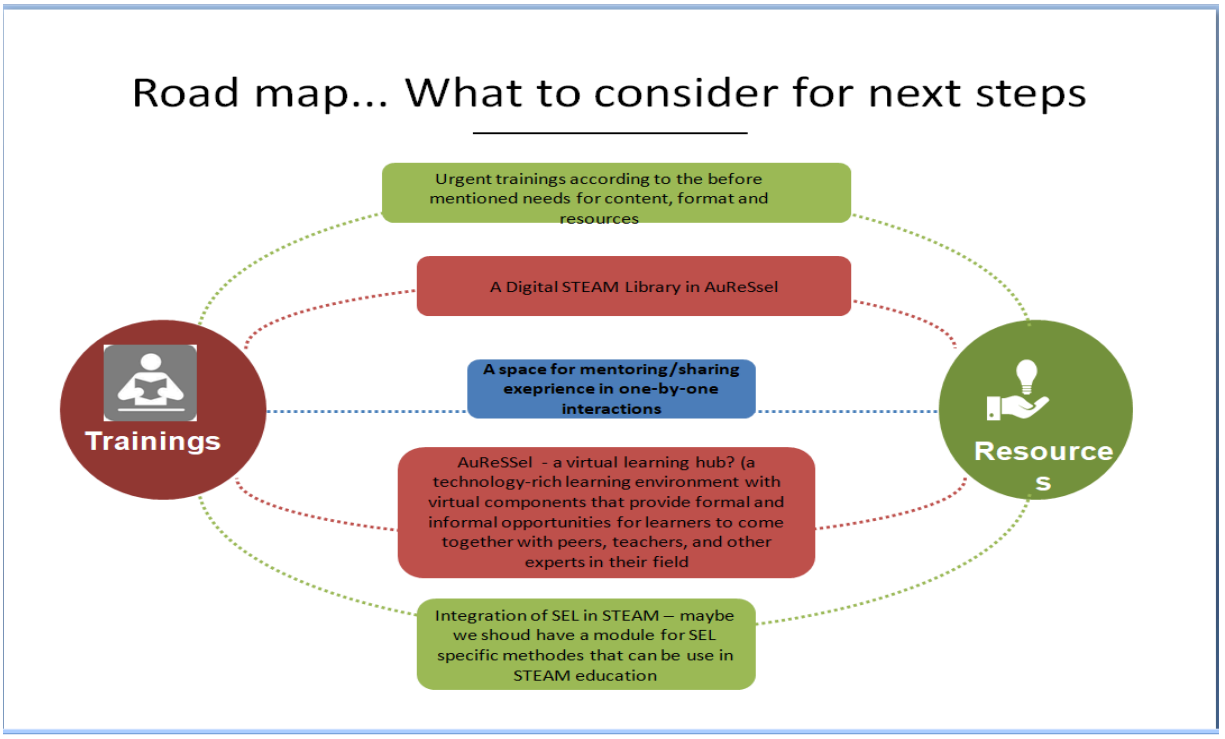
| | |
|---|---|
| primary schools – including STE(A)M model.<br>• Collaboration between teachers from the same country or foreign country to share their experience. (workshops, conferences, any practical learning activities)<br>• Possible help from from students of Kaunas Technology University and Panevėžys College. (Lithuania)<br>• Free transportation for students to other cities were they can acces science or art institutions (like botanic garden, museums etc.). | girls roles in the future (especially in Turkiye) |

## 5.3. Value of STEAM education in increasing the motivation, participation of young girls in STEM fields

- All the participants agreed on the fact that **there is no difference between boys and girls in engaging into STEAM activities in pre-primary and primary school;**
- Teachers and STEAM professionals reported that the **interests and performance of the kids in differents STEAM lessons/activities depend on their abilities, temperament and talents** and these are no gender related.
- Most of the participnts (teachers, parents and STEAM professionals) outlined that **STEM+ARTs approach facilitates to a greater extent the discovery of a child's talents and abilities**.

- Some participants admited that there are some parents and older teachers that have biased gender expectations and tend to guide or encourage the participation of boys and girls in activities traditionally considered specific to one gender or another.
- So, **formal STEAM education offer the framework and the space for both gender children to learn and develop on equal oportunities, according to their talents and interests.**

## 5.4. Overall general conclusion: what to consider for the next steps




**Overall, we consider that NGSS project could really make a difference on STEAM implementation in early education in partner countries, and not only, by developing teachers competences in this regard and providing ways to positive change in the education systems for inclusive education, development of science literacy and socio-emotional intelligence in future adults.**

By offering guidelines, the Concept Paper create the opportunities for transfer and application of best practices and methodologies to school learning environments as well as in all educational systems in the countries involved. – see and Annexes (**Autodidactic Resources based on Steam and Social and Emotional Learning, Digital Toolkit for Teacher Training Course and STEM+Art Kit for pupils, Online Guidebook for students & teachers how to think and create STEM+Arts education projects, Policy Recommendation Paper for STEM+Arts Education)**

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