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

ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
UNIVERSITY OF CRETE

NGSS

NGSS

National Report

GREECE

Project Information

Project acronym	NGSS
Project title	**Next Generation Science Standards through STEAM**
Authoring partner	VALAHIA UNIVERSITY of TARGOVISTE
Document version	1.0
Date of preparation	April 2021

Document History

Date	**Version**	**Author**	**Description**
30/04/2021	1		National Report Template

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1. Introduction

1.1. Context of the National Report

This document will present the state of STEM and STEAM in Greece. More specifically it will describe the place of STEM and STEAM in the Greece Primary Curriculum with emphasis in the Curriculum for the Early Years. It will also report on advances in the academic sector and any relevant published research. Finally, the report will present a summary of a focus groups survey carried out to detect educators awareness, knowledge, practices, ideas etc. about STEM and STEAM.

1.2. Objectives of the study:

O1. Identifying teachers, education stakeholders, parents and STEAM professional opinions related to STEAM implementation (good practices, difficulties, strengths, effects) in their region and the value of STEM+Arts education in increasing the motivation and participation of young girls in science education and careers.
O2. Identifying parent`s perceptions of gender differences in their children's play and/or school activities and
O.3. Identifying teachers training needs;
O4. Identifying criteria for good practices from the teacher`s perspectives.
O5. Offer a background in the development of the NGSS teaching resources for preprimary and primary school teachers .

2. Methodology

2.1.Methodes

The reserch methodology combined file research (the Focus Group Interviews) and desk research.

In Greece we had the opportunity to form and interview two groups of educators: a) Professional teachers and b) student teachers. A call was issued via the University publicity channels and it was addressed to professional teachers, student teachers, professionals form the STEAM sectors, artists, and parents. The educators' interviews were carried out online, using platforms such as Microsoft Teams, Zoom, BigBlueButton, etc. This was due to the quarantine imposed by Governments to prevent the spread of COVID-19. Artists, professionals and parents had the opportunity to meet during a period in which the pandemic restrictions were loosened. Each focus group interview lasted for one-two hours. All

participants signed a consent form which was approved by the University of Crete and were provided with a certificate of participation.

2.2.Study population and samples:

Study population:

We managed to form the following groups:

i) Professional teachers: Professional teachers were representative of all areas in Crete (urban or rural environments, disadvantaged environments, etc.). There were also representatives from both the Primary and Pre-primary (Preschool) education sector.

ii) Student-teachers in their final year of studies. These student teachers have completed three levels of teaching practice at schools, so they were already building their experience in dealing with curriculum subjects and classroom implementations.

iii) Parents from a variety of backgrounds

iv) STEM professionals and

v) Artists.

All of the above were invited via an open call which was distributed by the University communication channels (e.g. contacts with schools accomodating the University Practicum, educators attending University conferences, etc.).

Samples:

a) Teacher sample: 24 teachers (five from the Primary and 15 from the Preschool sector, from both rural and urban, wealthy and disadvantaged areas), 3 Males and 21 Females, with an average teaching experience of ten years.

b) Student teacher sample: 17 Student-teachers, in their final year, coming from a variety of backgrounds, all females, 23-50 year old (the sample included a mature student)

c) Stake-holders (parents) sample: 9 parents from a variety of backgrounds (3 Males and 6 Females) (Occupations: Policeman and policewoman, Bank clerk, Web designer, Childcarer, English teacher, Engineer, Housewife, Unemployed)

d) STEAM professionals sample: 6 professionals (4 Male and 2 Females) (Occupations: Mathematician, Engineers, Project manager, Physics teacher, Biologist)

e) Artists sample (2 Males and 2 Females) (Occupations: Musicians, Museum educator, Actor, Writer, Painter).

3. Results

3.1. Focus group inteviews results

3.1.1. The sinthesis of the participants answers:

- What kind of experience the teachers and STEAM professionals had with STEAM approach; what do they know about STEM / STEAM

  Most teachers and STEAM professionals knew about STEAM, but only a few had the experience of implementing it. In general, they identified themselves as inexperienced in teaching STEM subjects through Art and inexperienced in teaching STEM in general. Their understanding of STEAM is that of using Art to make teaching more enjoyable and creative for children. A small number of teachers did mention that Art could also contribute to the development of a better understanding of the world, the society and art could contribute to the child's socio-emotional and holistic development. STEAM professionals were found to be informed about STEAM. Student teachers were also more informed than professional teachers about the approach, and this can be explained by the fact that new teachers have more input about the STEAM approach during their undergraduate studies.

- If the STEAM professionals are aware of the possibility of teaching / approaching science and/or art in an integrated way (trans- and interdisciplinary) (see the answers to questions C1 and C2)

  STEM professionals had a very superficial idea about the STEM – Art integration. Their answers did not show good understanding, all of them linked art with creativity.

  Artists on the other hand were more aware that the art they serve is primarily defined by science. Artists displayed the belief that good art demands good science and science can be artistic by itself.

- What 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.)

The difficulties reported by the Greek teachers and student teachers can form the following categories:

- Difficulties in applying the STEAM methodology: Teachers reported a difficulty in applying and developing several attributes of the STEAM approach. They reported difficulty, for example, in initiating children's interest, in adjusting to

children's level, making STEAM learning experiential, ensuring safety during experiments and difficulty to act with flexibility to an unexpected development.

- Lack of knowledge, appropriate training and experience. Many teachers reported that the limits in their knowledge and experience were affecting their efforts to deliver STEAM lessons adopting a flexible inquiry-based and art-based approach.
- Finally, teachers identified the lack of resources as a restrictive factor in implementing the STEAM approach.

- How did they overcame these difficulties; which were their strengths; what/who helped them; did they have any support from the policy makers/stakeholders etc.

None of the teachers reported receiving any help from policy markers or stakeholders, advisers, etc. Some teachers reported that they it was their personal interest and study and effort that helped them to understand more and learn how to implement STEAM lessons and practice itself was also a significant means of understanding, especially for student teachers. The collaboration with a more experienced teacher or mentor has helped some of the teachers and student teachers. Finally, they mentioned technology and the internet as a source of education about STEAM.

- Their own perceptions on **their readiness for the implementation of STEAM approach, their training needs (**especially regarding the use of methods and tools necessary for teaching STEAM).

Most of the participants reported that they did not feel quite ready to teach STEAM lessons in their class, especially to implement an art-based approach, although artistic and creative activities belong to the routines of preschool education. They all identified their need to further training and student teachers expressed their wish to have more STEAM lessons in initial training too. One group identified the need for personal study in order to increase their knowledge of the subject and another group concluded that in order to implement the STEAM approach they would need careful and thoughtful preparation.
When they were to identify their training needs teachers and student teachers mentioned the following: They need to be offered with opportunities for professional development on the use of information platforms and open source digital materials, mentoring, fieldwork in non-formal education providers such as museums, demonstration lessons and exemples of the best teaching approaches. They all mentioned funding and the provision of resources that would enable them to implement successful STEAM lessons. Finally, they

mentioned the need to be provided with predesigned school projects on STEAM topics. Some groups suggested training on the pedagogical content knowledge, and on important STEAM topics and concepts.

- What are the **expectations related to the implementation of STEAM in their teaching**; what they consider to be the characteristics / attributes of a "good practice" in STEAM education .

Regarding their expectations and the attributes of good practice in STEAM we could group teachers' answers into the following categories:

Teachers expect that STEAM will enrich the curriculum and will increase the time of STEAM and children's contact with digital environments. It will also increase childen's appreciation of art.

STEAM will have a positive overall impact on children's knowledge, both in terms of theoretical knowledge and the understaning of everyday life.

As a learning process STEAM includes and should result in active and experiential learning with hands-on experimentation, and good teamwork. Children can become good inquirers and art will provide more stimuli and more fun, that will increase children's interest for STEAM.

They also expect that the STEAM approach will help children's socio-emotional development through teamwork, increasing children's self-esteem and cultivating children's communication skills.

Some teachers realised that the STEAM approach demands and brings changes in their own practices and pedagogical attitudes. They mentioned that succeseding in STEAM demands teachers to act less like experts and more like inquirers who are not afraid to make mistakes. Learning with the children is also identified as an attribute of the STEAM approach.

- What are the **expected effects of STEAM teaching on children?** (e.g. they will be more motivated; facilitating the understanding of science; increasing the interest in science for both boys and girls etc.)

Teachers could detect the effects of STEAM on the following:

- Increase the quality of learning: Children will find learning through STEAM easier, more fun, and active. They will get important knowledge about the world and will learn to use the scientific method of discovery and the extraction of conclusions.
- Develop good communication skills and increase their creativity through art. They will also learn to appreciate art better.

- Develop better thinking: STEAM is expected to open children's minds and help them to think at different levels. Children will exercise in problem solving and develop critical thinking skills.
- Finally, a better understandings of difficult concepts and the way the world works is expected to be achieved.

- Did they take the pupils` **social and emotional learning process** into account, while teaching STEAM or science lesson.

All teachers claimed that they took children's social and emotional learning into account. Some teachers could explain this further and showed a good understanding of this issue. For example, teachers with good understanding said that giving students the opportunity to present findings and express themselves that had a positive impact in their self-esteem and self-confidence. They also said that art enables children to discover multiple perspectives and develop empathy. It also provides a means of communication for children with language issues (e.g. immigrant and refugee children). In general teachers who understood how STEAM can promote SEL could explain how an open and child-centered methodology could contribute to children's healthy social and emotional development.
Not all teachers seem to recognize how STEAM can contribute to SEL or, the opposite, that SEL is of primary importance in successful STEAM lessons.

- What is their perception on the **value of STEM+Arts education in increasing the motivation and participation of young girls** in STEM fields of study and careers.

Teachers did refer to the professional perspectives STEAM lessons offer to children. They believe STEAM lessons prepare children for choosing and profession in the future.

- How did the STEAM professional manage to make STEM/STEAM more attractive to girls and disadvantaged students, and to get them become familiar with tools and other devices.

STEAM professionals mentioned that it is best to start with simple tasks and then get at more complicated stages when working on a STEAM topic. They also suggested to resort to children's interests. They also suggested that ICT provides good help towards the attainment of learning targets and it can be especially helpful to disadvantaged students.

- If parents have biased perceptions of gender differences in the use of toys, programs and activities specific to their children's age.

Parents were did not have a clear picture about gender differences in children's behavior, learning and preferences. Although they all claimed that both genders show the same interest to STEAM subjects nowadays, they simultaneously recognized that they noticed differences in the preferences of boys and girls. However, the majority of them concluded that this could probably be due to stereotypical behaviors children observe and parochial ideas that might be passed on to them by their environment.

- What are the parents perceptions on the value of Science and Art; If and how did they helped children understand it too.

Parents understood the difference between STEAM and STEAM mainly in terms of creativity. Greek parents do not have much knowledge and experience on the subject as this was recently introduced to the school reality in Greece. Therefore, they tried to imagine what the difference would be. They concluded that art would enable children to express their ideas better and bear innovative ideas.

3.1.2 *The conclusions of the Focus Groups Interviews* (from all of the 3 groups)

The general conclusion we were driven to through this process was that people (teachers, perspective teachers, parents, professionals) might be very excited about integrating Art with STEM subjects, but they might not quite understand the real reasons and benefits of this. They do not realise the potential of depper understanding and holistic ddevelopment the sTEAM approach offers.

Moreover, teachers might understand that the STEAM approach is part and parcel with a constructivist teaching and learning methodology where children are frequently encouraged to take the lead. However they either don't feel knowledgeable or confident enough to change their old practices or they are not willing to make the necessary steps towards change. Almost all of them stressed the need for training but very few realised that they also need to try harder in putting new methodologies into practice.

3.2. Desk research results

a) **The framework provided by the national curriculum for science education**: **Pre-primary**

The national curriculum, "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).

Primary Education

"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).

Table 1: The topics of the content of Science and Technology in Primary school

Topics	Year/Grade1	Year/Grade 2	Year/Grade 3	Year/Grade 4	Year/Grade 5	Year/Grade 6
Life around us	√	√	√	√	√	√
Energy	√	√		√	√	√
Electrical and magnetic phenomena	√	√	√	√	√	
Sound phenomena (Phenomena based on the sound)	√	√	√	√		√
Machines and dynamics interactions		√	√	√		√
Properties of matterials	√	√		√	√	
Thermal phenomena	√	√			√	
Light phenomena	√					√

Chemical phenomena				√	√	√
Hours per week	4	4	2	2	3	3

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 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. These activities encourage students to think outside of the box and they intensify their environmental consciousness. They are reflected on climate change and its consequences, they discover and they learn the variables that assemble both recording and predicting weather conditions. They are experimenting with the concepts of conservation and change. Among all the benefits resulting from the implementation of the STEM-STEAM program, the following abilities and goals are also being developed:

1. **Learning Skills**

- Critical thinking

- Communication

- Collaboration

- Creativity

2. Life Skills

- Adaptability Responsibility

- Organizational Ability

3. MIT: Technology and science skills

- Modeling and simulational 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

4. Mind Skills

- Strategic Thinking

- Problem resolution (Matters resolution)
- Case studies

- Constructions

The structure of the program is designed to allow the participation of all students equally, regardless of the gender or the disadvantages some students may have, as they practice multiple forms of intelligence and they develop different and varied skills, in addition to traditional educational approaches. So, 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 approach, the activities follow 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 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.

b) **The previous use (if any) of STEM or STEAM approach in national or regional pre-primary and primary education**.
c) **Results/outcomes of previous projects on STEM education/ Arts education/ Social and Emotional Learning related to science education :**

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).

a) Identifying 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

Even tho 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.

4. Conclusions and recommendationes

Regarding STEAM implementation in primary and preprimary education the conclusion can be presented in the form of a SWOT analysis

Strengths	**Weaknesses**
There is a new statutory curriculum focused to STEM/STEAM. Teachers seem to be excited about the STEAM approach.	Systematic training of teachers is required regarding STEAM. Parohial and outdated teacher-centred perceptions are still very much evident in teachers' thinking about STEAM. This may hinder progress on STEAM implementation.
Opportunities	**Threats**
There is a great opportunity to improve teachers' overall understanding about learning through STEAM approach. If teachers embrace this approach, they will improve the approaches they adopt in every other subject.	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. This encourages professionals to postpone trials of new methodological approaches, especially those that demand a change of perceptions and understanding.