State of the art analysis of existing initiatives, best practices and attitudes towards STE(A)M in educational contexts

D2.3 State of the Art Study

CHOICE

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CHOICE

Increasing Young People's Motivation to Choose STEM Careers Through an Innovative Cross-Disciplinary STE(A)M Approach to Education

WP2 - State of the art analysis of existing initiatives, best practices and attitudes towards STE(A)M in educational contexts

D2.3 State of the Art Study

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EUROTraining

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Introduction

The following State-of-the-art study was developed by the work package leader EUROTraining – Greece under the guidance of the project coordinator CESIE – Italy and with the contributions of the core project partners GrantXpert – Cyprus; Blue Room Innovation – Spain; and Lifelong Learning Platform – Belgium. It was finalized after being reviewed by all core consortium partners.

It gives an overview of the educational system and the types of educational programmes offered by public and private schools. It highlights the need to reform STEM-related curricula and integrate good practices in teaching STEM that foster the students' interest in STEM subjects as well as the attractiveness of STEM-related careers.

The desk-based research results part consists of findings from the desk-based research of each country, while the analytical part with the students and teachers' attitude toward STEM subjects is based on field research of questionnaires for students and teachers. The questionnaires consisted of closed-ended questions where the students could choose between *Not confident at all*, *Fairly Confident* and *Very confident* in order to assess their confidence level and attitude toward STEM subjects at school. Similar questions were included to provide a view of their future plans about following a career in STEM subjects. The gathered data was initially included in the National reports.

Lastly, an add-on to the State-of-the-art report is the *Reflective Practice Case-study Compendium* that is a collection of case-studies discussed during the reflective groups by the three key stakeholder groups: representatives from businesses, HEI and local authorities. The reflective group meetings were conducted in all implementing partner countries. It also functions as a collection the results of an in-depth reflection on existing measures, best practices and needs from the academic and business world, as well as on the policy level, thus providing a lever to align the new action proposed by CHOICE to existing initiatives.

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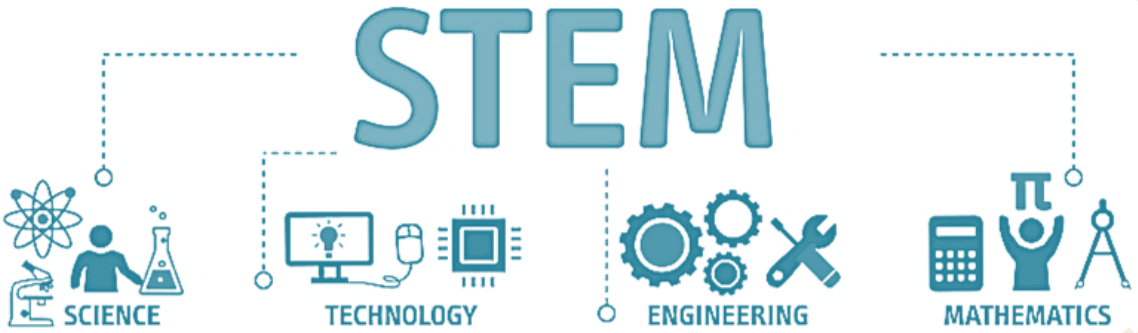
The EU and National European Contexts

The acronym *STEM* derives from Science, Technology, Engineering & Mathematics, and it is a curriculum based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in an interdisciplinary and applied approach. Rather than teach the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real-world applications.



Source

On the other hand, the acronym STE(A)M stress the importance of including Arts in teaching STEM disciplines, as a new and innovative teaching method. It also means "All" including both STEM and non-STEM subjects. STE(A)M is a way to take the benefits of STEM and complete the package by integrating these principles in and through the arts. STE(A)M takes STEM to the next level: it allows students to connect their learning in these critical areas together with arts practices, elements, design principles, and standards to provide the whole pallet of learning at their disposal.

STE(A)M removes limitations and replaces them with wonder, critique, inquiry, and innovation. Moreover, policy trends regarding the integration of STE(A)M in the educational system are described, as well as existing initiatives implemented by schools focusing on the integration of good practices regarding teaching STEM disciplines in high schools. The strategic framework for European cooperation in Education and Training (ET 2020)[1] is a forum which allows Member States to exchange best practices and to learn from each other. The ET 2020 framework provides opportunities to build best practices in education policy, gather and disseminate knowledge, and advance educational policy reforms at the national and regional levels.

The framework is based on the lifelong learning approach. It therefore addresses outcomes from early childhood to adult vocational and higher education, and is designed to cover learning in all contexts: formal, non-formal and informal.

[1] Education and Training - European Commission. 2020. *European Policy Cooperation (ET 2020 Framework) - Education And Training - European Commission*. [online] Available at: <https://ec.europa.eu/education/policies/european-policy-cooperation/et2020-framework_en>

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ET 2020 pursues the following four common EU objectives:

- Make lifelong learning and mobility a reality
- Improve the quality and efficiency of education and training
- Promote equity, social cohesion, and active citizenship
- Enhance creativity and innovation, including entrepreneurship, at all levels of education and training

Background Information

Among the benchmarks set at European level by 2020, the EU Member States agreed on an attempt to reduce the rates of underachieving 15-year-olds, with a goal of reducing their share to less than 15% by 2020. This still remains a challenge. According to the *Education and Training Monitor 2019* (the annual report on the progress of Member States towards achieving the ET 2020 objectives and benchmarks), across the EU the share of pupils who fail to complete basic tasks is around 20% (19.7% in reading, 22.2% in maths and 20.6% in science). Compared to the previous PISA round, conducted in 2012, in 2015 the proportion of underachievers at EU level increased by 1.9 points in reading and 4 points in science, while remaining overall stable in maths. Between 2012 and 2015, the EU actually moved further away from meeting its objective.[2]

Source

When it comes to STEM, some student profiles are more in need than others of specific programmes and attention by schools and policy makers. For example, if the goal is to boost young people's engagement in science, then emphasis should be put on girls, in order to improve gender equality in scientific fields (science, engineering, technology and mathematics).

EU policy and civil society position

In the *EC Communication - School development and excellent teaching for a great start in life (2017)*, acknowledging that *"schools play a pivotal role in life-long learning, and therefore action is needed to improve the quality and performance of school education", and identifying as top priority the development of a better and more inclusive school, actions are taken at EU level in order to "support improvements in school level education in science, technologies, engineering and maths (STEM) by promoting best practice in developing links and cooperation of higher education, research, businesses with schools at EU level and effectively addressing gender gaps and stereotypes in STEM, using Erasmus+."* Although it is not explicit, at EU level a

[2] Education and Training Monitor 2019 – European Commission, Ec.europa.eu. 2020. [online] Available at: <https://ec.europa.eu/education/sites/education/files/document-library-docs/volume-1-2019-education-and-training-monitor.pdf> [Accessed 22 July 2020].

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step forward is foreseen, considering that "*science, technologies, engineering and mathematics (STEM) education is more effective when linked to economic, environmental and social challenges or to arts and design, demonstrating its relevance for daily life."*[3]

A 21st century vision for science for society - *Science Education for Responsible Citizenship*

The publication "*is aimed primarily at science education policy makers. It identifies the main issues involved in helping citizens to access scientific debate; it provides guidance on how industry can contribute to science education; and it proposes a new framework for all types of science education from formal, to non-formal and informal approaches*." [4]

Regarding STE(A)M, a key objective is that *science education should focus on competences with an emphasis on learning through science and shifting from STEM to STE(A)M by linking science with other subjects and disciplines*. In this sense, inter-disciplinarity (STE(A)M rather than STEM) can contribute to our understanding and knowledge of scientific principles and solve societal challenges.

Source

Science and STEM have to be linked with all other subjects or disciplines at all levels of education: it involves the incorporation of the knowledge and the methods and approaches of more than one disciplinary context to enable new ways of thinking and identifying solutions to problems that fall outside the boundaries of just one discipline. This requires new ways of working and strengthening links and interaction between formal, non-formal and informal science education. The shift from STEM to STE(A)M means that the *A* includes *ALL* other disciplines.

"Making connections between STEM and all other disciplines – what is often referred to as STE(A)M – pushes beyond the boundaries of science to embrace the creative potential of linking the arts, scientific inquiry and innovation. Innovative new ideas and creative solutions often emerge at the interface between disciplines and involve different societal actors. Innovation is linked, directly or indirectly, to human experience, needs and

[3]European Commission - School development and excellent teaching for a great start in life, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0248&from=EN
[4]European Commission - Science education for responsible citizenship, https://op.europa.eu/en/publication-detail/-/publication/a1d14fa0-8dbe-11e5-b8b7-01aa75ed71a1/language-en

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problems. This can occur through engaging with the arts – playing or listening to music, dancing, experiencing or creating art, watching and creating video or film, or being involved in designing and making".[5]

The actions identified at EU level that could support the shift from STEM to STE(A)M, can be summed up into the following points:

- The support of arts-based initiatives with a STE(A)M focus, e.g. film, media, visual arts, etc. to develop resources promoting science learning, positive views of science and scientific culture;
- The development of a portal with information on "good practices" in STE(A)M, targeted at encouraging collaboration between enterprise and business (including SMEs), arts and design organisations and educational institutions at all levels for more contextualized contents.

In the following sections, you will first read the good practices and on-going initiatives on a local/national level for each partner country, and then the most significant findings of our field research involving students and teachers from the subject areas.

In **Italy**, STE(A)M education is currently a priority of the Ministry of Education, especially in the sense of bridging the job shortage in STEM careers in Italy. In 2015 the Italian parliament approved Law 107/2015, commonly known as the *Good School reform (La Buona Scuola).* The law includes reforms regarding the teachers' recruitment, teachers' professional development, mandatory traineeships for all upper secondary students. An important stress on reforming curricula and improving digital skills was pointed out, particularly: Emphasis has been put on introducing or enhancing the teaching of certain subjects, such as economics, music, arts, law, sports, sustainable development, Italian, English and mathematical reasoning; The three-year *National Plan for Digital Education (Piano Nazionale Scuola Digitale)*, aims to improve digital competencies of both teachers and students.[6]

In addition to these plans and policies, the Italian government is trying to improve its education systems by providing materials to support innovation and teaching reform. INDIRE (*Istituto Nazionale Documentazione, Innovazione e Ricerca Educativa*) has promoted the development of particular resources for STEM education for teachers: more than 800 resources developed for the main STEM subject areas and for different school levels are available in the "Scuolavalore" portal.

Similarly, in **Greece** what is relatively new regarding STE(A)M is the part of the Arts being embedded with Science, Technology, Engineering and Mathematics (STEM) and brings the STEM together with Arts - STE(A)M. Therefore, this addition is introducing students and educators a more holistic approach in the

[5] Id
[6] *La Buona Scuola*, Ministero dell'Istruzione, dell'Università e della Ricerca https://www.istruzione.it/allegati/2017/La_Buona_Scuola_Approfondimenti.pdf

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classroom that involves inquiry, innovation and critical thinking. Teachers in Greece have been trying to motivate the students in order to think of STE(A)M education and the connection of STE(A)M education and Greek ethnicity. STE(A)M is developed to integrate STEM scientific subject categories into various relevant disciplines for education. These constructed programs aim to teach apprentices to think critically and use engineering, technology, natural sciences in virtual designs or creative approaches to real-world problems while building on them mathematics and science base. Thus, STE(A)M programs add Art to STEM curriculum by depicting design principles and enheartening and invigorating creative solutions.

In other words, it introduces students and educators to a holistic approach in the classroom. STE(A)M removes limitations and replaces them with wonder, critique, inquiry, and innovation. Considering the importance of helping pupils understand that STE(A)M education is connected to everyday life, teachers in Greece need to motivate the students in order to think of the interdisciplinarity of STE(A)M education and more specifically, the connection that may exist between STE(A)M education and the Greek culture. In other words, pupils have to cooperate in an interdisciplinary way during discovery, inquiry and experiential learning activities.

STE(A)M rises up STEM to the next level: it provides students to network their learning in these critical areas together with arts concepts and practices, design principles, and standards in such a way to provide the whole floor of learning at their disposal.[7]

The school laboratory of natural sciences (SEFE) covers the needs of natural sciences laboratory teaching. The implementation of lab activities is an integral part of teaching natural sciences subjects. Students work in groups on a specific subject, developing their creativity in a spirit of cooperation. At the same time, they have at their disposal up-to-date instruments. The latter help them discover the environment and the laws that govern it. In order to offer extra support to lab teaching of natural sciences (Physics, Chemistry, Biology, Geology-Geography), laboratory centres of natural sciences (EKFE) operate. There can be one or more depending on the number of school units at each education directorate. Parallel to SEFE, all school units are equipped with a school laboratory for information technology and computer applications. Its function is to teach computer science and computer applications as defined by the curricula and the greater educational goals.

[7] Watson, A.D., Watson, G. H. (2013) cited in Liritzis I. (2018) 'STEMAC (SCIENCE, TECHNOLOGY, ENGINEERING, MATHEMATICS FOR ARTS & CULTURE): the emergence of a new pedagogical discipline ', DOI: 10.5281/zenodo.1214567

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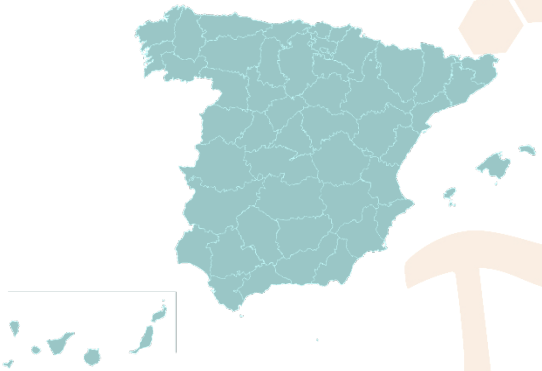
After reviewing the educational context in **Cyprus**, the pattern is again similar to the previous countries in terms of numerous initiatives and policies that support the STEM education of young people. However, the percentage of young people aged 25-64 years old in Cyprus with very basic digital competences is slightly higher than the average in the EU (34% versus 30%) and the percentage of individuals in Cyprus having more than basic digital competences is much lower than the average in EU (22% versus 36%). The percentage of schools in Cyprus providing essential equipment to support digital education, such as laptops, computers,

cameras and interactive boards, is lower than the average percentage across the EU at both primary and secondary levels. Only 40% of middle schools and 59% of high schools offer the necessary equipment to support digital tools as opposed to 54% and 84%, respectively in Europe.[8] Additionally, Cyprus has one of the lowest shares of STEM graduates in the EU and a lower share of ICT specialists in the workforce than the EU average. Approximately, one third of bachelor's students graduate with a degree in business, administration and law, a percentage much higher than any other discipline in Cyprus and the highest in the EU. Studies critical for innovation are underrepresented. Only 2.4% of Master's students graduate with a degree in natural sciences, mathematics and statistics and only 1.5% graduate with a degree in ICT. Therefore, there is a great need to enhance students' interest in STEM subjects and increase the attractiveness of STEM-related careers.[9]

The annual *Circular of the Cypriot Ministry of Education and Culture (MoEC)* in Cyprus stressed for the first time in 2005 the critical role of education in supplying the market with young people with the right employability skills all of which can be taught and learnt at school so that pupils can cope with the challenges of the modern world and labour market later on as citizens. These skills include creativity, critical thinking, validation of non-formal and informal learning, as well as analysing and implementing learning outcomes in different subsystems are expected to be completed in 2020.[10]



When it comes to **Spain**, in the first three years of secondary education, i.e. among students aged 12 to 14 years, science subjects account for 21% of class hours. In the stages of primary and nursery education science has a far lower presence in the classroom. In the upper secondary stage (16 to 18 years), it depends on the track chosen. These

[8] Ευρωπαϊκή Ένωση 2019. Έκθεση παρακολούθησης της εκπαίδευσης και κατάρτισης 2019 – Κύπρος.
[9] European Commission. 2018. Education and Training Monitor – Cyprus.
[10] Cedefop, 2019. Cyprus – European Inventory on NQF 2018.

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conditions will change with the entry into force of the Spanish Law for the Improvement of Educational Quality (LOMLOE) which will focus on the improvement of STEAM motivation on students, especially among girls. [11]

However, according to a recent DigitalES study, there are at least 10,000 vacant jobs in the technology sector in Spain due to lack of qualifications.[12] Technology companies are not the only ones which demand these profiles. The energy sector, banking or healthcare also seek this talent. But despite the job potential, the reality is these facts do not come up with an increase of students in STE(A)M careers.

Taking into account these issues, the Spanish Ministry of Education, has elaborated a *Proposal for a common digital frame-work for teachers* in line with the proposal generated by the center of investigation *Joint Research Centre*, from the European Commission which published in June 2016 the second version of the DigComp Project results, within the European framework on citizens' digital competence. [13]

[11] http://www.educacionyfp.gob.es/dam/jcr:babf11e0-696f-41e4-b278-81cd89c24d68/10-dossier-de-infografias-lomloe.pdf

[12] El desafío de las vocaciones STEM: https://www.digitales.es/wp-content/uploads/2019/09/Informe-EL-DESAFIO-DE-LAS-VOCACIONES-STEM-DIGITAL-AF-1.pdf

[13] Digital Competence Framework: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC101254/jrc101254_digcomp%202.0%20the%20digital%20competence%20framework%20for%20citizens.%20update%20phase%201.pdf

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Desk-based research results

Source

The first step of State-of-the-art analysis of existing initiatives, best practices and attitudes towards STE(A)M in educational contexts, consisted in conducting desk research as well as the collection of data to lay the basis for the innovative creation of cross-disciplinary OERs (Open Educational Resources) for the MOOC (Massive Open Online Course) on STE(A)M education. Furthermore, the project partners gathered information on existing local, regional and national initiatives to reform STEM education and contributing to close the skill mismatch in the current labour market. Best practices regarding the use of STE(A)M approaches to STEM education have been collected in each partner country as well as on a European level. The desk-based research results were developed under the guidelines and templates provided by EUROTraining, under the guidance of CESIE and they were finalized after the review of all project partners. The template that was followed can be found in Annex I. The gathered data was initially included into the National reports.

Italy

Local level

Planetarium of Palermo – Villa Filippina

Target group: children, youth, students, teachers, scientific community in general.

Aims: to encourage the dissemination of scientific knowledge.

Procedural information: The Cultural Association URANIA a.c.s.d. manages the "*Planetario di Palermo*" a museum and exhibition space of about 300 square meters, dedicated to Astronomy and Earth Sciences, for the public and schools, plus the outdoor spaces, terraces and lawn of the villa.

Resource and activity: the planetarium organises different events with schools and kids. Worth mentioning is the event "*Learn science and put it into art*", during which the rooms of the planetarium have been enriched with paintings and photographic exhibitions dedicated to naturalistic landscapes and with scientific exhibits dedicated to insects and volcanoes.[14]

[14] Planetario di Palermo. 2020. *Planetario Di Palermo* https://planetariovillafilippina.com

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PALERMOSCIENZA

Target group: children, youth, students, teachers, scientific community in general.

Aims: *PALERMOSCIENZA* is a project aiming at offering the possibility to experiment science communication activities in informal situations. The association *PALERMOSCIENZA* aims at the creation of a Sicilian Science Centre, which is not simply a physical space for exhibitions and laboratories but, above all, a space for a laboratory of ideas that allows different types of users to get in touch with the world of science.[15]

Robotic Team of the High School B. Croce: Robot.202 (Team Robotica del Liceo B. Croce)

Target group: high school students, teacher

Aims: the project aimed at fostering learning of disciplines such Mathematics, Physics and Computer Science. An upgrade path was planned, aimed at learning the contents necessary to carry out the "Mini-robot Race" promoted by the University of Catania scheduled for May 2019.

Procedural information: a project implemented by the High School Benedetto Croce and lasted one year.

When the Past becomes Future - From burning mirrors to solar power panels (Dagli specchi ustori alle centrali solari)

Target group: high school students, teachers, scientific community.

Aims: this one-year project, implemented by the High School Benedetto Croce aims at increasing the number of students enrolled in scientific faculties, to contribute to the construction of some European key competences, by fostering their knowledge in scientific subjects, as Mathematics and Physics. Moreover, it aims at strengthening students' curricula and fostering continuity between high school and university and student orientation. Finally, the project aims at the realization of a technological product made by 30 students, to present at the National Ricci Prize.

Resource and activity: use of computer labs, two temperature sensors, two LCD displays, glue gun, MDF panel, 3D printings.

Teaching strategies: lectures, 6 hours of Mathematics lesson in English language, 14 hours for the laboratories.

Procedural information: the project provides for introduction to coding and robotics to foster the skills of students through the philosophy of "do it by yourself".

[15] PALERMOSCIENZA https://www.palermoscienza.it/

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Scientific Degrees Project (Progetto Lauree Scientifiche)

Target group: high school students, teachers, scientific community.

Aims: improving the knowledge and perception of scientific disciplines in high school, offering students in the last three years to participate in stimulating and engaging curricular and extra-curricular laboratory activities; starting a process of joint work between School and University for the design, implementation, documentation and evaluation of the above-mentioned laboratories; promoting the optimization of training paths and the transition from School to University, strengthening and encouraging internship activities at universities, public and private research institutions and companies engaged in research and development.

Procedural information: The *Scientific Degrees Project* is the result of a collaboration between the Ministry of Education, the National Conference of Science and Technology Department Deans and *Confindustria* (The General Confederation of Italian Industry). The project was born in 2004 with the aim to increase the number of students enrolled in the degree courses in Chemistry, Physics, Mathematics and Science; the educational guidance of students was carried out through more than 100 sub-projects. [16]

Mathematic High School (Liceo Matematico)

Target group: students

Aims: the project analyzes the relationship between mathematics and literature, history, philosophy, as well as with chemistry and biology, re-launching the role that mathematics has played over the centuries in the social context. The aim is to provide students with knowledge and skills related to mathematics, so that they can consciously orient themselves in the different contexts of the contemporary world.

Procedural information: the *Liceo Matematico* project was launched in 2017 in Palermo. The courses of *Liceo Matematico* make use of the teaching methods and scientific contribution of professors of the University of Palermo and in particular of the Department of Mathematics and Informatics of the University of Palermo. The high school Benedetto Croce is involved in this project.[17]

National level

March: the STEM Month

The Italian Ministry of Education and Researches (MIUR) has launched a series of initiatives as part of the promotion of equal opportunities aimed at tackling gender stereotypes.

[16] Progetto Lauree Scientifiche https://www.unipa.it/dipartimenti/matematicaeinformatica/Progetto-Lauree-Scientifiche/
[17] Liceo Matematico https://www.liceomatematico.it/palermo/

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Target group: young female students, teachers.

Aims: the STEM Month is an initiative aiming at promoting the STEM (Science, Technology, Engineering, and Mathematics) disciplines in schools of all levels.

Procedural information: on the 8th of March, International Women's Day, the *STEM: Female plural* competition[18] is therefore issued, which aims to encourage reflection on the presence of women in STEM disciplines, in order to encourage students to develop a critical reading of prejudices and gender stereotypes regarding science, technology, engineering and mathematics, and to encourage female students to study these subjects.[19]

Ricci Prize (Premio Ricci)

Target group: high school students, teachers.

Aims: to foster the teaching of STE(A)M disciplines and stimulate students' creativity.

Procedural information: it is a national competition addressed to high school students for the design and realization of an object conceived as a support (or complement) to the learning of scientific disciplines. The competition takes place every two years. The nature of the project to be submitted for the competition is not precisely defined: a mechanical or computer device illustrating one aspect of mathematics or its application, a series of posters or posters, interactive materials and tools.[20]

Archimedes Prize (Premio Archimede)

Target group: students, teachers.

Aims: to foster the teaching of STE(A)M disciplines and stimulate students' creativity.

Procedural information: the Archimedes Prize is a national competition and its main aim is the creation of new board games. The Prize is dedicated to Alex Randolph (considered the inventor of the profession of game inventors), who was its president for the first 7 editions. For aspiring inventors, it is not only an important showcase where they can showcase their creativity, but above all an opportunity to grow professionally by comparing their ideas with those of other authors and with the experts of the international jury.[21]

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[18] *STEM: femminile plurale – II edizione*, Ministry of Education and Research (MIUR), http://istruzioneer.gov.it/wp-content/uploads/2019/03/Bando-STEM-2019_v2.pdf

[19] NoiSiamoPari - Il mese delle stem. NoiSiamoPari. https://www.noisiamopari.it/site/it/mese-delle-stem/. Published 2020.

[20] Laboratorio Matematico – Premio Riccardo Ricci. Premioricci.unifi.it. http://www.premioricci.unifi.it/. Published 2020.

[21] Studiogiochi. studiogiochi. https://www.studiogiochi.com/premio-archimede/ed-2020/. Published 2020.

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*STEM*Lab – Search, Transmit, Excite, Motivate*

Target group: students, students' families, teachers, educating community in general.

Aims: the main aim of the project is to strengthen in the partner regions (Sicily, Campania, Lombardy and Piedmont) the competences and aspirations of children through the acquisition of cognitive and non-cognitive skills.

Resource and activity: during this 4-years project, the activities that will be carried out are:

Co-planning and training workshop for sharing and using an innovative educational methodology for teaching and learning STEMs and sharing of experiences

Creation of STEM*Labs, multi-functional spaces capable of hosting educational activities, laboratories and events

Empowerment of families: programming aimed at students' families to extend the empowerment pathway initiated by the project to the entire family unit[22]

International level

FemSTEM - Coaching-Recruitment, Retention and Progression Coaching for Women in STEM:

a project co-founded by the Erasmus+ programme of the European Commission in which CESIE is involved.

Target group: women and professionals in the field of STEM

Aims: the main objectives of the project are: to create a comprehensive approach to deliver interventions to address the challenges faced by women during the Recruitment, Retention and Progression stages; to develop an E-Coaching programme for women in STEM; to develop a face-to-face peer coaching programme for women in STEM; to increase women's self-confidence, self-efficacy and develop their soft skills and employability skills.

Resource and activity: Recruitment, Retention and Progression (RRP) Framework testing; E-Coaching Programme that supports the learners in using digital technology in creative, collaborative and efficient ways and inspires new ways of thinking. An in-depth research on the barriers that women face in the labour market in all partner countries has been carried out; moreover, the development of the E-coaching programme for women in STEM, and other initiatives useful for women in STEM has been launched.

Teaching strategies: Coaching Circles methodology includes coaching, mentoring and action learning techniques to help the participants reach your goals with the support of an experienced facilitator and a small group of peers.

[22] STEM*Lab – Search, Transmit, Excite, Motivate https://cesie.org/en/project/stemlab/

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

Procedural information: the project will last three years and it involves Countries as UK, Italy, Greece, Luxembourg, Spain.[23]

FeSTEM - Female Empowerment in Science, Technology, Engineering and Mathematics in Higher Education:

a project co-founded by the Erasmus+ programme of the European Commission in which CESIE is involved.

Target group: female students, teachers and educators

Aims: it aims to promote an innovative method and pedagogy that will allow HE students to use traditional and computationally-rich media to create meaningful, shareable exhibits that will act as mentoring models for encouraging girls and women to remain active in STEM.

Resource and activity: A Research on academic and industrial levels into the challenges and expectations of women in STEM was carried out. Development of a toolbox with traditional and digital materials for constructing gender-sensitive exhibits. The FeSTEM community platform, aiming at linking HE students in STEM with experienced mentors in the field.

Teaching strategies: FeSTEM methodology: a gender-sensitive curriculum for STEM that consists of a set of training methodologies that can be used for guiding gender-sensitive teaching and the FeSTEM approach that informs the training methodology. At least 20 teachers and students will participate in transnational learning, teaching and training activities.

Procedural information: the project will last two years and it involves Countries as Cyprus, Greece, Italy, Slovenia and Spain.[24]

Greece

National level

The Hellenic Education Society of STEM

An example of the national level initiatives regarding the national level is the Hellenic Education Society of STEM.

Target group: students, parents, teachers

[23] FemSTEM - Coaching-Recruitment, Retention and Progression Coaching for Women in STEM https://femstem.eu/
[24] Festemproject.eu. 2020. *Festem | Female Empowerment In Science, Technology, Engineering And Mathematics In Higher Education*. [online] Available at: <https://festemproject.eu/>

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Aims: to provide best teaching and learning practices and concepts for the operative delivery of STEM in Education didactics models; provide applied teaching projects/didactic scenario and curriculum activities; provide material towards the clarification of the concepts "STEM in Education" and "STEM epistemology"; promote the implementation of "engineering pedagogy" in Education integrated in STEM Education; provide guidance through the support of STEM based laboratories; provide innovative ideas for implementation of "STEM in education" in curriculum models; create and sustain a national professional association representing the educators in STEM in Greece; preserve and deliver a representative national opinion for member associations; provide a common forum for educators in STEM education at National and International level; cooperate with other organizations and stakeholders at local, national and international levels; facilitate and provide strategies for the dissemination STEM epistemology and practices for the teaching and learning process at local, national and international level.; provide support for member associations; organize and conduct workshops, conferences and seminars; be involved in National, European and International projects; publish publications with an International focus; increase community awareness of STEM epistemology; provide a repository with "STEM in Education" learning design activities.[25]

Resource and activity: Membership provides access to material, training, advice and support. It can support and represent those in the foundation years of their career as teachers and it runs by providing seminars and workshops to students and schools.

Teaching strategies: The Hellenic Education Society of STEM engages in the development of STEM applications and epistemology with practices linked to the Inquiry Based teaching and learning approaches. It aims to promote the STEM epistemology, computing, computational science and computational thinking, and to advance understanding and education of the STEM methodology alongside contemporary learning theories and didactic models. It is the only professional body for STEM education in Greece with the vision to grant chartered status to STEM in Education professionals.

Procedural information: the Hellenic Education Society of STEM was first created back in 2017 and is an independent, non-profit, registered professional body and its members work for STEM education in primary, secondary and tertiary education. It is a community of University Professors, School educators and School Advisors who share a common vision for the role of STEM epistemology in promoting education.

The MAthisi STEM Camp at Moraitis School

Mathisi Initiative is a not-for-profit organization dedicated to introducing innovative and recognized educational programs in Greece in an open and affordable way. It is supported by foundations and private donors. For the summer 2019, it collaborated with the MIT Jameel World Education Lab (J-WEL) to establish an MIT-supported STEM Camp for the first time in Greece (and in Europe) at the Moraitis School in Athens.

[25] "Hellenic Education Society Of STEM (E3 STEM) – E3STEM". 2020. *E3stem.Edu.Gr*. http://e3stem.edu.gr/wordpress/?page_id=48&lang=en.

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While we haven't been able to run and expand our scheduled 2020 camp due to Covid-19, we are pursuing our work to be back with adaptative programs in the near future.

Target Group: pre-high school students (12- to 14/15 -year old children)

Aims: provide pre-high school students with local and affordable access to programs of internationally recognized excellence and relevance, to foster independent and curious learners, critical and creative thinkers, and problem-solving young adults engaged in the world.

Resource and Activity; The 2019 Mathisi Camp took place at the Moraitis School in Athens, with the participation of 60 students from 1st, 2nd and 3rd Gymnasium, coming from 20 different schools. The program cost for 2 weeks was €650 and almost a quarter of the students received financial support. Buses were provided along main routes[26]

CTY Greece – Center for Talented Youth at Anatolia College

CTY Greece at Anatolia College is the culmination of the strategic partnership of three organizations with a long tradition in education and social contribution. Anatolia College, Johns Hopkins University in the US and the Stavros Niarchos Foundation, all came together to establish a center that is unique to Greece and Southeastern Europe in general.

Target Group: primary and secondary education students

Aims: The program aims to offer summer programs on STEM subjects that provide the eligible students the opportunity to engage in challenging academic work in the company of peers who share their exceptional abilities and love of learning. As part of the Older Students Summer Day Programs, students enrich their experiences inside and outside the classroom. At CTY Greece the main components of the program's educational experience are both learning and cultivating social skills, as students develop lifelong friendships. The courses are fast-paced and have high academic requirements, so that they meet the needs of the respective high academic potential children they are serving. The students come from different places and have different educational experiences. For three weeks they are invited to delve into their academic interests while being part of an extraordinary community, without distractions. [27]

[26] Mathisi http://www.mathisi.org/indexeng.html
[27] CTY Greece at Anatolia College. Cty-greece.gr. https://www.cty-greece.gr/en. Published 2020. Accessed July 28, 2020.

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International level

Annual International Symposium on the Future of STE(A)M (sciences, technology, engineering, arts and mathematics) Education

The Natural & Formal Sciences and the Engineering & Architecture Research Divisions of the Athens Institute for Education and Research (ATINER) organize An Annual International Symposium on the Future of STE(A)M (sciences, technology, engineering, arts and mathematics) Education sponsored by the Athens Journal of Sciences and the Athens Journal of Technology & Engineering.

Target group: educators, students

Aims: The aim of the symposium is to bring together scholars and students of sciences, technology, engineering, mathematics and arts Education. You may participate as panel organizer, presenter of one paper, chair a session or observer. Papers (in English) from all areas of mechanical engineering are welcome.

Resource and activity: The Athens Institute for Education and Research (ATINER) was established in 1995 as an independent world association of Academics and Researchers. Its mission is to act as a forum where Academics and Researchers from all over the world can meet in Athens, in order to exchange ideas on their research, and to discuss future developments in their disciplines.

The organizing and hosting of International Conferences and Symposiums, the carrying out of Research, and the production of Publications are the basic activities of ATINER. Since 1995, ATINER has organized more than 400 International Conferences and other events, and has published close to 200 books. [28]

SMART MATHEMATICS TEACHER (SMART-MT)

The project integrates innovative ICT methods in the learning process, managing to stimulate the pupil's interest towards mathematics teaching and improving their performance. More specifically, e-tools were created for teaching math as well as for developing the students' critical thinking.

Mastering Energy Supply focusing on Isolated Areas (MESfIA)

The project involves the development of an MSc course specialized in Energy Supply for Isolated Areas, aimed at engineer students. The joint collaboration of academics, Engineering associations, as well as local industries, ensures the delivery of strong teaching materials and transfer of valuable skills to create a sustainable energy system for these isolated areas.

[28] EU Agenda. EU Agenda. https://euagenda.eu/events/2019/07/22/3rd-annual-international-symposium-on-the-future-of-STE(A)M-sciences-technology-engineering-arts-and-mathematics-education-2225-july-2019-athens-greece. Published 2020.

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CIRCLE

Among others, the **CIRCLE** project has promoted the social integration of migrants in the educational system, through the development of innovative pedagogies. This project aims at increasing the spread and use of state of the art, effective tools for the assessment and validation of prior learning of newly arrived migrant/refugee students in primary & secondary education. The involvement of several social actors, such as the Family and Childcare Centre from Greece and the Institute for Migration in Germany, were not only able to achieve the exchange of good practices and know-how between European partners, but were also able to influence policy making and measures dedicated for the inclusion of migrant children in the educational systems, as well as the adoption of innovative learning techniques.

Cyprus

Various initiatives regarding the enhancement of digital education at schools are underway in Cyprus. Due to unpredictable developments in the labour market and misalignment, the Cypriot MoEC is reinforcing its partnership with the Cyprus Employers & Industrialists Federation (OEB) and the Cyprus Chamber Of Commerce and Industry to identify the needs of today's labour market in order to modernise the school curricula by integrating new subjects that will reduce the skill mismatches in the labour market. The subject Design and Technology is delivered to students of all ages and it is based on a problem-solving approach, exploration and implementation of knowledge in other sciences through experiential learning and practical sessions. During the 2017-2018 academic year, the curriculum was revised to integrate the subject or Robotics with an aim to cultivate algorithmic thinking and foster programming skills.[29] In February 2019, a pilot programme was launched, through which approximately 205 robots were provided to secondary schools with an aim to support modules on robots and to implement national robotics competitions.[30] The first National Space and Robotics competition was planned to take place this year.[31]

National level

The Robotics Academy at Frederick University Cyprus

Is a research and educational unit, that conducts and stimulates educational robotics. Recently, they developed the Educational Robotics Curriculum which was tested in a non-formal educational setting in

[29] Annual Report (2018). Ministry of Education and Culture in Cyprus. URL: http://www.moec.gov.cy/etisia-ekthesi/index.html [Accessed on the 7th of April 2020]
[30] Έκθεση παρακολούθησης της εκπαίδευσης και κατάρτισης 2019 – Κύπρος. Ευρωπαϊκή Ένωση 2019.
[31] Enimerosi, moec http://enimerosi.moec.gov.cy/archeia/1/ypp10452a

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collaboration with a Private Summer School for kids from 8 to 12 years old. The analysis of the data collected through surveys, observations and focus groups, revealed the positive impact and great potential of this curriculum as a cognitive-learning tool, which increases students' excitement, critical thinking skills, creativity, innovation and collaboration.[32]

STEM programme and Robotics Academy

At Grammar School, the STEM programme, introduced into its curriculum since 2015, aims to educate students in STEM subjects in an interdisciplinary and applied approach. The STEM programme follows a teaching approach relying on applied knowledge, real-world problem-solving, structured inquiry-based learning and students' active and creative contribution. Students learn by doing, designing, making and programming robots or other equipment. The programme aims at enhancing the students' critical thinking, team spirit and creativity. Additionally, students have the opportunity to join the Robotics Academy, an Academy set up as an extracurricular activity, where students learn the basics of building and programming miniature robots using LEGO MINDSTORMS. Finally, members of the Academy are selected to take part in Science and Robotics competitions and fairs at a national and an international level.[33]

The STE(A)Mers

The STE(A)Mers is a programme organised by the Youth Board of Cyprus that aims to cultivate young people's creative development, entertainment and learning, to enhance their creativity, innovation and communication skills, as well as their personal development and wellbeing. It offers a series of workshops on Robotics, Coding, Film making, Photography, Graphic Design, Creative Writing, Music, Drama and Art delivered by specialised and professional trainers to children and young people aged 6-35 years old.[34]

Youth Makerspace Larnaca

The Youth Makerspace was established by the Youth Board of Cyprus in collaboration with Larnaca Municipality in 2019. Makerspaces represent the democratisation of design, mechanisation, construction and education forming hubs for hands-on, project-based learning, creation and invention supporting the

[32] Eteokleous N & Neophytou R. 2019. The case of the Robotics Academy @ Frederick University: 21st Century Skills Developed through a Non-formal Educational Setting. *10th International Conference in Open & Distance Learning*
[33] The Grammar School -Robotics Academy. Grammarschool.ac.cy. http://www.grammarschool.ac.cy/easyconsole.cfm/id/1542. Published 2020.
[34] Page H, Services P, Activeness C. «The STEAMers» – ONEK. Onek.org.cy. https://onek.org.cy/en/home-page/programs-and-service/creative-activeness/youth-multicentres/#toggle-id-1. Published 2020.

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integration of Art in STEM subjects. It fosters horizontal and transferable skills, use of new technologies, such as 3D printers, laser cutters and drones, creativity, innovation and entrepreneurial mindset.[35]

National Competitions fostering STE(A)M

The University of Nicosia organises an annual competition entitled "**Research by Students**" and invites students from Middle, High and Technical schools to submit their team-based innovative projects focusing on social sciences, applied sciences, economics or health.[36] The Research and Innovation Foundation in Cyprus organises an annual competition entitled "**Students in Research**" with an aim to cultivate a research and innovation culture. The aim is to familiarise students with scientific research processes and to boost their creativity, innovation, communication skills and critical thinking.

Robotics Seminars for STEM teachers and trainers

In 2018, the Paedagogical Institute in collaboration with ENGINO co-organised the 1st national seminar on "STEM and Robotics in Education – State-of-the art approaches and applications".[37] Then in 2019, the TIME Private Institute in Larnaca in collaboration with Eduk8 in Greece started offering Robotics seminars in Cyprus delivered by Teacher Trainers certified by the LEGO Education Academy. The trainers provide the tools and resources teachers need to successfully integrate the LEGO Education Academy's solutions into existing STEM curriculum and daily lesson planning.[38]

International level

The Cyprus Pedagogical Institute, Cyprus' main educational institution that was founded in 1972 and undertakes the training of educators of all educational levels, has recently participated in a number of European projects for innovative teaching approaches including:

EDUCATE: Enhancing Differentiated Instruction and Cognitive Activation in Mathematics Lessons by Supporting Teacher Learning.STE(A)ME: Raising STE(A)M in education[39]

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[35] Page, H., Services, P., & Activeness, C. (2020). «Makerspace» – ONEK. https://onek.org.cy/en/home-page/programs-and-service/creative-activeness/makerspace/

[36] Research By Students. 2020. *University Of Nicosia*. https://www.unic.ac.cy/support/research-innovation-office/research-by-students/.

[37] Επιμόρφωση 2017-2018 - Λεπτομέρειες| Καινοτόμα Σχολεία". 2020. *Innovativeschools.Pi.Ac.Cy*. https://innovativeschools.pi.ac.cy/education-details-2017-2018/kain-sem-2018-engino.

[38] TIME Private Institute: Προσφέρουν Σεμινάρια Ρομποτικής Για Εκπαιδευτικούς Και Για Ενήλικες Εκπαιδευτικής Ρομποτικής STEM". 2020. *Larnakaonline.Com.Cy*. http://larnakaonline.com.cy/2019/08/02/time-private-institute-prosferoun-seminaria-rompotikis-gia-ekpaideftikous-kai-gia-enilikes-ekpaideftikis-rompotikis-stem/.

[39] Ltd, White. 2020. "Educate Platform (EN) – An Erasmus+ K2 Learning Platform". *Educate-Platform.Com*. http://educate-platform.com/.

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EDUCATE is a 30-month-long project (02/2017 – 01/2020) funded under the Erasmus+ KA2 programme and coordinated by the University of Cyprus, which aims to develop, implement, validate and refine educational materials for educators that integrate cognitive activation through the use of challenging mathematics tasks and differentiation. The project addressed academics, teachers and educators from Cyprus, Greece, Ireland and Portugal.

M4TM: Mathematics for the million: mathematics for my world[40]

M4TM is an ongoing project funded by the Erasmus+ KA2 programme that aims to provide an innovative approach to teach mathematics that will enhance existing good practices and support teachers' skills, confidence and competence to teach. Moreover, it aims to embrace, instil and facilitate 21st century skills for teachers, pupils and parents.

STE(A)ME

A project co-funded by the Erasmus+ programme Key Action 2, aimed at facilitating learning difficult subjects, such as natural Sciences, Technology, Engineering and Maths through Art by taking a more interdisciplinary and holistic approach based on hands-on experience, experiment and learning-by-doing, as well as enabling artistic expression. It involved 5 partner schools from 5 different countries, including the Institute of Maths and Science in Cyprus.[41]

Aim: Experimental workshops based on the STE(A)M approach that can be implemented in the classroom.

Resource and Activity: Each STE(A)M subject was explored in each transnational meeting in order to jointly develop the workshops, experiments, seminars, tasks, games, flipped classroom and peer teaching, artistic events and academic training material. Final topics included Chemistry All Around, Maths and Us, Green Engineering, IT, Robotics, Digital Art and Biodiversity.

STEMitUP

STEMitUP, a project funded by the ERASMUS+ programme 2017, involved 7 organisations, including GrantXpert Consulting, from Cyprus, Spain, The Netherlands, Norway and the United n Kingdom. The duration of the project was 24 months between 01/09/2017 and 31/08/2019.

Target group: Teachers, students aged 11/15, parents, career counsellors and decision-makers

Aims: To develop a state-of-the-art comprehensive educational programme providing STEM teachers with innovative pedagogical tools that maintain student engagement.

[40] "Maths For The Million". 2020. *Sites.Marjon.Ac.Uk*. https://sites.marjon.ac.uk/mathematicsforthemillion/contact/.
[41] STE(A)M - Erasmus. http://STE(A)M-erasmus.eu/.

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To make STEM-related courses 'fun' and interesting for students aged 12-15 in order to boost their skills, knowledge and competences combined with an entrepreneurial mindset.

Resource and activity: The project entailed the identification of the teachers' training needs regarding STEM entrepreneurship education. Partners went on to develop an innovative training programme that offers exciting activities and ready-to-use educational resources for teachers to integrate STEM education, Entrepreneurship and Gender Inclusiveness in the classroom.[42]

CSRC – Centre for STE(A)M Education Research, Science Communication and Innovation

The project was co-funded by the European Commission under the HORIZON 2020 programme "Teaming of excellent research institutions and low performing RDI regions". The coordinating organisation was the University of Cyprus and the partnership was composed of 14 organisations, including GrantXpert Consulting LTD, from 7 different countries.

Aims: The project aimed to establish a Centre of Excellence in Cyprus and the Easter Mediterranean to:

undertake competitive interdisciplinary research for the development of innovative tools and exhibits for STE(A)M Education and Science Communication.

Promote science literacy and capacity building through informal STE(A)M education using interactive Science Technology and Engineering exhibits, demonstrations and contacts with scientists.

Contribute towards a Responsible Research and Innovation (RRI) culture.

Provide teacher professional training for integrating in-house ICT tools in formal STE(A)M education and promote integration of new STE(A)M approaches in educational curricula.

Serve as a hub to communicate and disseminate to public and industry innovative technology research outcomes and evidence-based practice to policy makers.

Resource and activity: During Phase 1, the consortium effectively completed the development of a feasibility study and business plan to allow the establishment of an operational and financially viable centre, the formulation of a CSRC research strategy and the implementation of a range of dissemination and communication activities related to the project for key stakeholders.[43]

[42] STEMITUP - https://www.stemitup.eu/
[43] Center for STEAM Education Research, Science Communication and Innovation. https://cordis.europa.eu/project/id/763594

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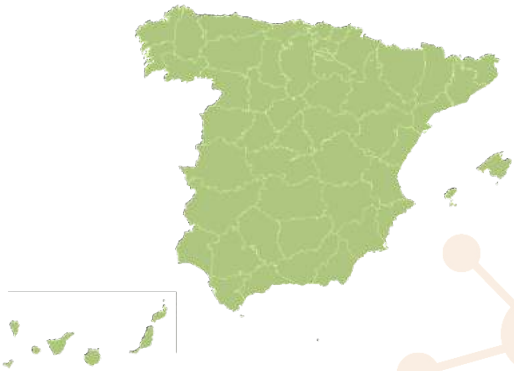
Spain

Local level



In Spain there are examples such as the Community of Madrid, which launched ***STEMadrid***in 2019, an initiative to promote the student vocation of the STEM disciplines in 28 public educational centres. [44] The Catalan Government also approved at the end of 2019 the ***STEMcat Plan***, a joint program of the departments of Education, Digital Policies and Public Administration, and Business and Knowledge aimed at promoting scientific, technological, engineering, and mathematical vocations. [45] The creation of the STEMcat Plan, along with other programs already in place, such as *mSchools*, *donaTIC.cat*, *Ciència i* Aula (Science and Classroom), *Impulsem la robòtica* (Fostering Robotics), *Formació permanent del professorat en CTM* (Teacher's Training in Science, Technology and Mathematics), are in compliance with the specific educational policy objectives included in this legislature's Government Plan.

- **Inspira STE(A)M**

In June 2017, the regional education department of the Basque Country adopted the University Business strategy 2022. Its objectives are to generate knowledge based on scientific excellence and apply it in the business sector, and to train highly skilled people with the skills needed in the business sector. The strategy is aligned with the regional smart specialization strategy (RIS3- Euskadi). The Cluster 4Gune was created in 2017 to foster collaboration between academia and education and training bodies in STEM areas. In 2019, the Plan for the Basque University system 2019-2022 was adopted to strengthen cooperation between the three Basque universities (UPVEHU, Mondragón University and Deusto University) and research, innovation and business organizations (BERCs, Ikerbasque, Unibasq, Clúster 4Gune and Euskampus). In 2018/2019, the universities offer 25 dual-university degrees (bachelor and master's levels), including training in companies (accounting for 25-50% of credits). [46]

- **The School of Computational Thought**

It is a project of the Ministry of Education and Vocational Training which is developed in collaboration with the Councils and Departments of Education of the Autonomous Cities and Communities. The objective of the

[44] STEM – Educación STEM". 2020. *Educacionstem.Educa.Madrid.Org*. http://educacionstem.educa.madrid.org/.
[45]Government Of Catalonia - Government Of Catalonia. 2020. *Catalangovernment.Eu*. https://catalangovernment.eu/catalangovernment/news/299244/government-catalonia-approves-stemcat-plan-encourage-technological-vocations-national-education-system.
[46] InspiraSTEAM - https://inspiraSTE(A)M.net/

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school is to offer open educational resources, training and technological solutions that help Spanish teachers to incorporate this skill into their teaching practice through programming and robotics activities.
With a sample of over 8,000 students, the research developed is probably the largest worldwide research to date on the development of this skill in education. From Primary to High Secondary Education the results show that it is possible to develop computational thinking skills through creative technology projects, furthermore the youngest ones developed mathematical competence through computer programming activities, such as Scratch.[47]

Teaching Science with Science

Target group: students, teachers

Aims: promoting STEM vocations through scientific dissemination among young people.

Resource and activity: The main objective is to bring the results of interdisciplinary research related to scientific education closer to teachers so that they are encouraged to apply them in their classrooms or, in the case of several who already do so, so that they feel supported and reinforced with evidence obtained from dozens of years of research in science education.

Teaching strategies: the project has worked for the definition and implementation of an impact evaluation system that has allowed to objectify the degree to which manages to increase interest in studying STEM of the students participating in these activities and identify key influencing factors in youth vocational decision.

Procedural information: The project has been implemented for two years and it has reached 2.500 students form 12 – 16 years old. The main result has been an increased interest in studying STEM of the participating students (5.63%).[48]

mSchools

Target group: students, teachers, parents, policy makers.

Aims: Encourage learning with Mobile, improve digital skills & entrepreneurial spirit and build an open environmental for mEducation.

Resource and activity: mSchools is a multidisciplinary, project-based and challenge-based learning that fosters critical thinking and problem-solving skills. It promotes scientific-technical vocations among Primary and Secondary School students through transforming their cell phone into a pocket lab.

- Scratch Challenge: Modular course that uses the free programming language Scratch, addressed to Higher Primary and Secondary Education.

[47] La Escuela De Pensamiento Computacional - INTEF. 2020. *INTEF*. https://intef.es/tecnologia-educativa/pensamiento-computacional/.
[48] Enseñando Ciencia Con Ciencia. 2020. *FECYT*. https://www.fecyt.es/es/publicacion/ensenando-ciencia-con-ciencia.

- TechCamp: An immersive workshop experience in app design and development. Students can put their creative power to work conceiving and building apps while learning more about the business of software development and marketing strategies.

A computer science course offered in Catalan High Schools (3rd and 4th year of Secondary School, High School and Professional Training) based on app design and prototype development. Aimed at stimulating entrepreneurial spirit amongst students and with the support of industry experts as mentors.

Teaching strategies: There are different initiatives to improve teacher's knowledge about STE(A)M good practices such as Eduhack[49] which is a large scale co-creative process for schoolteachers that connects and allows the educational community to develop innovative classroom experiences for all levels and subjects. Furthermore, Mobile Learning Awards[50] acknowledge innovative teachers and school-led projects.

Procedural information: Through the capacitation achieved by Eduhack teachers reached 800 students last year using innovative techniques and mobile devices to improve students' digital skills, problem solving and critical thinking. The main tools used are Mobile history map: geo-positioning app that allows students to collaboratively create content on points of interest close to their schools.[51]

International level

Being aware of the challenge about having skilled population, the European Commission has invested more than 90 million euros from the Framework Program since 2014 to subsidize initiatives that are dedicated to increasing the attractiveness of science education and scientific careers, as well as increasing the interest of young people in STEM.[52]

MASDiV

Is a European high-level educational research project focused on evaluation (Erasmus + Key Action 3), whose fundamental objective is to implement effective measures based on research evidence in Europe. Regarding Spain, work is carried out in tandem with the University of Jaén. One of its objectives is the development, implementation and systematic evaluation of professional development courses for teachers in STE(A)M fields.[53]

[49] Mobile World Capital Barcelona: EduHack Programm https://projectes.xtec.cat/eduhack/que-es-edu-hack/
[50] Mobile World Capital Barcelona: Mobile-learning awards: https://mschools.mobileworldcapital.com/our-initiatives/mobile-learning-awards/
[51] Mobile World Capital Barcelona: mSchools Programm https://mschools.mobileworldcapital.com/es/iniciativas/
[52] European Comission: SwafS policies and aims: https://ec.europa.eu/research/swafs/index.cfm?pg=policy&lib=education
[53] International Center for STEM Education: MasDiV Project: https://icse.eu/international-projects/masdiv/

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STEM PD Net

Is a European cooperation project for innovation and the exchange of good practices, whose main objective is the creation of a European network of teacher training centers for teachers in the STEM field. The European Network of Professional Development Centers (STEM PD Net) arose from the idea that training centers in different countries should be connected internationally as they have similar goals and agendas. Its actions are framed in the promotion of European programs to publicize professions in the scientific and technological fields.[54]

EuroSTE(A)M

Target group: Students, teachers and school support partners from UK, Belgium, Italy, Portugal and Spain.

Aims: improve STE(A)M skills for students offering educational resources and open and free source materials to be used across Europe to motivate young people in STE(A)M subjects.

Resource and activity: to co-develop 3 STE(A)M Camps and supporting teacher materials which will be used as an innovative and effective method to directly address the underachievement in basic skills of maths, science, and literacy.

Teaching strategies: provide an online toolkit that will serve as a library for teachers across Europe to access if they need to deliver a STE(A)M-based lesson or workshop in their classrooms. It is an open source code of free access for students and teachers.

Procedural information: the training camps are focused on three modules: i) Introduction to programming with Scratch; ii) Inside Maths which aims to improve problem solving skills in order to strengthen students' logical thinking using abstract concepts such as variables and the ability to analyze a complex problem; iii) Interactive science, explaining concepts such as microcontroller and the properties of the components installed in an electrical circuit.[55]

The STE(A)M Alliance – inGenious Education

Target group: Students, industries, ministers of education, and education stakeholders,

Aims: promote Science, Technology, Engineering and Math education and careers to young European's and address anticipated future skills gaps within the European Union.

Procedural information: with the support of major industries and private partners, the **STEM Alliance** for inGenious Education and Industry activities promote STEM jobs in all industrial sectors and contribute to build a STEM-skilled workforce. The **STEM Alliance** will join forces to improve and promote existing industry-education

[54] European STEM Professional Development Center Network: STEM PD Net: http://stem-pd-net.eu/en/
[55] euroSTEAMproject http://www.euroSTE(A)Mproject.eu/

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STEM initiatives (at national, European and global levels) and contribute to innovation in STEM teaching at all levels of education.[56]

Scientix

This is an open community platform for teaching science in Europe that aims to distribute and improve the quality of science while making it more accessible to society. Created in 2010 by the network of Ministries of Education of the Member States and is supported by the Horizon 2020 program of the European Commission of the European Union and coordinated by the European Schoolnet.[57]

Other projects

Space EU; TIWI-Teaching ICT with Inquiry; BRITEC; Learning Leadership for Change (L2C); BLOOM; STEM School Label; Amgen Teach; Go-Lab; Next-Lab

[56] STEM Alliances http://www.stemalliance.eu/
[57] Scientix Project EU http://www.scientix.eu/

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Analysis of students' attitudes and teachers' approaches

Source

A survey was carried out in order to identify students' attitudes towards STEM subjects teaching and learning, also regarding their choices in their University/career paths, and the teachers' and school directors' approaches to STEM education.

This primary research was conducted through online questionnaires to a total sample of at least 320 students from secondary schools, age range 13 to 18, and 160 teachers. The questionnaires were translated in all partner languages and were used when needed.

- The first questionnaire (Annex 2) is addressed to ***13-18-year-old students*** and it is aimed at identifying the students' attitudes towards STEM subjects, also regarding their choices in their University/career paths.

It is available on Google forms here.

- The second questionnaire (Annex 3) is addressed to ***teachers and school directors*** and it is aimed at identifying the teachers' approaches towards STEM and non-STEM subjects.

It is available on Google forms here.

The information collected is processed in order to gain an idea of the attitudes young people have towards STEM fields and its teaching at schools, as well as the practical approaches to STEM education that are already in place in the partner countries.

The results of this analysis are critical for the set-up of the framework for reforming STEM curricula responding to real needs, as well as for orienting the contents and the structure of the OERs for the MOOC on STE(A)M education. The gathered data was initially included in the National reports.

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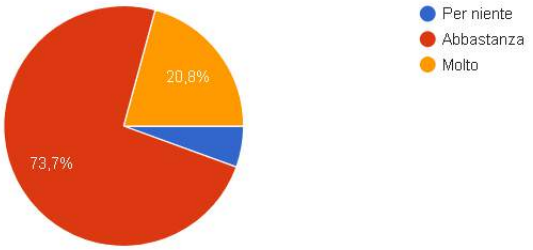
Data collected from the students' questionnaires

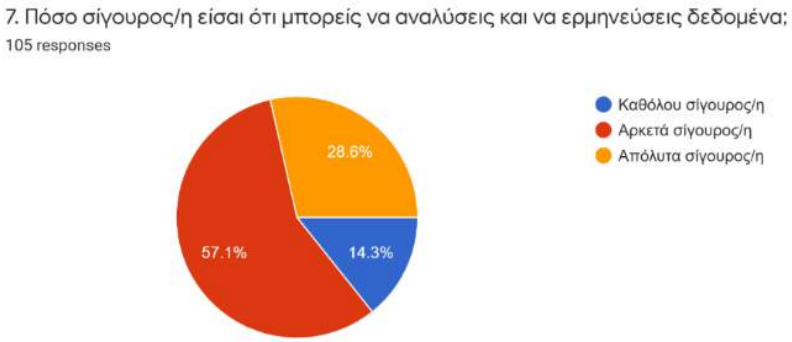
The information collected is processed in order to gain an idea of the attitudes and status of students towards STEM careers and its teaching at schools. The results of this analysis are critical for the set-up of the framework for reforming STEM curricula responding to real needs, as well as for orienting the contents and the structure of the OERs for the MOOC on STE(A)M education.

The questionnaire was completed by at least 320 students and showed over all positive results. In the following section, we shall examine the answers to some of the most significant questions of the questionnaire.

- In the question **(7) How confident are you that you are able to analyse and interpret data?**
  - In Italy 73.7% of students say they are fairly confident in analysing and interpreting data; only a low percentage of 5.5% are not able at all in doing it.



  - In Greece more than half of the participants replied with Fairly Confident at 57.1%, with 28.6% with Very Confident and 14.3% with Not Confident at all.



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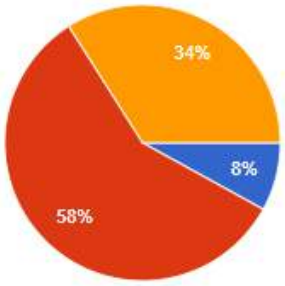
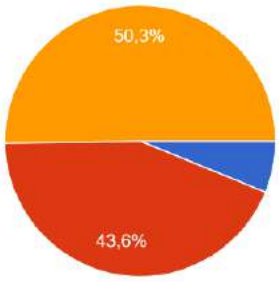
- In Cyprus the majority of students (58%) reported that they feel fairly confident that they are able to analyse and interpret data, 34% reported very confident and 8% reported not confident at all.



- In Spain 50.3% of students say they are very confident analysing and interpreting data; 43.6% fairly confident and 6.2% answer they are not confident at all.



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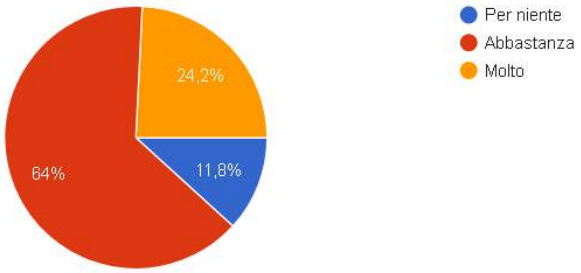
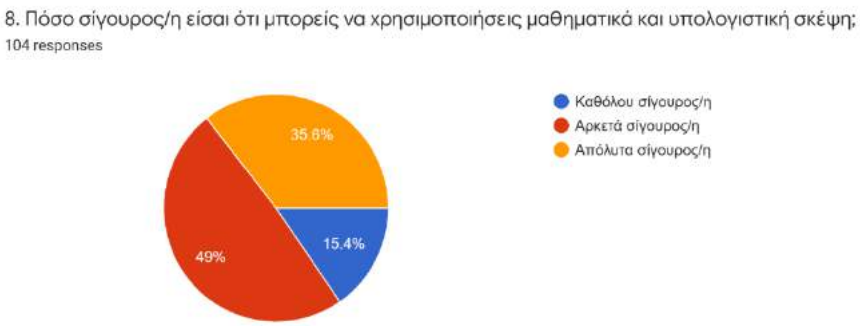
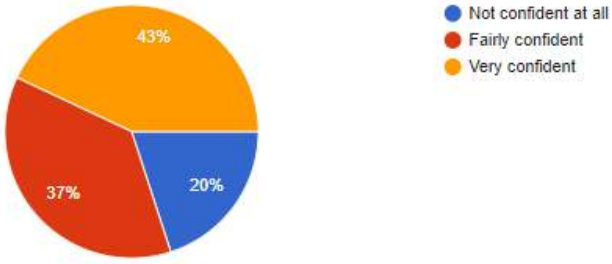
- In the question **(8) How confident are you that you are able to use mathematics and computational thinking?**
  - In Italy the majority of students reply they are fairly confident (64%); 24.2% reply they are very confident. Only 11.8% answer they are not confident at all.



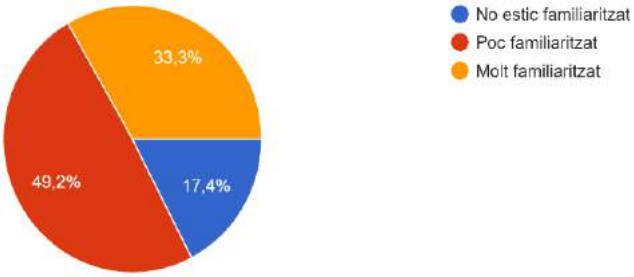
  - In Greece the responses are quite parallel to the previous ones with 49% answering with Fairly Confident, 35.6% with Very Confident, and with 15.4% with Not Confident at all.



  - In Cyprus about 37% of students reported that they feel fairly confident and 20% not confident at all.



  - In Spain one third of the students answer they are very confident (33.3%), nearly half of them (49.2%) are fairly confident and 17.4% not confident at all.



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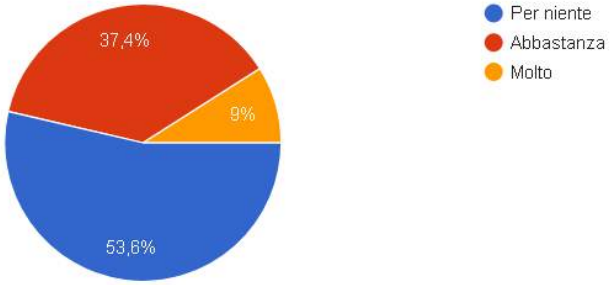
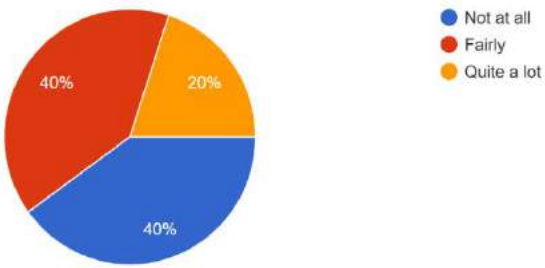
- In the question **(16) For my future job it is important to me to work with mathematics rather than people**:
  - In Italy 53.6% of students don't agree with this statement; only 9% of students believes that for their job mathematics will be more important than people.



  - In Greece the majority of the students replied with 55.8% with Not at all, 33.7% Fairly, and 10.6% Quite a lot as shown below.

  - In Cyprus 40% answered not at all, 40% answered fairly and 20% only answered quite a lot. When they were asked to think about science and technology subjects and select which of them they feel more capable and willing to study in the future (Q17), most chose Physics/Chemistry (32%), 25% chose Biology/Geology, 24% chose Informatics and 19% chose Mathematics.



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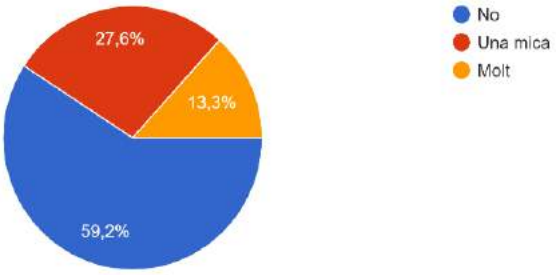
- In Spain 59.2% of students do not agree with this statement; only 13.3% of students believes that for their job mathematics will be more important than people.



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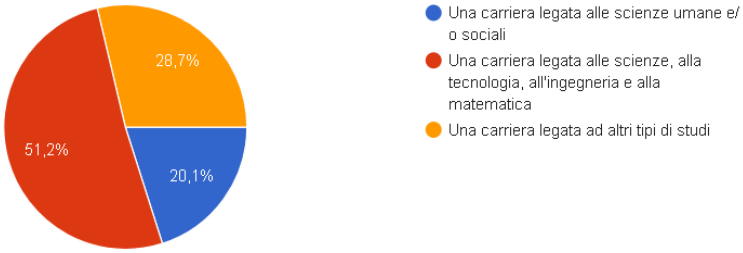
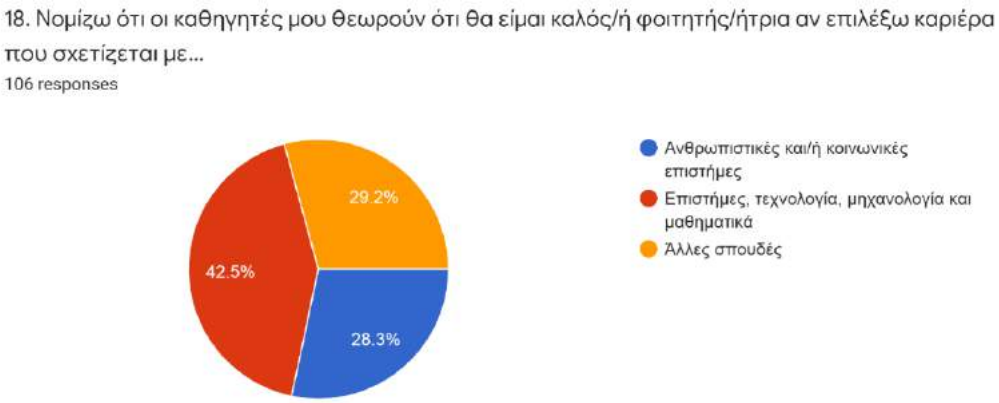
- In the question that, **(18) According to their teachers – they could be good students of (A) a career related with humanities and/or social sciences, (B) a career related with science, technology, engineer and mathematics or (C) a career related with other type of studies.**

  - In Italy students claim that – according to their teachers – they could be good students of (A) a career related with humanities and/or social sciences (20.1% of students), (B) a career related with science, technology, engineer and mathematics (51.2% of students) or (C) a career related with other type of studies (28.7% of students).



  - In Greece the 42.5% answered (A) A Career related with science, technology, engineer and mathematics, the 29.2% answered (B) A career related with humanities and the 28.3% selected (C) Other studies.



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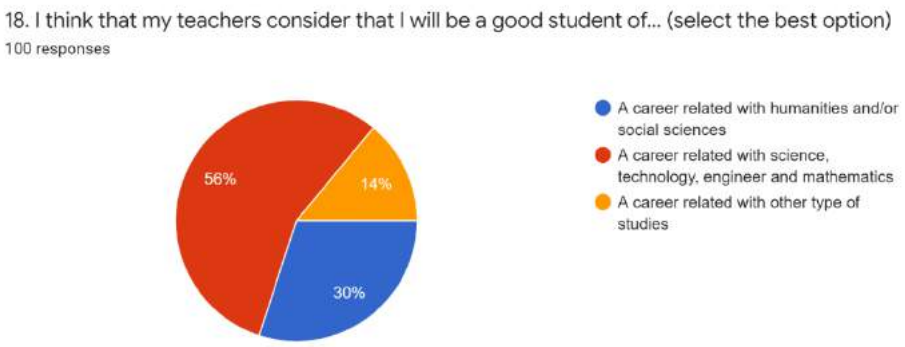
- In Cyprus most students believe that their teachers consider them good candidates for a career related with science, technology, engineering and mathematics (56%), followed by a career related with humanities and/or social sciences (30%) and then a career related with any other type of studies.



- In Spain students claim that – according to their teachers – they are a good candidates of (A) a career related with science, technology, engineer and mathematics (42.3% of students), (B) a career related with other type of studies (34.7% of students) or (C) a career related with humanities and/or social sciences (23% of students).

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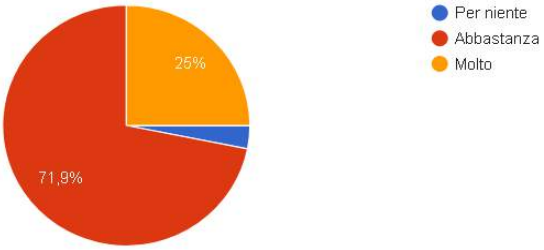
Data collected from the teachers' questionnaires

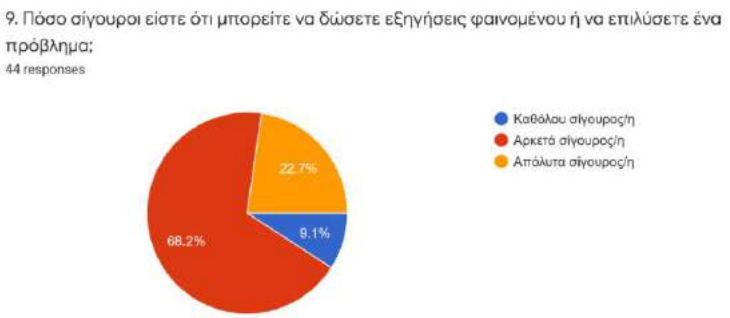
A survey was carried out with at least 160 teachers in order to identify teachers' attitudes towards STEM subjects, also regarding their choices in their University/career paths and teachers' and school directors' approaches to STEM education.

The information collected is processed in order to gain an idea of the approaches and status of educators towards STEM fields and its teaching at schools, as well as the practical approaches to STEM education that are already in place in the partner countries. The results of this analysis are critical for the set-up of the framework for reforming STEM curricula responding to real needs, as well as for orienting the contents and the structure of the OERs for the MOOC on STE(A)M education. In the following section, we shall examine the answers to some of the most significant questions of the questionnaire.

- In the question **(9) How confident are you that you are able to build explanations about a phenomenon or design solutions for a problem?**
  - In Italy the majority of teachers (71.9%) claim they are fairly confident in building explanation about a phenomenon or designing solutions; the other 25% of professors define themselves "very confident". Just one professor says he/she is not confident at all.



  - In Greece the majority answered with 68.2% Quite Confident, 22.7% Very Confident and 9.1% Not Confident At All as shown below:



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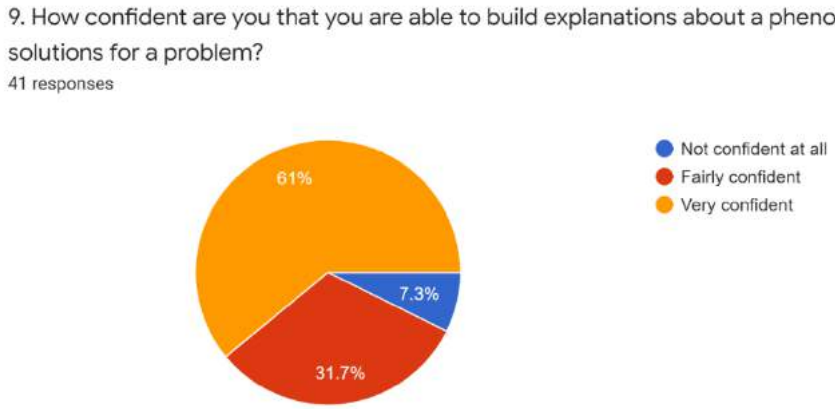
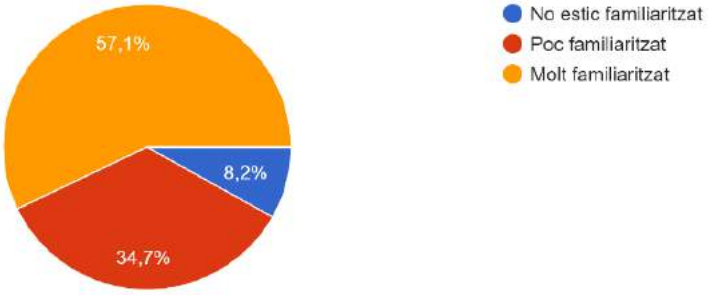
- In Cyprus the majority of teachers (61%) also feel very confident building explanations about a phenomenon or designing solutions for a problem. About 7.3% of teachers do not feel confident at all.



- In Spain 57.1% of teachers say they are very confident in describing a phenomenon; 34.7% say they are fairly confident. And the remaining 8.2% say they are not confident at all.



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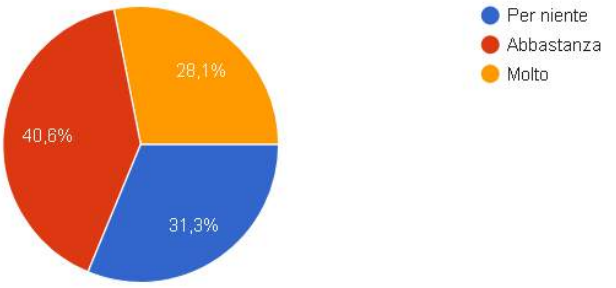
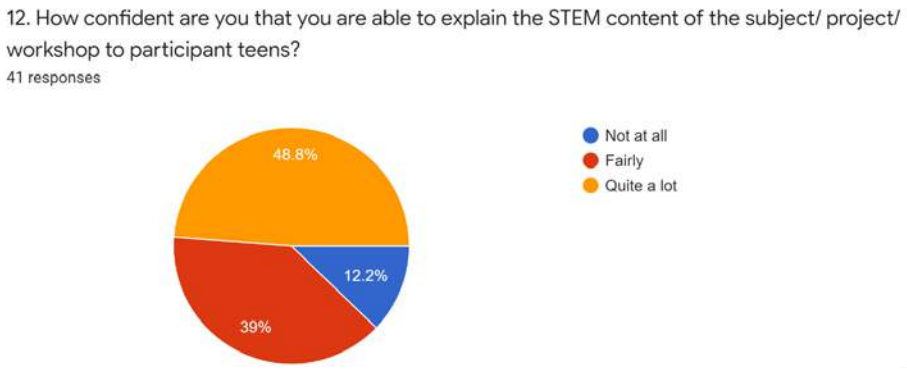
- In the question **(12) How confident are you that you are able to explain the STEM content of the subject/ project/ workshop to participant teens?**
  - In Italy 40.6% of professors reply they are fairly confident in explaining STEM content; 28.1% of professors define themselves as "very confident". The remaining 31.3% say they are not confident at all in explaining STEM content to students.



  - In Greece the majority answered with Quite A Lot at 45.5%, Fairly at 38.6% and 15.9% Not At All as we can see below:

- In Cyprus nearly half of the teachers (48.8%) also feel very confident that they are able to explain the STEM content of the subject/project/workshop to participant teens.



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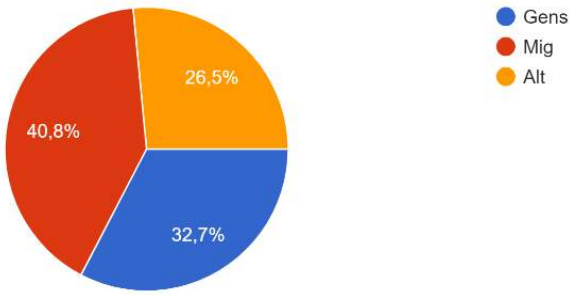
- In Spain 32.7% of teachers reply they are very confident in explaining STEM content; 40.8% of teachers define themselves as fairly confident and the remaining 26.5% say they are not confident at all in explaining STEM contents to students.



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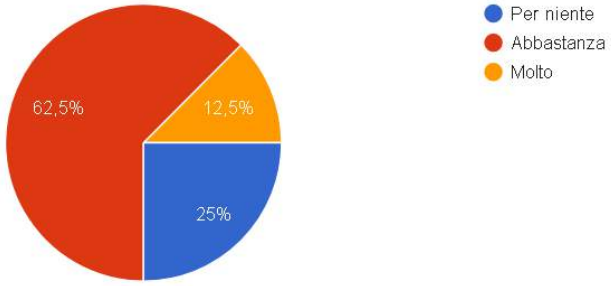
- In the question **(16) I can select effective teaching approaches to guide student/teens thinking and learning in mathematics/science/technology.**
  - In Italy 62.5% of professors are fairly able to select effective teaching approaches to guide student/teens thinking and learning in mathematics/science/technology. 12.5% of professors define themselves as “very able”. Finally, the remaining 25% say they are not able at all.



  - In Greece the majority with 55.6% are very able, 28.9% are quite able, and 15.6% are not able at all.

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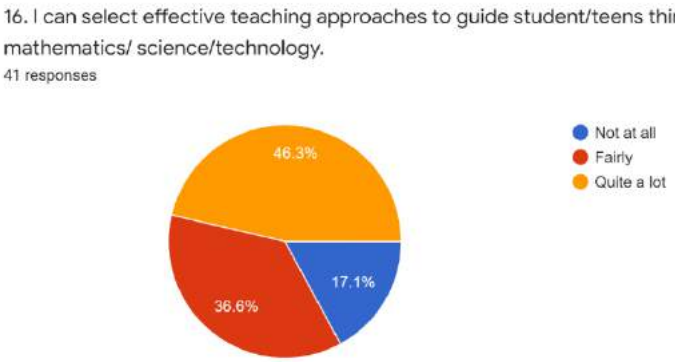
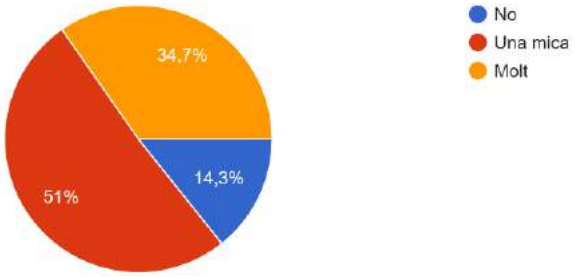
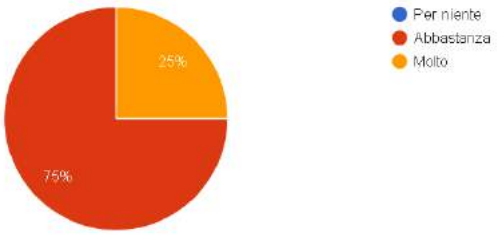
- In Cyprus 46.3% feel very capable, 35.6% feel fairly capable and 17.1% do not feel capable at all.



  - In Spain 51% of teachers are very capable, 34.7% of teachers define themselves as quite able. Finally, the remaining 14.3% say they are not able at all.



- In the question **(19) I can adapt my teaching style to different learners.**
  - In Italy 75% of professors are fairly capable to adapt easily their teaching style to different learners; the remaining 25% say they are very capable.



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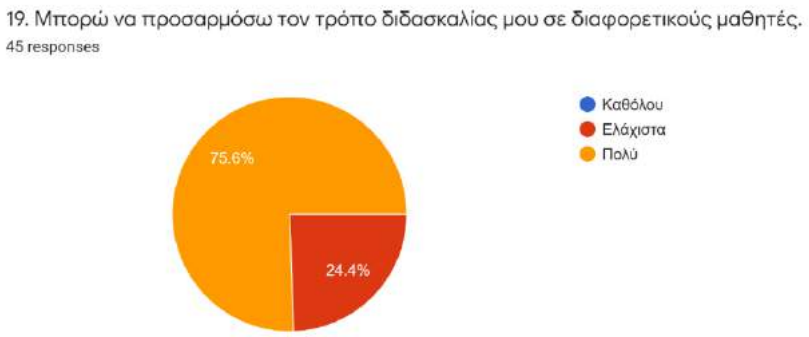
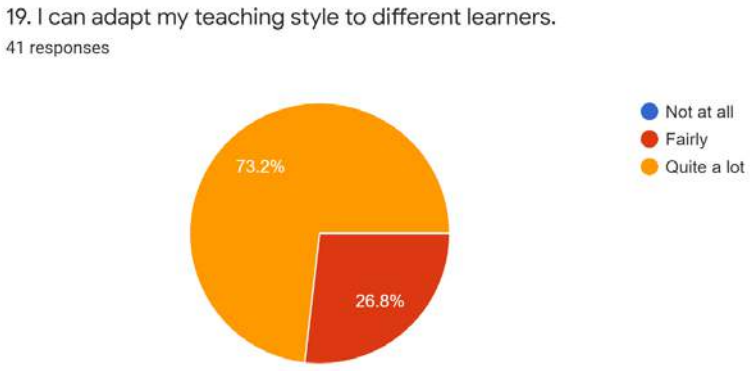
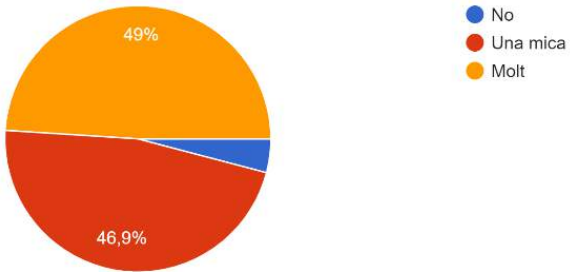
- In Greece the majority at 75.6% are very capable while the remaining 24.4% are fairly able.



- In Cyprus a significant number of teachers (73.2%) believes that they can adapt their teaching style to different learners, while the remaining believe that they are fairly capable to adapt it.



- In Spain 49% of teachers are able to easily adapt their teaching style to different learners; the remaining 23% say they are fairly able. And just only two teachers say they are not able at all.



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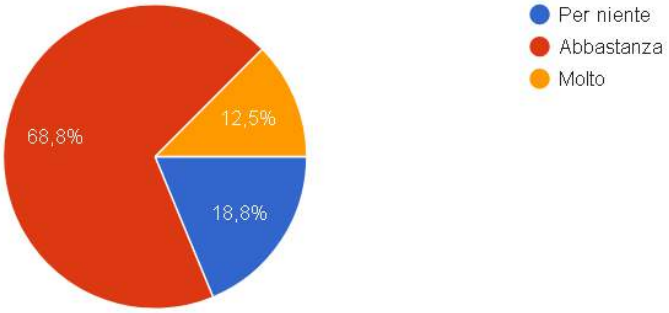
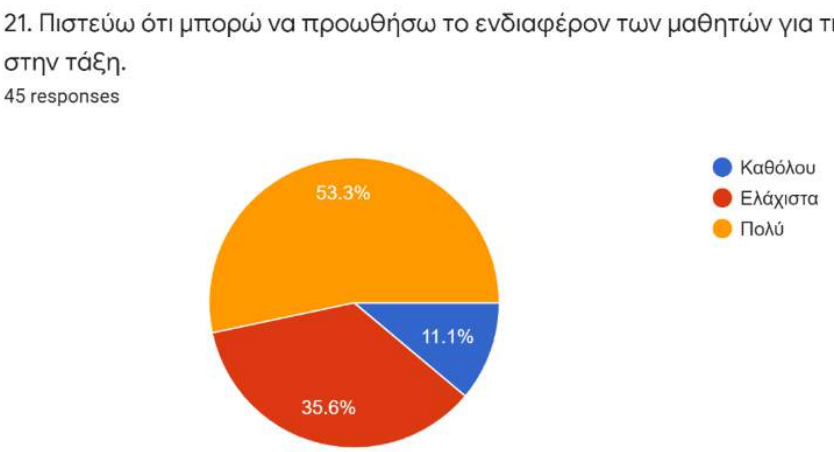
- Lastly, in the question **(21) I can create a classroom setting to promote students' interest for learning STEM concepts.**
  - In Italy the majority of professors (68.8%) reply they are fairly confident in creating a classroom setting to promote students' interest for learning STEM concepts. The remaining 12.5% are very confident and 18.8% of professors are not confident at all.



  - In Greece more than half of the teachers (53.3%) believe that they are fairly capable in About 35.6% believe that they are very capable and 11.1% believe they are not capable at all.



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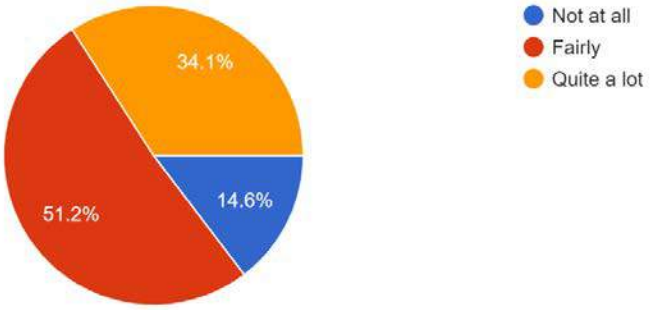
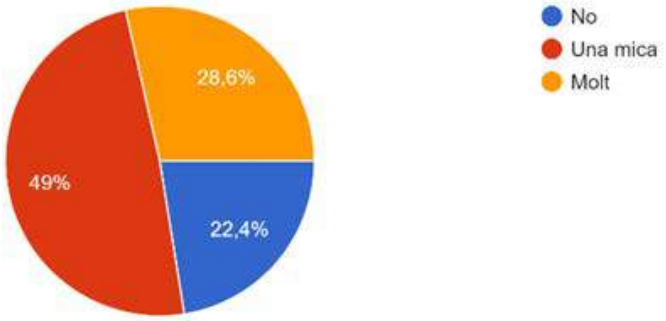
- In Cyprus more than half of the teachers (51.2%) believe that they are fairly capable. About 34.1% believe that they are very capable and 14.6% believe they are not capable at all.



- In Spain, most of the teachers (28.6%) reply they are very able to create a classroom setting to promote students' interest for learning STEM concepts. 49% are fairly able and 22.4% of teachers are not able at all.



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Conclusions

The current study is a cross-country comparative analysis of the collected data of the four partner countries that developed the research, aiming to provide a comprehensive overview of the state of the art across the involved countries.

The comparative analysis addressed the following topics:

• The initiatives and strategies connected to the reforming of STEM education identified across the involved countries which were identified through a desk-based research.

• Best practices, at local, regional and European level, concerning STE(A)M approaches to STEM education, and innovative and collaborative practices to the development of educational resources identified across the partner countries, which were products of research.

•The students' attitudes towards STEM subjects and STEM careers and teachers' and school directors' approaches to STEM education, which were the results of the questionnaires of the primary research that was conducted.

The results from the research on **Italy** show that the government has had a strong policy on STE(A)M education, such as the national Coalition for Digital Competences, and the National Plan for Digital Education, along with the Piano Lauree Sceintifiche which is a national plan supporting activity that encourage careers in the STEM areas. Additionally, Italy holds a large number of associations that deal with the teachers' improvement, such as the Italian Union of Mathematics, the Physics Teachers Association, the Natural Sciences Teachers National Association and more. The Italian Ministry of Education and Researches has launched a series of initiatives for the promotion of equal opportunities regarding gender stereotypes in STE(A)M disciplines. Among these initiatives are the Archimedes Prize, the STEM*Lab project, the Planetarium building, and PALERMOSCIENZA a project about experiments with science. International projects are also quite common in Italy which are funded by the European Union.

Same with Italy, regarding the initiatives and strategies connected to the reforming of STEM education, the results from the research of **Cyprus** show a plethora of good practices and ongoing national initiatives and projects regarding the integration of STE(A)M to school, such as The Robotics Academy at Frederick University Cyprus, the STE(A)Mers by the Youth Board of Cyprus, and the Robotics Seminars for STEM teachers by the TIME Private Institute. Additionally, on the International level, there are numerous European-funded programs regarding STE(A)M education, such as the projects EDUCATE, STE(A)ME, STEMitUP, or the CSRC.

The desk-based research for **Greece** has shown that there are only some national/public initiatives regarding the education of STEM namely the Hellenic Education Society of STEM only some of its actions involve teaching practices, applied teaching projects and guidance through the support of based laboratories. Membership provides access to material, training, advice and support. Additionally, the research has shown

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that there are numerous educational programs that are implemented in the private sector of education in Greece, such as the Mathisi STEM Camp and the Center for Talented Youth in private institutions of Greece. Finally, there is a very large number of European-funded projects taken upon by private or public institutions and non-governmental organizations on international level, such as SMART Mathematics Teachers, In2STE(A)M and CIRCLE (also implemented in Italy) and MESfiA – Mastering Energy Supply focusing on Isolated Areas.

In **Spain**, the results have shown that Spain has made limited progress in increasing public investment in research and innovation so far. The STEM policy framework in Catalonia and Spain involves Laws on education regarding digital competences. Same with Greece and Italy, there are numerous European-funded international projects that the country partakes, along with national government strategies that have created programs such as mSchools, Impulsem la robotica, and many more.

The results from the primary research involving students and teachers has shown many similarities and differences among the partner countries, and the results were very promising and encouraging.

Regarding the students' confidence in their ability to use mathematics and computational thinking, the results from all the countries showed that **the majority of the students are either fairly or very confident in using mathematics and computational thinking**, while only around 10-20% from each country said they are not able at all.

Regarding, whether they get good grades in STE(A)M subjects, **the majority in all countries gets good grades**, while around 11% or less, do not get good grades at all. It is remarkable that in all countries, more than 70% of the students answered that they understand everything in the STE(A)M subjects. In Cyprus and in Greece less than 10% do not understand everything, while in Italy and Spain only 10,2% do not.

It is impressive to see that in Cyprus and Greece the majority above 70% of the students, while in Italy and Spain the majority at around 60%, **find science subjects easier than theoretical subjects**. Overall, in Cyprus, Italy and Greece only 10 to 20% students answered they do not look forward to science subjects at all, however the percentage was high for Spain at 31.6% compared to the other countries.

Only in Cyprus does the majority of the students over 70% feel that for their future job it is **important to work with mathematics** rather than people, while slightly more than half of the students in Italy, Greece and Spain do not agree with that at all.

Regarding the opinion of the teachers about what the students are good at, the results for science in both Cyprus and Italy were above 70%, while in Greece and Italy a little less than half the students. Regarding the opinion of the parents about what the students are good at, the results for science varied with Cyprus at almost 80%, Italy at almost 60% and again a little less than half the students for Greece and Italy. Overall, the **results are very positive** except for the case of Spain regarding whether the students find STE(A)M subjects easier than theoretical subjects, and whether they look forward to science subjects.

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There is therefore a balance, regarding the future career choices of the students, who may choose to work with people rather with mathematics, but still the majority get good grades, and understands most of the material.

Regarding the teachers' approaches and their abilities in STEM courses, the results varied greatly. In all countries except for Italy, the majority above 70% of the teachers feel fairly to greatly confident in their ability to use math, and feel that they can help students from low socio-economic backgrounds. The majority in all countries, with above 70% in Cyprus and Greece, are also confident to explain STEM content. In all countries, the majority uses a variety of teaching approaches, but only in Cyprus does the majority feel that they can teach children who do not speak the national language. In the rest of the partner countries the 35-55% of the teachers do not feel that they can teach foreign students who do not speak the language at all.

In all countries, the majority of the teachers are familiar with common understanding and misconceptions of the STEM content by the students, while around 30% of them in Italy and Spain do not feel they are familiar with that at all. In all countries, the majority of the teachers feel that they can create a setting to promote students' interest for learning STEM concepts.

After reviewing the findings from the questionnaires, the lack of digital skills of some teachers, and a need to implement an interdisciplinary methodology instead of the traditional followed from most of teaching staff are noticed. Regarding the students' results there is an absence of attractiveness on the actual teaching model which ends up on a lack of interest from students, hindering their learning.

In conclusion, the content of the MOOC will be carefully discussed according to the needs detected: improving teachers' skills and knowledge and incentivizing students' attractiveness for STE(A)M subjects with transversal programs interconnected between subjects.

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Annexes

Annex 1 – Template for the collection of Best practices and initiatives

Local/National level

Include 2 scientific articles and/or chapters in books describing STE(A)M programs implemented in your own country

Target group: [children, teachers, parents, partners involved]

Aims: [specific knowledge acquired]

Resource and activity: [describe the types of activities carried out]

Teaching strategies: [describe the strategies adopted as related to the dimension of the teacher's role]

Procedural information: [duration and structure of proposed activities, tools and technologies]

International level

International programs in which the country has been involved

Please, select up to 2 evidence-based, international programs in which the country has been involved. Use for instance, reports of national and international programs/EU in which the country has been involved to describe the program

Target group: [children, teachers, parents, partners involved]

Aims: [specific knowledge acquired]

Resource and activity: [describe the types of activities carried out]

Teaching strategies: [describe the strategies adopted as related to the dimension of the teacher's role]

Procedural information: [duration and structure of proposed activities, tools and technologies]

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Annex 2 – Questionnaire for participant students

This questionnaire is part of the CHOICE project - Increasing Young People's Motivation to choose STEM careers through an Innovative Cross-disciplinary STE(A)M approach to education and is aiming to identify *students' attitudes towards STEM subjects*, also regarding their choices in their University/career paths.

All the information you provide in this questionnaire will be kept ***anonymous*** and it will not be given to third persons, such as your teachers or your parents.

1	What is your age?			
2	What is your gender?	Male	Female	Other
		Not confident at all 	Fairly confident 	Very confident 
3	How confident are you that you are able to ask questions a phenomenon or define a problem that needs to be solved?			
4	How confident are you that you are able to plan and carry out investigations?			
5	How confident are you that you are able to analyse and interpret data?			
6	How confident are you that you are able to use mathematics and computational thinking?			
7	How confident are you that you are able to build explanations about a phenomenon or design solutions for a problem?			
8	How confident are you that you are able to find evidences that helps you to reason and argument when finding the best explanation to a phenomenon or the best solution to a problem?			
9	How confident are you that you are able to obtain, evaluate, and communicate information?			

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			Not at all	Fairly	Quite a lot
10	I get good grades at science, technology and/or mathematics.				
11	I understand everything in my science, technology and/or mathematics lessons.				
12	I find science, technology and/or mathematics easier than theoretical subjects.				
13	I look forward to my science, technology and/or mathematics lessons.				
14	For my future job it is important to me to work with mathematics rather than people.				
15	Think about science and technology subjects. Which of them do you feel you are capable and willing of studying in the future?	Biology/ Geology 	Physics/ Chemistry 	Informatics 	Mathematics 
16	I think that my teachers consider that I will be a good student of… (select the best option)				
	A,	A career related with humanities and/or social sciences			
	B.	A career related with science, technology, engineer and mathematics			
	C.	A career related with other type of studies			
17	I think that my parents consider that I will be a good student of… (select the best option)				
	A,	A career related with humanities and/or social sciences			
	B.	A career related with science, technology, engineer and mathematics			
	C.	A career related with other type of studies			

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Annex 3 – Questionnaire for participant teachers

This questionnaire is part of the CHOICE project - Increasing Young People's Motivation to choose STEM careers through an Innovative Cross-disciplinary STE(A)M approach to education and is aiming to identify t*eachers' and school directors' approaches to STEM education.*

All the information you provide in this questionnaire will be kept anonymous and it will not be shared with third parties.

1	What is your age?			
2	What is your gender?	Male	Female	Other
		Not confident at all 	Fairly confident 	Very confident 
3	How confident are you that you are able to ask questions a phenomenon or define a problem that needs to be solved?			
4	How confident are you that you are able to plan and carry out investigations?			
5	How confident are you that you are able to analyse and interpret data?			
6	How confident are you that you are able to use mathematics and computational thinking?			
7	How confident are you that you are able to build explanations about a phenomenon or design solutions for a problem?			
8	How confident are you that you are able to find evidences that helps you to reason and argument when finding the best explanation to a phenomenon or the best solution to a problem?			
9	How confident are you that you are able to obtain, evaluate, and communicate information?			

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		Not confident at all	Fairly confident	Very confident
10	How confident are you that you are able to explain the STEM content of the subject/ project/ workshop to participant teens?			
11	How confident are you that you have sufficient knowledge of STEM subjects to answer participant teens' questions during your lesson/workshop?			
12	How confident are you that you are able to use a variety of teaching approaches or strategies to develop your cognition of mathematics/ science/ technology concepts?			

This section measures the impact of your initiative on teachers/volunteers/STEM experts' teaching strategies, especially on those ones aimed at raising teens' self-efficacy in STEM

		Not at all	Fairly	Quite a lot
13	I am familiar with the whole structure and directions of the lesson/ project/ workshop.			
14	I can select effective teaching approaches to guide student/teens thinking and learning in mathematics/ science/technology.			
15	I use a variety of teaching approaches or strategies to raise teens' confidence in their capacities to perform successfully STEAM activities.			
16	I know how to choose effective teaching approaches to guide students' learning and thinking.			
17	I can adapt my teaching style to different learners.			

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		Not at all	Fairly	Quite a lot
18	I am familiar with common student understandings and misconceptions of the STEM content I am teaching.			
19	I can create a classroom setting to promote students' interest for learning STEM concepts.			
20	I know the steps necessary to teach STEM concepts effectively.			
21	I find it easy to explain to students why STEM experiments work.			
22	When teaching STEM, I usually welcome students/teens questions.			
23	I am able to effectively teach STEM content to teens/students whose first language is not English.			
24	I can do a great deal as a teacher to increase the achievement of STEM subjects of children who do not speak the national language as their first language.			
25	I have the ability to help teens from low socioeconomic backgrounds be successful in STEM.			

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