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Learn STEM

Innovative Model of learning STEM
in secondary schools

ERASMUS+ KA220
Cooperation partnerships in school education

Overview on existing practices in teaching STEM through innovative pedagogical approaches for GREECE

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Date:
22.08.2023

Reference Number:
2022-1-TR01-KA220-SCH-000087583

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Kind regards,
Marc

1 The importance of STEM in Educational contexts

Please, write here about half a side about the importance of STEM in education with regard to your partner country.

At SEV (Hellenic Federation of Enterprises) and Endeavor's Big Webinar, Innovative Community Kickoff Greeks, more than 10,000 people watched leading Greeks of innovation from all over the world to share knowledge and experiences on how to substantially strengthen the innovation ecosystem in Hellas. One of the common narratives that the speakers agreed upon is that of creation innovation, knowledge (scientific, technical, and horizontal) is important, alongside understanding that innovation and productivity go together. A second common finding was that the degree complexity, but also the scope, of the contemporary challenges of globalization, the digital transformation, and sustainability imposes access to many different specialties and to specialized skills. And the expected shift in the division of labor between people and machines is expected to eliminate approximately 85 million jobs by 2025, and create 97 million new mainly in the green economy, data analysis and artificial intelligence, but also in engineering, Cloud Computing, even business development or the development of new products (World Economic Forum 2020).

Greece can lay claim to an important position in the new international value chains, as long as we invest in extroversion, innovation, and sustainability. - The upgrading of our human capital involves covering major deficits education in Greece in order to be a main force for the production of innovation in our economy. - SEV systematically emphasizes the need to promote a modern education model and training, harmonized with the needs created by international competition, the transition to green and digital economy and the shifting division of labor between people and machines with the removal of 85 cm. jobs and the creation of 97m. of young people by 2025 (World Economic Forum 2020). - The most critical knowledge fields in this environment are STEM (Science, Technology, Engineering, Mathematics). They are at the core of the educational strategy in technology developing countries in Asia but Europe and North America are losing ground. In Greece, the picture is mixed with a high participation rate in STEM programs, but low performances. - STEM education is a pedagogical model based on interdisciplinarity, the exploratory and experiential learning, teamwork, combinatory thinking and problem solving problems (Problem-based learning - PBL), with the students at the center. - SEV proposes, among other things, a coherent and long-term strategy with adaptation of syllabi, the strengthening of STEM teaching in initial and ongoing teacher training, the promotion of educational excellence and mobilization of business to support STEM education.

Science, technology, engineering, and mathematics (STEM) are fields of knowledge particularly important for the adaptation to this environment and a modern trend of educational systems is being formed emphasis on them, and on their effective teaching. It is a pedagogical model based on interdisciplinarity, inquiry and experiential

learning, teamwork, combinatorial thinking and problem solving (Problem-based learning - PBL), with students in epicenter. At the same time, skills are developed, such as methodological understanding, analytical thinking, creativity, etc. That is, it faces to a large extent the various challenges they will encounter today's young people in their professional careers.

In the technologically developing economies of Asia, this approach has been adopted for decades. In contrast, Europe and North America have lost ground, as shown by the worsening student performance in mathematics and science - a consequence of low participation in studies of a positive and technological direction, as well as the limited encouragement of women to pursue technological professions.

In Greece, the picture appears mixed, with a high level of participation in tertiary STEM programs and balanced distribution of the sexes, but with alarmingly low performances in the positive and natural Sciences.

This weakness of the Greek education system undermines the long-term professional perspective of students and the development perspective of European and American businesses and economies (see indicatively here). SEV (Hellenic Federation of Enterprises) 's firm position is that in order for human resources to be the main strength production of innovation, we must cover the above major gaps in modern education in the country. In this direction, in addition to the detachment of school education from face-to-face teaching and the memorization of theoretical knowledge, with the main goal of admission to higher education, important it is also the acquisition, utilization and synthesis of knowledge. Despite positive steps such as the gradual inclusion of STEM in the educational agenda, and other efforts such as skill workshops, IT enhancement, etc. the country needs to significantly speed up the step towards modern and qualitatively upgraded STEM education, while at the same time the companies must place great emphasis on the development of their human resources. Education and upgrading the skills of all employees is a long-term investment for its development creativity, the growth of innovative capacity, and finally the extroversion in the global Buy. For the educational system, the challenge concerns how to integrate the above characteristics in the educational process, with which strategic planning, which educational content and which support in terms of teachers and logistical infrastructure.

Greek education system shows a significant lag over time in terms of convergence with the rest of Europe and effectively addressing the challenges of the 21st century, despite the ongoing reform efforts and the progress made in recent decades; mainly at the level of syllabi. Especially when it comes to STEM, except that an integrated national strategy for the promotion of STEM education, its structure, is absent educational system, the educational tradition, social and historical parameters do not facilitate the adoption and consolidation of the basic principles of STEM education, especially in secondary, general and vocational education. The negative effects of the ineffectiveness of the Greek educational policy reflected in chronically low student performance, especially in terms of level scientific and mathematical literacy of students who complete the compulsory education. In the latest PISA competition

(2018), Greece ranks 45th out of 78 countries/regions, based on average student performance. This picture does not seem to be improving at highschool.

Refering some useful Statistics about schools in Greece and in order to have a more objective view regarding the situation about the importance of STEM in education in Greece, most High Schools operate from 8am to 2pm, but there are also evening schools that operate from 7pm till 10pm for students – mainly adults – who work during daytime.

A variety of subjects are taught in Junior High Schools, including Modern and Ancient Greek Language, Maths, Physics, Chemistry, Geography, History, Physical Education, Religious Studies, Music and Art, while special emphasis is given to foreign language learning, as students are taught both English and another European language of their choice (students tend to choose between French and German). Students take exams in all subjects at the end of each school year.

Students may also pursue vocational training in Vocational High Schools, or, once they are 16, they may enrol in a Vocational Evening High School and graduate after 4 years of study. In addition, there are Vocational Training Schools; in these schools, as well as in all Vocational High Schools students attend general education courses combined with workplace courses. At the final stage of their studies, a student may work as an apprentice and gain valuable work experience.

High Schools offer a combination of General Education courses and Advanced Placement courses. Students who wish to pursue studies in Higher Education take Panhellenic exams in a specific number of Advanced Placement courses which fall into one of the following categories: Humanities, Science, Technology. This is considered to be a tough and highly competitive exam process that students go through in order to ensure education at a higher level 3.

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.

The lab operates complementary to the educational process. It offers a modern and interactive way of learning and training through the teaching of subject fields via:

1. The use of certified educational software

2. Pedagogical use of the Internet

3. The support of project-based learning in the framework of the school's activities

4. The European cooperation actions

5. The broadening of purely teaching activities (enhanced teaching, additional teaching support).

Additional comments:

• The teaching profession is highly attractive but opportunities and incentives to improve professionalism are lacking.

• Education expenditure is lower than in most EU countries and largely spent on salaries.

• Early school leaving has been further reduced, particularly in rural areas.

• Finding employment after education remains difficult, including for highly qualified people.

• Measures to tackle the brain drain of tertiary graduates are being implemented but

• internationalisation of Greek universities is underdeveloped.

The Directorate of Educational Technology and Innovation has invited again, in May 2023, Primary and Secondary Schools (public and private) to submit original material from educational visits-excursions, as well as material for the promotion of STEM and STEAM projects that are being developed or have already been developed by that's all.

Materials referenced in original educational field trips will include student texts of up to three hundred (300) words, photographs (up to five images per visit), videos (up to two videos per visit in the form of a link posted on an external channel), and artistic works (in image or video form, up to two per visit). Note that the material in question will be posted on the website: https://edu-gate.minedu.gov.gr/ in the Innovation category.

STEM and STEAM projects cross-curricularly approach science, technology, engineering and mathematics. Their display material will include student texts of up to three hundred (300) words, photographs (up to five images per project), videos (up to two videos per project in the form of a link posted on an external channel) and artwork (up to two per project), which will also be posted on the above website (https://edu-gate.minedu.gov.gr) in the Innovation category.

Focusing on integration of STE(A)M in schools in Greece and presenting Good practices and ongoing national and international projects, resources, initiatives related to STE(A)M we continue presenting what is relatively new regarding STEAM is the part of the Arts being embedded with Science, Technology,Engineering and Mathematics (STEM) and brings the STEM together with Arts (STEAM). Therefore, this addition is introducing students and educators a more holistic approach in the classroom that involves inquiry, innovation and critical thinking. Teachers in Greece have been trying

to motivate the students in order to think of STEAM education and the connection of STEAM education and Greek ethnicity. STEAM 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, STEAM programs add Art to STEM curriculum by depicting on design principles and enheartening and invigorating creative solutions.

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

STEAM 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.

STEM or STEAM alone miss several key components that lead to the feasible holistic approach, that many employers, educators, and parents have voiced as critical for students to thrive in the present and rapidly approaching future. STEM integrated with arts and culture could offer such miss and develop to an educational approach to learning that uses of Science, Technology, Engineering, Mathematics in Arts and Culture as access points for guiding student inquiry, intercultural dialogue, critical thinking, understanding, realization of a common language; that of STEM. The end results are students who take thoughtful risks,engage in experiential learning, persist in problem-solving, embrace collaboration, and work through the creative process.

The text right below focuses on some of the initiatives taken in Greece, the best practices, and the sustainability of their actions in National level:

1. 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

Aims: The aims and objectives of the E 3 STEM are 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

Resource and activity: Membership provides access to material, training, advice and support. (E3STEM), 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 with 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.

2. 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.

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.

3. 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 aim offers summer programs 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.

2 Presentation of examples for existing practices in teaching STEM in Greece

Despite the absence of a comprehensive STEM strategy in Greece, recent years have seen development important initiatives to promote STEM education at all levels, mainly but in secondary general education, and more systematically, in private secondary education.

Although these are, as a rule, isolated and piecemeal actions, the value and their impact on the educational and student community, but also on Greek society as a whole, are extremely important, as on the one hand they increase students' interest in these subjects scientific areas, on the other hand they gradually introduce STEM teaching in schools.

In in the majority of cases, these actions are implemented with the assistance, or even with initiative, of some private enterprise or organization, such as, for example, the

strategy Cosmote's collaboration with the Greek branch of the Educational Robotics Organization and of Science (WRO Hellas), Vodafone's Generation Next Program.

The activity of the teachers individually and collectively is also noteworthy level. Indicatively, the relevant initiatives of the Hellenic Scientific Union are mentioned STEM Educators (E3STEM), the Union of Greek Physicists, the Panhellenic Union of Teachers of Informatics (PEKAP) but also of the Open Technologies Organization (EELLAK) mainly through its participation in the Scientix European Network.

And in the field of politics, there is a tendency to strengthen STEM in education. According to current approach of the Ministry of Education, STEM is now gaining a place in education agenda and the first reform efforts have begun to materialize, at least at the institutional-regulatory level (e.g. skills workshops, IT support in analytical programs etc.). However, it is necessary for the country to open up and accelerate its pace in everything the issues pertaining to the national skill development ecosystem in order to maximize the contribution of human resources to economic growth and productivity transformation. Strengthening STEM across the spectrum of the education system is a necessary component for the modernization and upgrading of Education.

2.1 Presentation of best practice 1: Introduction to electronic technology

Name of providing Learn STEM partner	IEK KAVALAS
Title/Name of the example	Introduction to electronic technology
Organization, country and website	Educational Robotics and Science Organization (WRO Hellas), Greece, https://stem.edu.gr/en/
Brief description (abstract)	The world of electronics is significantly influencing the environment in which we live. It is critical for children to understand basic electronic principles so that they have control over the technological environment around them and can make smart decisions. Basic electronics principles are not taught in the school curriculum. STEM Education's proposed program fills this void in an interesting and entertaining way. How do a processor and its memory work, and how do they differ? How do device power supplies work, and what are the key elements by which we choose them? How do LED, neon, and fluorescent lights work, and how do we select a bulb? What antennas are used for wired and wireless data transmission? How are color

	and sound converted into data, and how are images and video displayed on screens? These are some of the questions that will be answered during the program's fun activities. Objectives On completion of the program, students will have: ➢ become familiar with the basic principles of electronics, ➢ created their own circuits to investigate the concepts of the project, ➢ developed critical thinking and expertise about electronic devices they use in their everyday lives, ➢ answer real-world questions according to the STEM methodology. Number of courses: 30 Duration: 90′
Age range	Secondary School
Subject/discipline or crossdisciplinary	Engineering

2.2 Presentation of best practice 2: Future Innovators

Name of providing Learn STEM partner	IEK KAVALAS
Title/Name of the example	Future Innovators
Organization, country and website	Educational Robotics and Science Organization (WRO Hellas), Greece, https://stem.edu.gr/en/
Brief description (abstract)	The Future Innovators program consists of a series of projects that students will implement, thus understanding genuine problems and providing innovative solutions using cutting-edge technologies. These include technologies such as 3D design and printing, cloud computing, machine vision and artificial intelligence. Through this program, students learn to design structures and parts of robotic systems in 3D applications, select and assemble the appropriate electronic parts (sensors, actuators, microcontrollers) and code using advanced practices and algorithms. They are also introduced to types and characteristics of data

	networks, as well as to concepts and methods from the field of artificial intelligence. At the same time, they develop communication skills by preparing presentations on their creations. Objectives On completion of the program, students will have: ➢ deepened their knowledge of cutting-edge technologies (robotics, artificial intelligence, etc.), ➢ programmed complex applications by creating algorithms with a high degree of complexity, ➢ designed and fabricated artifacts with 3D design and 3D printing, ➢ develop presentation, problem-solving and innovative thinking skills through the project process. Number of courses: 30 Duration: 90′
Age range	15-18 years old
Subject/discipline or crossdisciplinary	Engineering, Technology

2.3 Presentation of best practice 3: Educational Robotics

Name of providing Learn STEM partner	IEK KAVALAS
Title/Name of the example	Educational Robotics
Organization, country and website	Sparmatseto, Greece, https://sparmatseto.gr/events/kavala-ekpaideftiki-robotiki/
Brief description (abstract)	Educational robotics has built a solid base of theoretical, epistemological and practical principles that allow it to act autonomously as a means of education adapted to the particular principles of exploratory learning characteristic that makes it highly effective. We will get in touch with educational robotics, its theory and its materials. We will explore her wonderful world, build and program robotic structures that will create art. All this with the ultimate goal of knowledge and artistic awareness of the participants. Purpose and Objectives The purpose of the program is to provide knowledge, skills and experiences regarding educational robotics, its methods, the applications it can have and its effectiveness. At

	the same time it is sought to provide the appropriate background which is necessary to engage the participants in a highly effective through training. The goal of the program is to equip children with all the cognitive, methodological and practical skills that will allow them to delve into educational robotics, understand it and apply it by gaining useful experiences and mastering knowledge through robotics.
Age range	14-15 years old
Subject/discipline or crossdisciplinary	• Physics (motion, friction, energy, pressure, forces, etc.) • Mathematics-Geometry (proportions, sizes, perimeter, angles, etc.) • Engineering (construction, assembly, stability, etc.) • Programming (sensors, algorithmic perception, digital intelligence, etc.)

2.4 Presentation of best practice 4: R-Lab. Εργαστήρι Physical Computing

Name of providing Learn STEM partner	IEK KAVALAS
Title/Name of the example	R-Lab. Εργαστήρι Physical Computing
Organization, country and website	Robomatheia, Greece, https://robomatheia.gr/
Brief description (abstract)	Learning the secrets of the Internet of Things (IoT) This educational program introduces students to new trends in computer science and communication, equipping them with high-level skills. Students will learn to program computing devices and become familiar with sensors and electromechanical structures (IoT), solving everyday problems using robotic automation, thus connecting computers with the physical world (Physical computing). Objectives: ➢ Cultivating algorithmic thinking. ➢ Development of imagination and creativity. ➢ Improving self-esteem and confidence. ➢ Analytical and Synthetic Thinking - Formation of Critical Thinking. ➢ Cultivating a collaborative spirit and communicative clarity. ➢ Searching for information and acquiring new knowledge.

	➢ Search and find solutions to real, everyday problems. ➢ Innovation - Familiarity with the possibilities and applications of new technologies. ➢ Incorporating school material in an experiential way. 60 min / week
Age range	12-19 years old
Subject/discipline or crossdisciplinary	Science, Computer science, Arduino, Raspberry Pi, micro:bit

3. Final comment

The above information demonstrate the overall and timeless weakness of Greek education system to effectively impart knowledge and develop critical life skills, such as critical thinking, problem solving, self-management, etc. This negative image is due to a variety of combined factors. Despite her scientific proficiency of the majority of human resources employed in education is not disputed, reservations are expressed, regarding the pedagogical competence of the teachers, especially in secondary education.

Mainly at the didactic level, school education remains attached to the frontal teaching and memorizing theoretical knowledge, primarily aiming at access to higher educational levels, without any real concern for the acquisition of knowledge and development of corresponding skills and abilities. As with all centrally controlled, bureaucratic, systems, in the Greek school the teacher exercises his function within an introverted school environment. Faced with a variety of administrative and practical limitations and without substantial support - beyond the supplies he acquired during the initial education (which often lacks pedagogical content) and his personal conscientiousness - the Greek teacher exercises his function in conditions very different from those that apply to foreign teachers, with whom it is nevertheless compared systematically.

At the same time, the suffocating and conservative framework of the analytic programs, the intensifying student heterogeneity of the class, the bureaucratic system of governance, its weaknesses evaluation system of students, teachers and school units, its declining prestige of the teacher's profession and the absence of motivation for professional development and self-improvement, society's conservative perception of Education, its inadequacy and discontinuity of educational policy, constitute an environment that acts as a deterrent towards it adopting the critical components of STEM education.

In contrast to these negative findings, Greece shows a comparatively high level participation in higher education STEM degree programs, leaving behind some of the most economically and technologically developed countries. It is relatively positive the

image of the country and regarding the participation of women in STEM. Besides, the girls' academic performance, in the specific fields, does not differ significantly from that of men/boys. In the case of EPALs, in fact, the average score in all STEM fields is stable 1 unit higher than that of boys, although generally significantly lower in STEM EDUCATION relation to classical or theoretical courses (language, history, etc.).

The national education policy must capitalize on the comparative advantage of the increased interest of young people, men and women, for positive and technological career options direction. An overall improvement in the quality of school education in the direction is required strengthening of scientific and technological literacy, already from the first grades school. Achieving this goal requires a change in the educational model, with greater emphasis on interdisciplinarity, practical application and the cultivation of contemporary skills, and stronger interconnection of education with society and the economy, so that the students to understand experientially the importance of science and technology in real world.

Equally important is the redesign of the higher education map education in the direction of increasing enrollment in STEM degree programs, but and strengthening the provision of STEM educational pathways at lower grades, especially of Vocational Education and Training, so that even more young people can are directed to corresponding study programs.

As a final conclusion, what the country needs most is an integrated national strategy for the quality upgrade of the education provided, to all degrees, with a particular emphasis on STEM fields.

Resources:

- **https://www.britannica.com/place/Greece/Local-government#ref26469**
- **https://www.worldometers.info/demographics/greece-demographics/#pop**
- **https://www.fulbright.gr/en/study-in-greece/the-greek-educational-system**
- **https://eacea.ec.europa.eu/national-policies/eurydice/content/teaching-and-learning-general-lower-secondary-education-16_en**
- **https://ec.europa.eu/education/resources-and-tools/document-library/education-and-training-monitor-2019-greece-report_en**