COMPARATIVE REPORT

CODESKILLS4ROBOTICS: Promoting Coding & STEM Skills through Robotics: Supporting Primary Schools to Develop Inclusive Digital Strategies for All

IO1: Building the CODESKILLS4ROBOTICS Competence Framework: From Theory to Practice

Partner: Hellenic Mediterranean University (HMU)

Grant Agreement No: 2018-1-EL01-KA201-047823

Website: http://codeskills4robotics.eu/

April 2019

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

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein." "Funded by the Erasmus+ Programme of the European Union"

CODESKILLS
4ROBOTICS

Abstract

In this work, we present a comparative report for the current practice in Greece, Cyprus, Belgium and Sweden in relation to the teaching of digital, coding and robotic skills in primary education. The Report takes into account EU Recommendations as well as the needs of primary school teachers and students, which have been recorded and analyzed from a dedicated survey conducted in the first three months of 2019.

Firstly, we present the basic aims of the CODESKILLS4ROBOTICS project along with the six organizations that are part of the Consortium. Next, we present the EU policies on digital education and robotics in section three and compare the digital education policies for primary school education as well as the infrastructure in primary schools that support ICTs and Educational Robotics. After that, we compare the integration of Coding-Robotics and STEM skills in the school curriculum. A comparison of the existing teachers' training programs in Coding-Robotics and STEM skills is given next. Finally, we present the results from the empirical research survey. The outcomes outline the needs of the primary school teachers and students for coding skills and STEM education, according to the EU Recommendations.

CODESKILLS 4ROBOTICS

Table of Contents

1. Introduction

Programming and computational thinking skills are becoming ever more important in our working life and society. The evolving digitalized economy nowadays has transformed the labor market and brought digital skills to the forefront of the educational scene.

The COM (2015)408 report of European Union [1] on "New priorities for European cooperation in education and training" emphasizes that "knowing how to code is empowering. It allows to understand the digital world we live in and to shape it. Basic coding skills are essential for accessing the jobs of tomorrow and today. Coding is seen as the red thread that runs through future professions". Similarly, the 2018 Digital Education Action Plan [2] urges Member States of the European Union (EU) to bring coding classes to all schools across Europe at an early age either as part of educational curricula or through after-school classes while encouraging all schools in Europe to participate in the EU CODE WEEK by collaborating with authorities etc.

Considering these recommendations, ICT school curricula have been shifting their focus from computer literacy to digital literacy, i.e., on teaching students not only how to operate a computer, but mostly how a computer works and how to make it work for you. Often selected as an introductory channel to programming, robotics effectively initiates students to various STEM disciplines while promoting transversal employability skills such as problem solving, leadership and creativity.

In this context, the ERASMUS+ KA2 project "CODESKILLS4ROBOTICS" joins the efforts of Member States of the EU to promote coding and STEM skills in primary schools through robotics. It attempts to engage in an effective and innovative way the local school communities to create a holistic approach dealing with multiple digital competences.

Based on the above, the direct target group is primary school children from 9 to 12 years old (with emphasis on girls and children with less opportunities) who will participate in a coding program to learn how to program robots via smart devices. The indirect target group is primary school teachers whose profiles will be upgraded and strengthened through the professional development program to acquire the essential digital and coding skills. It is expected that programming robots will help students to learn the importance of clarity of expression, to develop skills such as analytical thinking, logical reasoning problem solving, and creativity.

The basic aims of the CODESKILLS4ROBOTICS project are:

- To design, pilot-test and evaluate a complete tool kit that will support primary schools in developing their own digital-inclusive strategies for the promotion of coding, robotics and STEM skills;

- To develop an educational pack containing all the essential materials, tools and resources for the introduction of coding and robotics to primary schools; the educational pack will be based on a targeted Digital Competence Framework, which will also serve as a basis for the monitoring and assessment of the students' progress;
- To introduce the Open Badges system as a method to validate and award the coding skills acquired by both teachers and students, in conjunction with an online assessment tool developed to this purpose; a mobile app meant to support teaching, learning and assessment will also be developed;
- To design, in accordance with the 2018 Digital Education Action Plan for EU, a strong campaign as part of the EU Code/Robotics Week; CODESKILLS4ROBOTICS Competitions will be organized at the regional, national and EU level, thus promoting transnational cooperation.

The present comparative report is mainly based on a survey conducted among students and teachers (see appendix) and also a desk research that can be found in four National Reports compiled by the Organizations involved in the project. In Section two we present the six Organizations that comprise the consortium and are engaged in the implementation of the project. The EU policies on digital education and robotics are presented in section three. Section four analyzes how Coding, Educational Robotics and STEM skills are involved in primary schools across the partner countries. A comparison is made on digital education policies, infrastructure, curricula and teachers training programs. In the final section, the results from the empirical research survey are presented, which are based on two different versions of questionnaires that have been designed to identify the gaps of the existing curriculum in primary schools along with the weaknesses of teachers in the educational process of ICT, STEM Skills and robotics.

2. CODESKILLS4ROBOTICS Project Consortium

The CODESKILLS4ROBOTICS Consortium consists of six (6) Organizations from four (4) European countries (Figure 1):

P1	GR	National Center for Scientific Research "Demokritos"
P2	BE	Lifelong Learning Platform
P3	GR	Regional Directorate of Primary and Secondary School Education of Crete
P4	CY	Emphasys Centre
P5	GR	Hellenic Mediterranean University
P6	SE	Halsingland Education Association

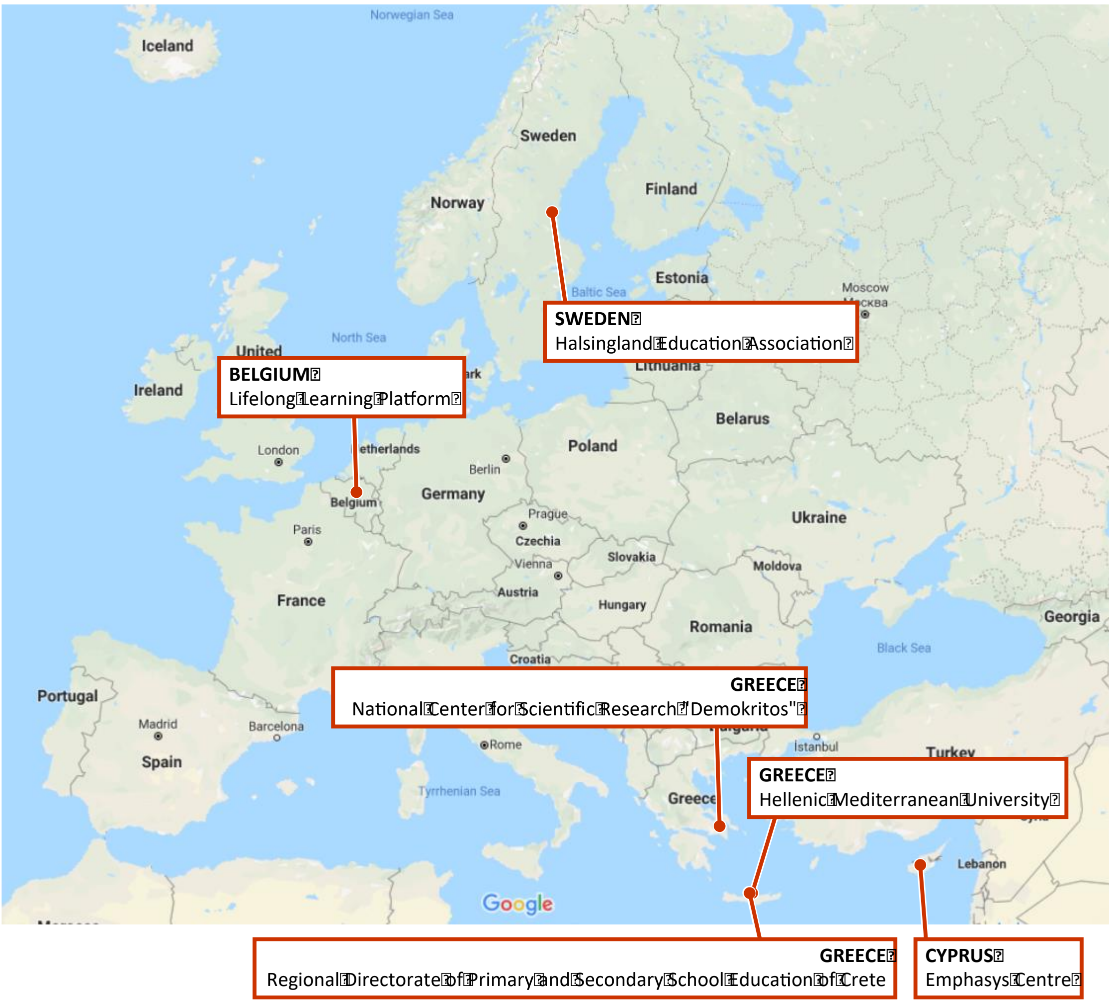


Fig 1: The Six (6) European Partners of the CODESKILLS4ROBOTICS Consortium

More specifically, the **National Center for Scientific Research "Demokritos" (N.C.S.R. "Demokritos")** (www.demokritos.gr/), which is the coordinator of the project, is the largest public multidisciplinary research center in Greece with over 800 employees, with critical mass in expertise and infrastructure in the fields of Informatics and Telecommunications, Nanotechnology, Energy & Environment, Biosciences, Particle and Nuclear Science. The N.C.S.R. "Demokritos" conducts world-class basic and applied research, for advancing scientific knowledge and promoting technological development in selected areas of national socio-economic interest. N.C.S.R. "Demokritos" also plays a pivotal role in graduate education and professional training and its unique infrastructure is employed for high-technology services to the Industry and the Society.

The **Regional Directorate of Primary and Secondary Education of Crete** (www.pdekritis.gr) is the second Greek partner of the Consortium. It is a large educational organization in Greece under the supervision of the Ministry of Education, Research and Religious Affairs, which is responsible for schools and teachers in four Prefectures, Heraklion, Rethimnon, Chania and Lasithi. The Regional Directorate of Primary and Secondary Education in Crete is in charge of 1100 schools of both levels of education: primary education with 866 schools and secondary education with 234 schools (117 junior high schools, 74 high schools, 43 vocational schools). The main task of Regional Directorate is to co-ordinate, supplement, back up and implement the educational policies of the Ministry, along with supervising the implementation of various education projects, like European projects, in schools.

The third Greek partner of the project is the **Hellenic Mediterranean University (HMU)** (formerly T.E.I. of Crete, www.hmu.gr). Its mission includes Higher Education (offering 11 First Degree Courses and 14 Postgraduate Courses) as well as Research & Development activities, directly contributing to regional and broader development, through lifelong learning, high profile technological and consultancy services to industry, and technology and knowledge transfer. The HMU, with its more than 200 highly qualified permanent academic staff members, 200 part-time associated lecturers and c.150 skilled technical and clerical staff, provides high quality education (documented by all external evaluators) to c. 15,000 students. Education is delivered at the main campus in Heraklion and at 5 branches in other cities of Crete (Chania, Rethymnon, Aghios Nikolaos, Ierapetra, Siteia). Numerous opportunities are offered for active student participation in R&D, for student exchanges with over 250 foreign universities and for paid work at the HMU laboratories. Graduates can also continue with Postgraduate Studies at the Institute or at cooperating Universities in Greece and abroad, with the active support of the Professors of the HMU. Spiritual, artistic and entertainment activities in and around the Institute are varied and shared by students and staff, with the University's financial support. Personal care and advice is provided to new incoming students by the multi-lingual staff of the International Office and the skilled staff at the Schools, and by the newly established Student Advice Centre. The HMU has demonstrated great success on a European stage in the academic year 2013-2014 with many activities in the framework of the different activities of the Programme LLP-ERASMUS. The University is committed to offering quality Higher Education and research at a Regional, National, European and International level.

Emphasys Centre (www.emphasyscentre.com) is the fourth Consortium partner, which is not only an «ICT EDUCATION AND VET CENTRE» but also a «EUROPEAN RESEARCH CENTRE». It has been operating in Cyprus since 1998 and is approved by the Cyprus Ministry of Education and Culture as an Educational and Vocational Centre specializing in the field of ICT. Furthermore, it is authorized by the ECDL Foundation and the Council of Europe Information Scientists (CEPIS) to offer specialized training courses for the acquisition of the European Computer Driving License (ECDL), whereas its staff is ECDL Certified Training Professionals. The «Emphasys Centre» functions also as an Examination Centre for the Cyprus Computer Society and is authorized by the British Council of Cyprus and the Cambridge International Examination Board to teach GCE A' Level Computer Science and organize various exams, as an approved examination centre. It has 8 highly qualified members of staff on a full-time basis and 5 other members of staff on a part-time basis.

The fifth partner is the **Lifelong Learning Platform** (www.lllplatform.eu, formerly EUCIS-LLL), which was created in 2005 in Belgium and gathers today 42 European networks working in education, training and youth. These organizations represent millions of actors across Europe & cover all sectors of education & training including networks for secondary and higher education, VET, adult education and popular education;

networks for students, school heads, parents, HRD professionals, teachers and trainers. LLP was acknowledged by the European Commission in 2009 as a "unique representation" of lifelong learning of the various education & training actors organized at EU level. It receives an operational support from the EU under the LLL and Erasmus+ programmes since 2010.

Lastly, the sixth partner is the **Halsingland Education Association** (HEA, www.hufb.se) from Sweden, which is a public authority and a non-commercial collaboration between the three municipalities of Bollnäs, Söderhamn and Nordanstig. In the HEA the municipalities cooperate around education and training on various levels from secondary level for youth, adult education, post-secondary VET and higher education. The municipalities within HEA organises education and vocational training for about 5,000 students per year. HEA makes it possible for the municipalities to offer a broad spectrum of courses that each municipality by itself would be unable to offer due to financial reasons. HEA was established in 2015. The municipalities have participated in numerous projects funded by the EU/ESF all related to lifelong learning and how LLL can be organized in rural areas. The HEA cooperation also focuses on R&D about for example distance learning using ICT technology and appropriate pedagogical methods.

3. EU Policies on Digital Education and Robotics

The issue of digital skills is not new to the European policy agenda and has been discussed in different policy documents since the late 1990s, when computers and the Internet first started to influence the economy, the labor market and society as a whole. From the point of view of education policies, the turn of the century marked a shift from operational to strategic policy objectives, and from technology integration towards fostering innovation and competitiveness through the integration of digital technologies into education.

In the year 2000, EU heads of state and government took a stance on technological change and adopted the so-called Lisbon strategy [7], a European commitment to overcome Europe's relative deficit in growth and productivity, mainly due to a lack of technological capacity and innovation. Within the strategy, significant emphasis was placed on access to ICT infrastructure and broadband Internet coverage, as well as on their better use.

The first major policy document on digital skills came a year later, when the European Commission adopted the e-Learning Action Plan - Designing tomorrow's education [8]. The document stressed the need to develop digital skills and set out a series of specific actions for different target groups; the actions targeted to the education sector included:

- Enabling high-speed Internet access in schools and universities;
- Providing access to educational services and e-learning platforms for teachers, pupils and parents;
- Training teachers in the use of digital technologies;
- Adapting curricula to incorporate new ways of learning ICTs.

Digital education policies up to this point are generally considered as part of a wider "first-generation" policy reform with a primary focus on infrastructure development. Starting from the following year and building on the foundation of two abovementioned documents, a "second generation" of digital education policies started shifting the focus on complementary policy measures such as teacher training, competence building and content development.

The two main policy documents that shape the course of the "second-generation" policies are the New Skills Agenda for Europe [9] and the Digital Education Action Plan [2].

The New Skills Agenda is the most important recent EU policy document in the area of skills. It focuses on digital skills as part of a wider commitment to the improvement of "the quality and relevance of skills formation" and it recognizes that almost all jobs, as well as participation in society at large, now require some level of digital skills.

As far as primary education is concerned, Council conclusions discussing digital skills argue that promoting creativity, innovation and digital competence through education during the early years can produce significant benefits later on [10]. While digital tools cannot replace essential classroom activities, experiences and materials, they can

CODESKILLS 4ROBOTICS

contribute to improve the quality and effectiveness of education, as well as the motivation, understanding and learning outcomes of pupils. This of course entails important implications for pedagogic approaches, resources and assessment as well as for the initial education and continued professional development of teachers. An increased use of digital tools in teaching and learning is also inevitably connected to concerns over the development of media literacy skills, particularly the issues of safety and responsibility online.

The Conclusions focus on the following areas of action:

- Access to and promotion of age-appropriate, safe and responsible ICT, digital equipment and digital tools in primary education;
- Focus on teachers and school leaders, including on their abilities to use ICT for teaching, on new pedagogical approaches and on the provision of more personalized teaching for a wide range of abilities and disadvantages;
- Cooperation - including e-Twinning and other collaboration at all levels, open source communities and exchange of good practices and effective methods of teaching and learning.

The other central document belonging to the "second generation" of digital education policies is the Digital Education Action Plan adopted by the European Commission in January 2018. The document introduces three (3) priorities, each of them outlining actions that aim to "help EU Member States meet the challenges and opportunities of education in the digital age" [2].

The priorities and actions of relevance to Digital Education are the following:

Priority 1 – Making better use of digital technology for teaching and learning

- Action 1: Connectivity in schools - Supporting the roll-out of higher-capacity broadband in schools

  Low connectivity remains one of the main obstacles to the uptake of digital tools that can trigger innovation in schools, coupled with the schools' frequent lack of technical competences to make credible decisions on digital infrastructure and its strategic development.

  In order to tackle the connectivity divide, the Action Plan highlights three action areas:

  1. Raising awareness of the benefits for schools, and of the available funding opportunities;

  2. Supporting connectivity, e.g. through a voucher scheme focusing on disadvantaged areas and ensuring full implementation of the toolkit for rural areas;

  3. Publishing data about progress.

  The main policy initiative that could contribute to raising awareness and supporting connectivity in rural areas is the EU network of Broadband Competence Offices.

- Action 2: SELFIE self-reflection tool and mentoring scheme for schools - Supporting the digital capacity of schools.
  While many teachers already apply some level of ICT-based teaching in class, they often lack the ability to use technology in a more advanced manner, apart from gathering information or making a simple presentation. Hence the need for specific ICT modules in teachers' degree curricula: education institutions need to stay focused on updating curricula and expanding the number of subjects related to digital competences and applying a horizontal cross-subject approach.

  The Digital Education Action Plan suggests the SELFIE self-assessment tool as the main policy initiative supporting the digital readiness of general and vocational schools. Based on the Digitally-Competent Educational Organizations (DigCompOrg) conceptual framework [11], SELFIE provides a snapshot of each school's strengths and weaknesses in its use of digital technologies for better learning. Schools can use the main output of this tool (a SELFIE School Report) to create an Action Plan to improve the use of digital technologies for better learning.

Priority 2 – Developing digital competences and skills

- Action 6: EU Code Week in schools - Getting more schools involved in EU Code Week
  Europe will lose its competitiveness if education fails to provide digital competences to Europeans of all ages: the lack of basic digital competences limits citizens' ability to take part in learning activities and to fully participate in a digitally-driven society, while the absence of advanced digital skills creates an evident gap in the labour market.

  The Action Plan acknowledges that Europeans should begin acquiring digital skills at an early age, through both curricular and extracurricular activities. One of the initiatives suggested by the Commission to this regard is participation in the EU Code Week [12], a grass-root movement run by volunteers, which aims to encourage more people to learn computational thinking, understand how computers work and discover coding.

- Action 8: Training in digital and entrepreneurial skills for girls - Addressing the gender gap in digital and entrepreneurship sectors
  The Digital Education Action Plan recognizes a lack of interest among girls to pursue studies in ICT or STEM; this is true from an early age and this is due to an extent to gender stereotypes.

  In order to address this concern, the Commission will support measures to further decrease the gender gap in the technology and entrepreneurial sector by promoting digital and entrepreneurial competences among girls as well as mobilize stakeholders to equip girls with digital skills and inspirational models.

According to the European Commission, “third-generation” digital education policies should focus on building teaching capacity combined with infrastructure measures, often in the form of mobile device provisions.

The general consensus underlying recent policy developments is that the provision of digital technologies leads to improved learning outcomes across different disciplines [13]. However, while “technology can amplify great teaching, great technology cannot replace poor teaching”: the impact of the implementation of digital technologies in education depends substantially on contextual factors, the role of teachers being one of the foremost [14]. In order to encourage the integration of digital technologies into teaching practice, teachers require professional development opportunities that focus on the use of technology from a pedagogical perspective. Furthermore, technological programmes need to be implemented as part of a wider pedagogical framework in order to be effective: many teachers still struggle to integrate technology and meet curriculum demands at the same time, indicating a need for a curriculum design that is more conducive to the use of digital technologies.

4. Coding, Robotics and STEM Skills in Primary Schools across the Partner Countries

4.1 Digital Education Policies for Primary School Education

All partner countries recognize the importance of STEM from primary school level onwards as the means for the achievement of the following three critical objectives:

a) the development of rational and scientific thinking,

b) the development of an insight into scientific phenomena, and

c) the raising of interest in technology and technical activities.

Especially for ICT, the identified objectives include for pupils to:

1) acquire a positive attitude towards ICT and be willing to use ICT in support of their learning;

2) use ICT in a safe, sensible and appropriate way;

3) be able to practice independently in an ICT-supported learning environment;

4) be able to learn independently in an ICT-supported learning environment;

5) be able to use ICT to express their own ideas in a creative way;

6) be able to retrieve, process and save digital information that is appropriate for them, by means of ICT;

7) be able to use ICT in presenting information to others;

8) be able to use ICT to communicate in a safe, sensible and appropriate way.

However, the lack of a cohesive and uniform strategy for digital education across Europe might lead to the creation of a digital divide between school students coming from different European countries. While some countries seem to be increasingly committed to fostering digital education through the development of policy initiatives and ICT infrastructures, other appear to be slightly less advanced. It has become common, however, in the last two decades, for national authorities to implement nation-wide large-scale horizontal projects for the provision of primary and secondary schools with quality equipment (personal computers, interactive whiteboards, projectors, networking devices, electronic and STEM equipment) and fast Internet connections. This is done in order to promote the use of digital technology, to facilitate the acquisition of specific digital skills and to support the learning process at all stages. In parallel, other similar national large-scale projects focus on the development of Internet services for the promotion of school activities to the society and the collaboration between schools and school communities. Finally, the reports mention the need for specific measures aimed at girls and female teachers. The following elaborate further on these measures:

In **Greece**, the Panhellenic School Network (www.sch.gr), operating since 2000, constitutes a nation-wide portal for the Greek schools, providing tools and services for Internet-based communication to schools and members of the school community (e.g. emails, web page hosting, e-class, conferencing, streaming, file storage, forums). It is the major tool for promoting Internet based education and collaboration among schools. The key action lines of the Greek National Policy for Digital Education in primary schools include:

1) the increase in the number of teachers/schools that use ICT in the classroom

2) the increase of the schools that develop their own website

3) students to get familiar with e-mail accounts

4) improvement of the ratio Personal Computers per students

5) availability of broadband Internet connections for all schools

6) in-service teacher training

7) promotion of Open Educational Resources (OERs)

8) creation of reusable units of learning

9) promotion of digital learning resources

10) improvement of the digital infrastructure to facilitate search, retrieval, access and utilization of digital learning resources for all (teachers, pupils, parents, everyone).

11) promotion of the active role of teachers and pupils in the creation, documentation and evaluation of digital learning resources

Similarly, the key action lines of the **Swedish** National Policy for Digital Education in primary schools include:

1) Digital Literacy for everyone in the school system

2) Equal access and use

3) Research and follow-up on digitalization opportunities, since digital tools increase motivation of pupils in learning, while offer challenges to teachers

4) Increased use of ICT in schools among students and teachers

5) Development of conditions for tech-supported learning

6) Training for students to use the computer as an educational tool.

7) Skills development at all levels: for students, teachers and school leaders

For **Cyprus**, there are not central recommendations for the use of ICT in pupil assessment.

Likewise, the **Flemish Community** in **Belgium** does not have a specific policy for digital education in primary schools. However, general guidelines can be derived from the STEM Action Plan 2012-2020, a project of the Flemish government covering the policy areas of Education and Training, Work and Social Economy, Economy, Science and Innovation. According to this plan:

a) an integrated approach to STEM education should be followed from primary school level onwards;

b) increasing training opportunities should be provided in order to grow more confident and better-equipped teachers of STEM subjects;

c) communication and sharing of best practices in STEM education between teachers should be encouraged.

The **French-speaking** and the **German-speaking Community** in **Belgium** implement a comprehensive digital education policy named École Numérique, which is part of a wider Digital Wallonia strategy. The École Numérique strategy pursues the overall objective of providing primary and secondary schools with quality equipment and Internet connection in order to promote the use of digital technology, to facilitate the acquisition of specific digital skills and to support the learning process at all stages. "École Numérique" comprises smaller projects, namely:

1) Call for projects "École Numérique": Individual projects developed by schools themselves function as triggers within a wider effort to initiate and establish pedagogic practices which either exploit or educate to the digital world: since 2011, several projects funded under the "École Numérique" call have indeed developed into durable pedagogic practices.

2) WiFi in schools: the Walloon government plans to equip 200 schools with high-quality WiFi connection, necessary complement to the use of the devices made available to schools (electronic white boards, PCs, tablets etc.) and to the development of an effective digital policy. The selected schools received funding to set up their connection, through an internet WAN connection, set up either via xDSL, cable, fiber, etc. and a Local Area Network (LAN) connecting school devices internally (via cable or, more often, through WiFi).

3) Bring Your Own Device (BYOD): in the spring of 2018, the Agence du Numérique has set up a working group to test the necessary technical and organizational conditions for the implementation of "BYOD" policies in schools. Ten institutes have volunteered for the pilot and will invite students to bring their own devices to school starting from the 2018-2019 academic year. Participating schools will be supported in defining user's guidelines and, if necessary, will be provided additional devices to ensure equality among students.

4) Cloud services: starting from the 2018-2019 academic year, the Walloon government has made Cloud services available to schools; this will allow teachers and students to access educational resources both at school and from home.

5) Baromètre "Education et numérique 2018": in order to assess the state of the art of digital education and the needs of the educational community, the Agence du Numérique has conducted a survey among principals and teachers between the months of May and September 2017. The survey resulted in a comprehensive report describing the state of digital education in the schools of the interested region and also produced policy recommendations.

In addition, the **German-speaking Community** decided to focus the school year 2017-2018 on the topic of Science and Technology in order to contrast the decreasing interest in STEM subjects among students. Schools were invited to take part in conferences, events and competitions as well as to submit project applications for the promotion of STEM skills.

4.2 Infrastructure Supporting ICTs and Robotics

In **Greece**, several schools have been equipped within the last 9-10 years and continue to be equipped with interactive boards and portable computer labs while their maintenance/upgrading is carried out on a regular basis. Many schools have acquired their equipment through various projects. Many more have been equipped with the help of Parents Associations and various local and national services. A small number of schools have acquired robots because of the initiative either of parents or of the school itself. Currently, the Greek government has not provided the schools with such equipment.

The objectives of the digital strategy for Greece are to reach (a) 75% use of ICT by teachers in the classroom, (b) 65% Schools with broadband, (c) 70% Schools with their own website, (d) 75% Students with e-mail accounts and (e) 8 Students per PC.

In primary schools of **Sweden**, there are about 1.8 students per computer and in upper secondary School 1.0 student per computer. Each public primary school has been supplied with (i) 2-4 ENGINO educational packs, (ii) 1 supporting material package including energy sources (photocell, manual generator, battery box, wind turbine), (iii) 1-2 PROBOT robots and supporting material, including PROBOTIX programming software (iv) Other software and free apps. Robotics equipment exists in schools for teaching.

In **Cyprus**, a concept mapping software was acquired and appropriately customized for all school and Staff personal computers of primary education. Several educational seminars/workshops are organized by the Pedagogical Institute of Cyprus in order to enhance the teacher's professional development.

In **Flanders** (**Belgium**), ICT-infrastructure policies are currently limited to telecom services and software provisions. The Flemish government negotiates framework agreements with telecom providers and software resellers in order to provide flat fees for educational institutions.

The **French-speaking Community** of **Belgium** has been very active in developing the digital capacity of their school network in recent years. A growing number of schools now have access to high-quality Internet connection, digital educational supports such as electronic white boards, PCs and tablets as well as Cloud services to store and share educational resources. All schools also have access to the calls for projects "École Numérique", among which programmable robots have made increasing apparitions. Robots allow pupils to familiarize themselves with the programming languages, which underlie the technology, the experience in their everyday lives and facilitate the learning process in science and mathematics. By May 2018, 800 robot-related projects had already been approved and funded by the Digital Wallonia strategy, each of them comprising the robots themselves, support in the development of the teaching program as well as specific teachers training. However, the number of robots available is as low as 3.6 per 10000 pupils, on average.

Comparing the above findings, we can conclude that **Greece** and **Cyprus** are behind in basic infrastructure and equipment compared to the north European countries of **Sweden** and **Belgium**. As it is clearly seen in the following comparison tables (I, II) basic infrastructure such as high-quality Internet connection or cloud services are not available in **Greece** and **Cyprus**, a fact that hinders further the use of ICT equipment in the classroom. It is also noted that all robotics equipment in **Greece** is bought by parents' associations or other non-government sources.

Table I: Equipment - Seminars - Workshops

Country	Equipment Type	Acquisition Source				Maintenance /Upgrading	Educational Seminars / Workshops
		Central Government	National or European Projects	Parents Associations	Local and/or National Services		
Greece	Interactive Boards		√	√	√	School staff	
	Portable PC Labs		√	√	√	School staff	
	Educational Robots			√		School staff	
Sweden	2-4 ENGINO Educational Packs	√					
	1 Supporting Material Package including Energy Sources (photocell, manual generator, battery box, wind turbine)	√					
	1-2 PROBOT Robots and supporting material, incl. PROBOTIX programming software	√					
	Other software and Free apps	√					
Cyprus	Concept mapping software	√					√
Belgium (Flanders)	Telecom services and software provisions	√					
Belgium (French, German)	Electronic white boards	√					
	PCs and tablets	√					
	Cloud services to store and share educational resources	√					
	“École Numérique”, among which programmable robots have made increasing apparitions	√					
	Robots available is as low as 3.6 per 10 000 pupils	√					

Table II: Infrastructure Objectives

	ICT Usage in Classroom by Teachers		Schools with Broadband Network		Schools with Own Website		Students with e-mail Accounts		Students per PC	
	From	To	From	To	From	To	From	To	From	To
Greece	36%	75%	30%	65%	37%	70%	44%	75%	17	8
Sweden									Primary 1.8, Secondary 1	Primary 1, Secondary 1
Cyprus									Primary 7	Less than 4
Belgium (Flanders)				Flat fees for educational institutions						
Belgium (French, German)			High-quality Internet connection	High-quality Internet connection						

4.3 Integration of Coding, Robotics and STEM Skills in the School Curriculum

In all partner countries, the necessity for introducing technology to pupils from the very beginning (not only from grade five or six) is identified and this should happen in equal measures among boys and girls. The proposed models focus not only on exposing pupils to technology but primarily on actively raising their interest through inquiry-based learning. For example, the “STEM Action Plan” of the Flemish community in **Belgium** notes that since fourth and fifth grade, students of primary schools should perceive an explicit attention for science and technology, since this will raise their interest in the topic and facilitate them in approaching STEM subjects in secondary school.

From a pedagogic point of view, the dominant model in most partner countries concerning STEM education is characterized by the combination of teaching "pure" IT lessons and the simultaneous integration of ICT as a cross-thematic means for the generic support of the learning process in various subject areas. For example, in **Greece** the factual pedagogical model is a combination of technocratic/techno-centric (which puts greater importance to Information Technology teaching and emphasis on technological innovation) and holistic (which considers as important the cross-thematic and holistic approach to knowledge with emphasis on disseminating ICT-related knowledge to the whole range of the curriculum as well as in the pedagogical innovation). From the partner countries, the **Flemish community** in **Belgium** is the only one where, in primary school, ICT is not taught as a separate subject but rather is integrated in the school curriculum as one cross-curricular objective.

In all other partner countries, distinct curricula for ICT have been developed and applied, while provisions have also been made in the curricula of various subjects for the use of ICT in the educational process. Furthermore, large-scale horizontal projects implemented during the past two decades introduced digital literacy in the school community and created a "critical mass" of teachers that utilize ICT in their school activities. During this first period, many educational software products and learning resources for school education have been developed within various national initiatives. These experiences are regarded to be valuable for the next steps on teaching supported by digital resources and the promotion of the digital school.

With respect to the integration of Coding-Robotics and STEM education into primary schools' curricula, the following can be noticed:

In **Greece**, Educational Robotics is not a teaching subject in public primary schools. Teachers, however, apply educational robotics activities and integrate them in their teaching driven from their personal interest and knowledge of the subject. Nevertheless, there is reference to Robotics in the new curriculum for Computer Science in primary education, which is taught by an IT teacher as a distinct subject in all classes of elementary schools for one (1) teaching hour per week. Learning objectives include "Modeling with conceptual charts" and "Programming the computer". At the same time, concepts of Robotics are presented in the individual modules of the curriculum for the 5th and 6th grades.

In **Sweden**, from autumn 2018 programming is included in primary schools, especially in the subject of mathematics and technology. In addition, several teachers have used educational robotics in their teaching but they all indicate that their own competence is limited.

In **Cyprus** the primary school curricula do not view ICT as a distinct subject but rather as a tool that has the potential to enhance teaching and learning. However, Robotics has been introduced since 2009 and today is a part of the 'Design and Technology' formal curriculum (2 periods per week in grades 5 and 6 for primary school), in the 'System and Control Technology' module, with the prospect to expand their presence in the near future. In Whole Days Primary Schools, ICT (and, in some cases, robotics) is taught as an extra-curricular topic. However, in the absence of teachers specialized in ICT, the Cypriot Ministry of Education and Culture:

a) formed a team of ICT advisors-consultants, consisting of seconded primary school teachers, with qualifications and expertise in ICT and

b) assigned a small number of teaching periods to one or two teachers in every school so that the teachers may have time to deal with ICT-related duties.

As far as **Belgium** is concerned, for the **Flemish community** ICT is considered to provide opportunities within all subjects and fields of study at primary school level. Therefore, ICT is not taught as a separate subject but rather is integrated in the school curriculum as one of three cross-curricular final objectives. One of the main initiatives implemented in the Flemish Community is KlasCement [15], an online platform where teachers and organizations can share educational resources and best practices with other users. KlasCement was initiated in 1998 to enable teachers sharing educational resources with each other; the idea was received with enthusiasm and the platform has since then grown at considerable speed. In the **French speaking community** of **Belgium**, education in technology is understood in a relatively broad sense as a course based on the idea of technology as a discipline that contributes to the overall training of young people just as much as general education courses do. More specifically, technology-STEM education is expected to contribute to the development of different ways of thinking and to favor the acquisition of a technological problem-solving approach with a technical object and/or technical concept as a support. In the **German speaking community**, primary school curricula are regulated by the Decree [16] establishing core competences and Framework plans in education. According to the Decree, the defined main objectives for primary school include the field of "Science and Technology", directly related to STEM. In this context, technology courses are intended for students to develop skills that will enable them to solve technical problems of everyday life, as well as to develop their creativity and crafting skills and to raise their interest in technology-oriented occupations. Nevertheless, according to the report "Education et Numérique" [17] mentioned above, only 30% of teachers in the **French-** and **German-speaking Communities** use digital devices in class. Therefore, the use of educational robots in primary schools, is still far from wide-spread.

A summarizing overview of the above findings is given in the following Table III.

Table III: Integration of Coding, Robotics and STEM Skills in Primary Schools

	ICT knowledge and skills	Integration of Coding	Integration of Robotics	Integration of STEM skills
Greece	YES 35% of teachers state they have used ICT for their lessons	YES very small percentage	YES very small percentage	YES very small percentage
Sweden	YES	YES	YES Teachers' competence is limited	YES
Cyprus	YES	YES small percentage	YES	YES
Belgium	YES see KlasCement [15]	YES 30% of teachers in the French- and German-speaking Communities use digital devices in class ("Education et Numérique") [17]		

4.4 Teachers' Training Programs in Coding, Robotics and STEM Skills

Although in most primary schools today infrastructure such as broadband Internet connectivity, dedicated computer labs and STEM equipment, are increasingly becoming more widely available, it is doubtful whether this IT infrastructure is used accordingly in the educational process by the teachers. The National reports from the partner countries reveal that the development of ICT infrastructure in schools is not supported yet by enough training courses for teachers. Despite the fact that several educational seminars and workshops are organized by the pedagogical institutes of partner countries, it seems that more effort is required to this end in order for the teachers' digital competencies to be enhanced. Hence, a large group of **Swedish** teachers indicates that they have learned on their own without the support of their employers. In the same context, school leaders from Sweden notice that they need skills development to be able to manage and exploit the available digital infrastructure at their schools. Evidently, this lack of STEM training might result in the development of a gap between the infrastructural and pedagogic capacity of primary schools in partner countries.

Furthermore, even though in all countries the training of the teaching staff is of priority, it seems that trained teachers are not confident to support STEM subjects in a classroom. Lack of technical knowledge represents a major hindering factor for the success of such train-the trainer workshops, as it appears that teachers do not attain actual confidence in what they have learned. The teachers' main concern remains how to acquire the necessary skills in order to use technology rather than the required knowledge to teach their subjects. It is worth noting that today in **Greece** 31% of teachers claim they have little or no experience of using ICT (EU average of 7%) and, also, 35% say they have used ICT for their lessons (EU average 74%). Similar, in **Belgium**, only 30% of teachers in the **French-** and **German-speaking Communities** use digital devices in class. Most teachers, however, regard STEM as part of all forms of teaching and that STEM teaching should be conducted by all types of teachers.

5. Empirical Research - Statistics

5.1 Profile of the Survey

Two different versions of questionnaires have been designed to identify the gaps of the existing curriculum in primary schools along with the weaknesses of teachers in the educational process of ICT, STEM Skills and Robotics. One version is aimed towards teachers and the other one towards students. The questionnaires' aim was to map the digital skills, challenges, mismatches and gaps of primary school students in the field of Educational Robotics and the digital needs, requirements and other opportunities for training of primary school teachers in this field as well as in the field of STEM. Closed type questions were used in both questionnaires, such as single and multiple-choice questions. The two questionnaires are given in the Appendix.

The results presented in this comparative report are based on the feedback from the three of the four consortium countries, i.e. Greece, Cyprus and Sweden. Belgium consists of three territorial divisions and the linguistic/cultural distinction between language Communities makes it difficult to draw general country-wide conclusions, thereby Belgium did not participate in this survey.

The Consortium decided to create and distribute the questionnaires both in print (sent out by post) and electronically, using Google Forms. Therefore, all the potential teachers-participants were equally likely to fill in the survey. On the other hand, the sample of student participants was based on teachers' participation. Teachers who showed an interest for the project and willingness to get involved in its next phases have supported and motivated their students to engage in this survey. The overall results are based on the feedback from 270 teachers and 526 students of various schools and disciplines, as per Table IV.

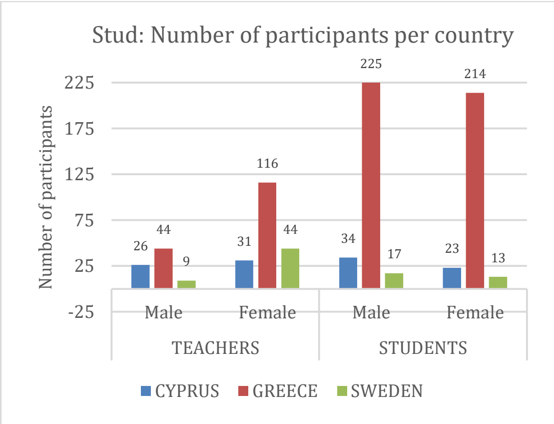
Table IV: Number of Questionnaires per Country

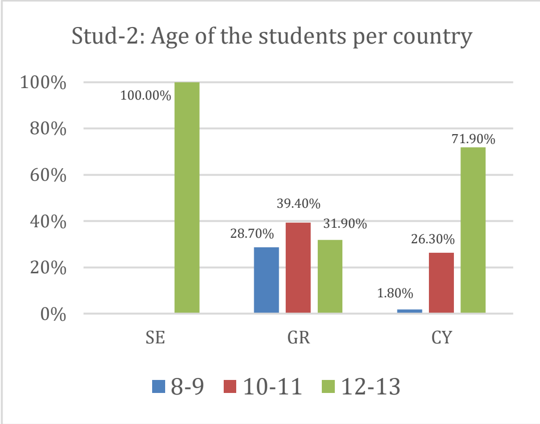
Country	Teachers	Pupils
Cyprus	57 (26 Male, 31 Female)	57 (34 Male, 23 Female)
Greece	160 (44 Male, 116 Female)	439 (225 Male, 214 Female)
Sweden	53 (9 Male, 44 Female)	30 (17 Male, 13 Female)
Total	270 (79 Male, 191 Female)	526 (276 Male, 250 Female)

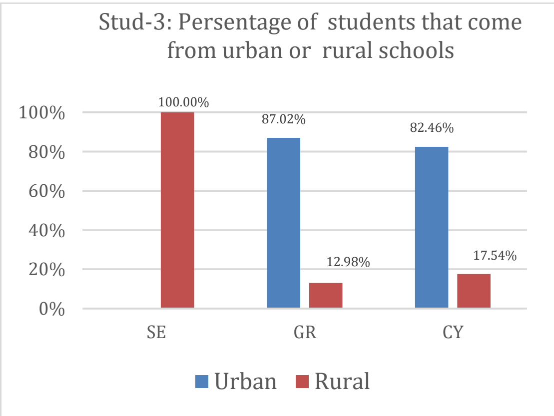
Regarding the gender of the participants, for the students the number of boys is slightly greater than that of the girls, whereas most of the teachers are female.

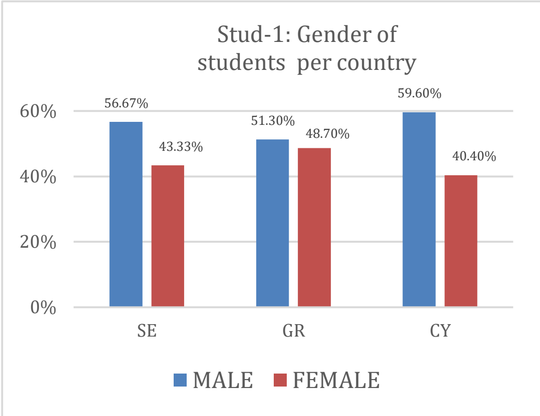
5.2 Results of the Students' Survey

The survey concerns students from the age of 9 to 13 (Stud-2) and most of them come from urban schools (Stud-3), while there was a slightly greater number of boys than girls (Stud-1). Although there is a relative balance per country in the number of boys and girls involved in the survey, the number of participants in Greece is about two to sixteen times bigger than that of the other two countries i.e. Cyprus and Sweden (Stud). Therefore, the results about Greece are more representative compared to those of the other countries.

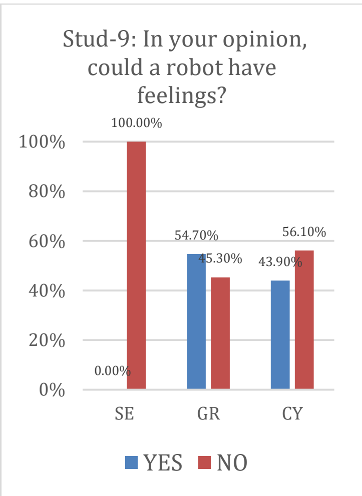


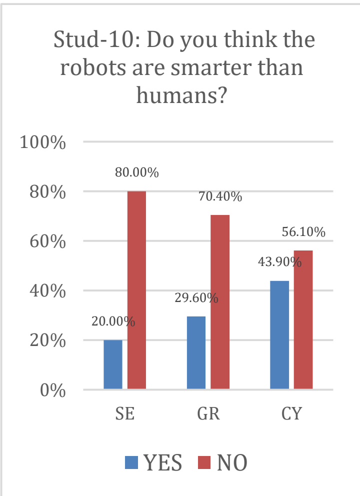


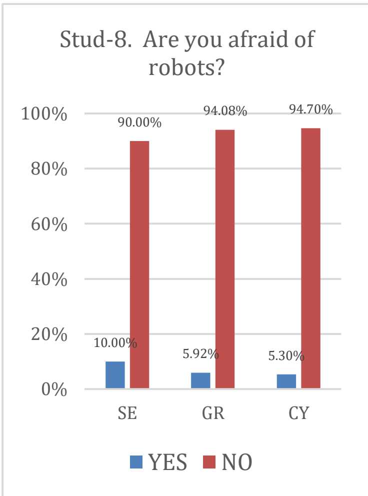




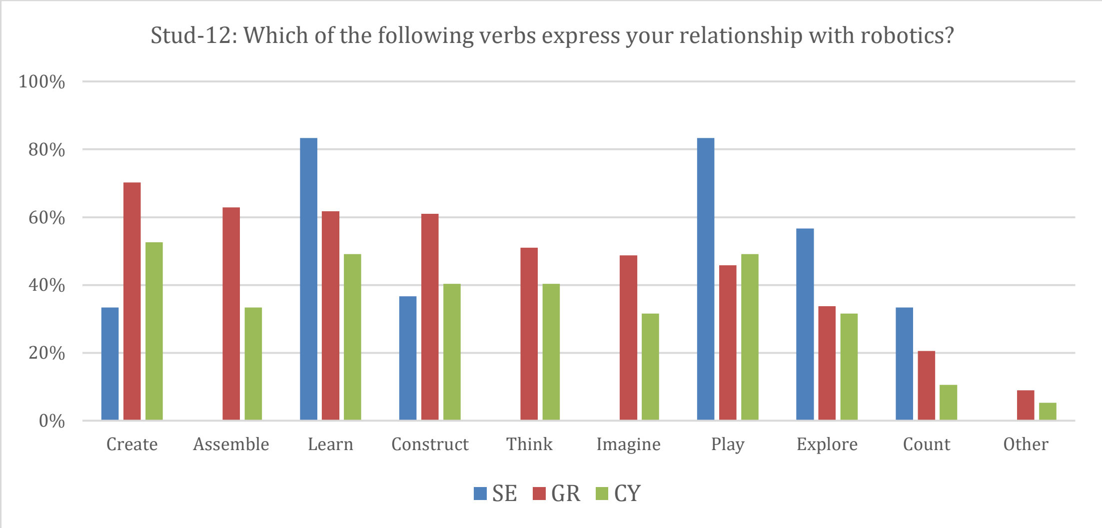
According to the survey, most students are not afraid of the robots (Stud-8) because they believe that they are not smarter than humans (Stud-10), but in contrast they are confused about whether the robots have feelings or not (Stud-9).

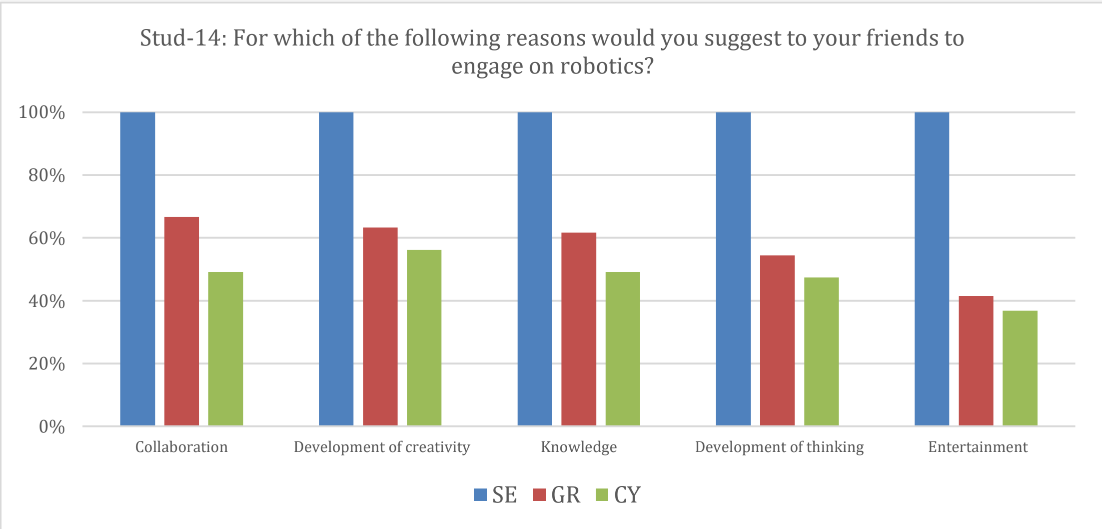




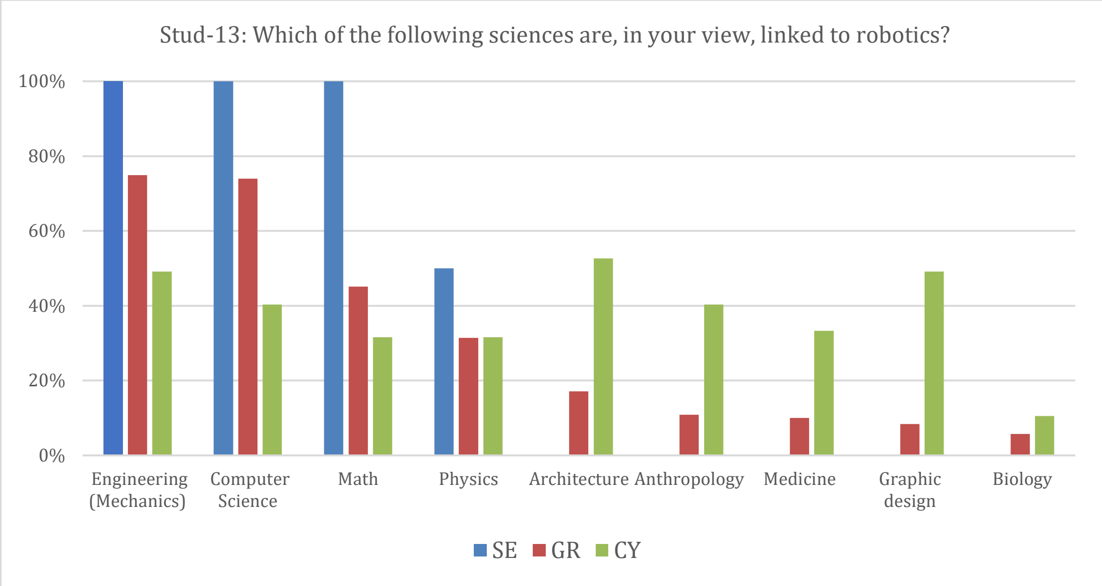


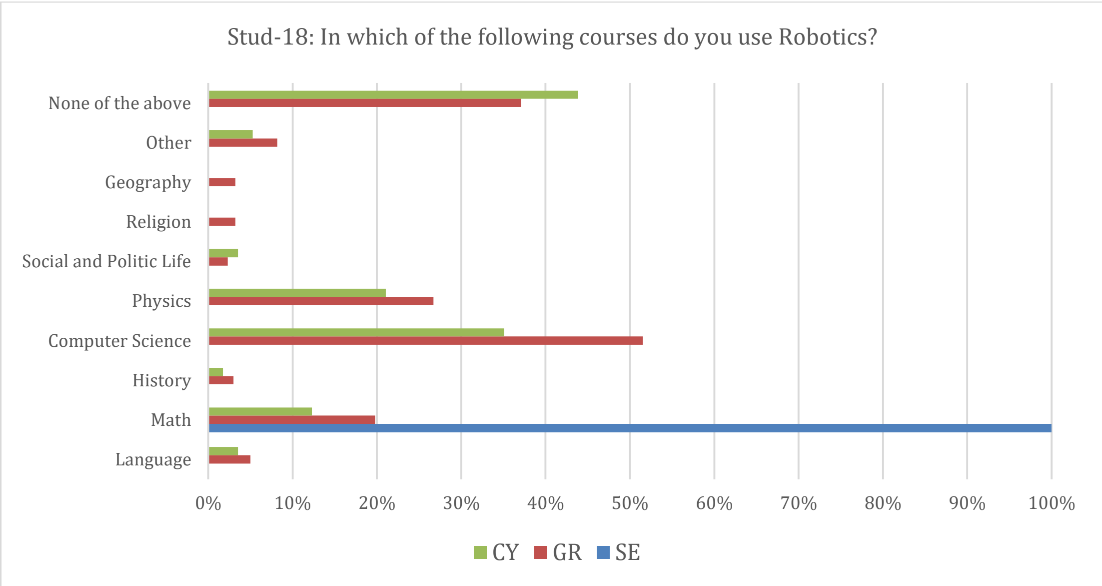
Moreover, students in all countries consider educational robots mainly to create, assemble or learn and partly to think, imagine or play (Stud-12). In addition, they believe that Educational Robotics can be used to enhance knowledge (Stud-14), creativity and collaboration among them.



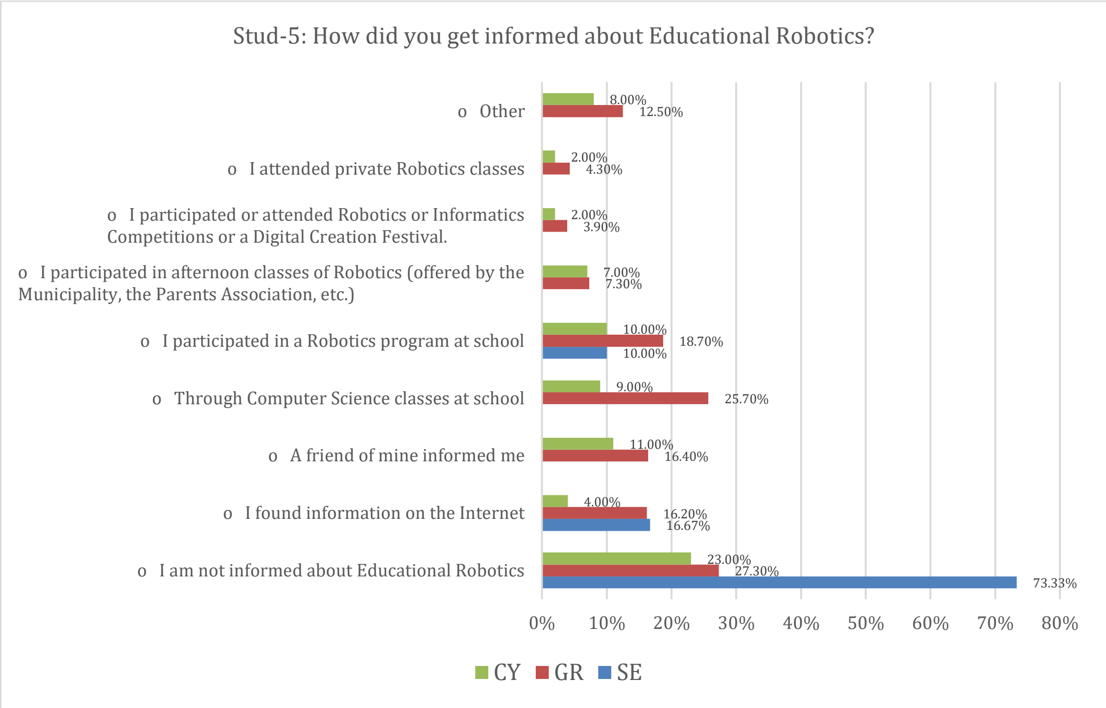


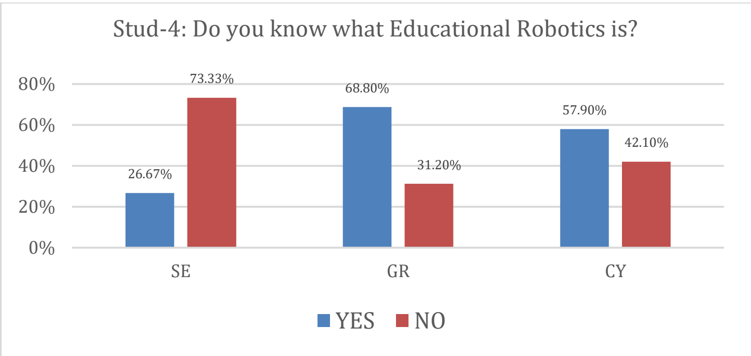
One point of interest is that, although students associate Robotics with the obvious Sciences of Engineering and Computer Science, they fail to relate them with the other STEM topics, like Physics or Math (Stud-13, Stud-18).



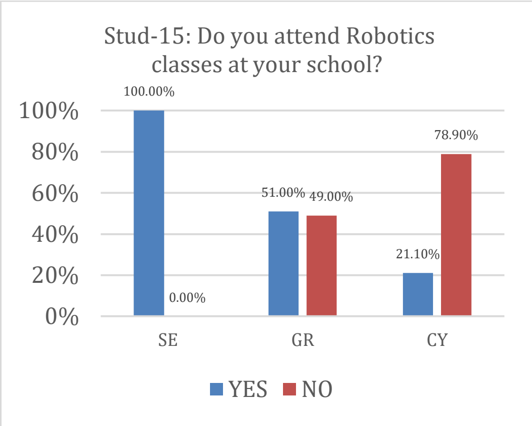


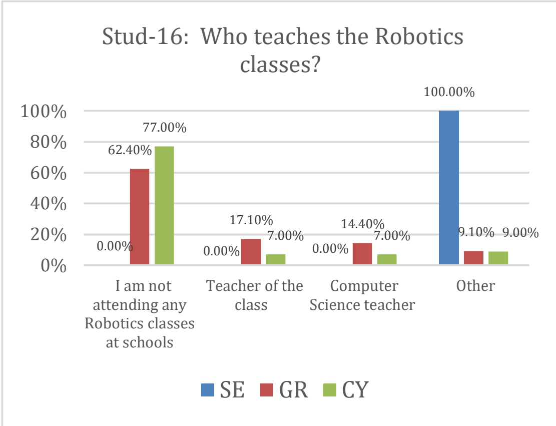
Despite only a small number of students having participated in organized Robotics programs at schools (Stud-5), the majority of them from Greece and Cyprus (68% and 57,9%, see Stud-4) are aware of the term «Educational Robotics». On the other hand, the majority of the students in the Swedish survey (73,33%, see Stud-4) appear to not be familiar with this term. This might be explained due to the fact that all the participating students came from provincial schools in Sweden.



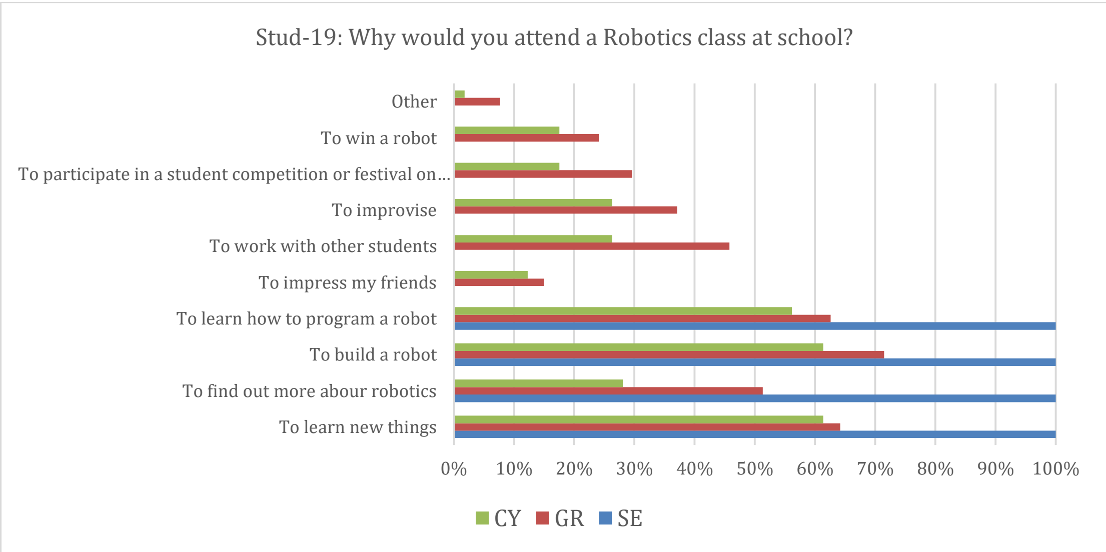


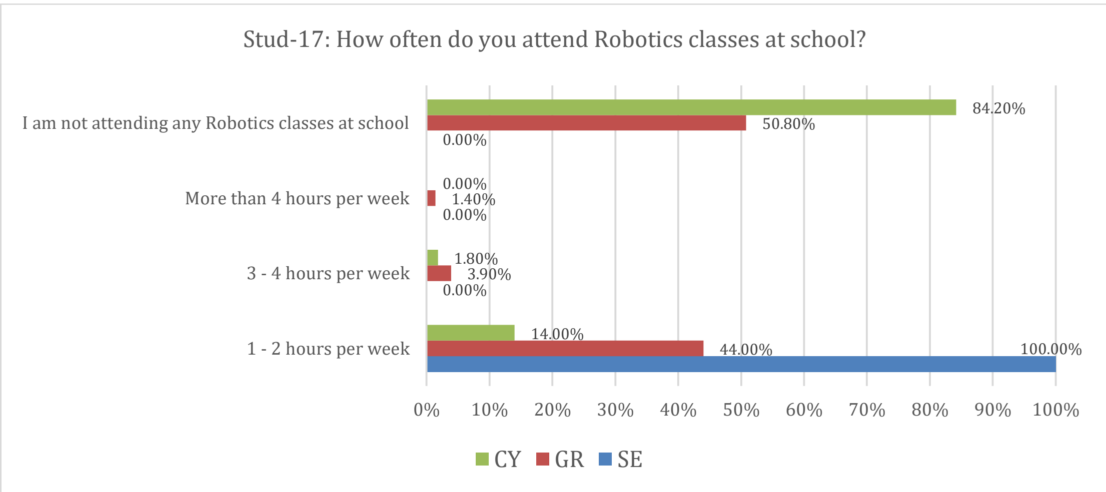
These contradictions also exist in (Stud-15, Stud-16) from which it appears that students from Sweden are confused about the meaning of Educational Robotics despite the fact all of them have attended Robotics classes at their school. Similarly, even if 51% of Greek students answered that they are attending Robotics classes at their school, in the question about who teaches the Robotics class, 62,4% answered that they were not attending any such class. These observations suggest that more emphasis should be given in explaining, as well as popularizing the term «Educational Robotics».





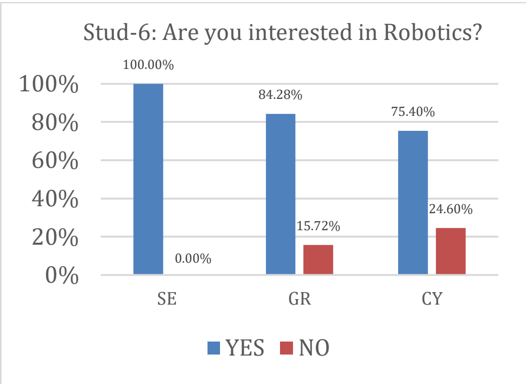
As indicated in (Stud-19), most of the students have already understood the importance of programming and also would like to attend a Robotics class in their school to build a robot, learn new things and especially to learn how to program a robot. Although students seem to be considerably interested in Educational Robotics and perceive it as a creative, exploratory way of learning that favors cooperation, they have not been given the chance to experiment in that field (Stud-17).

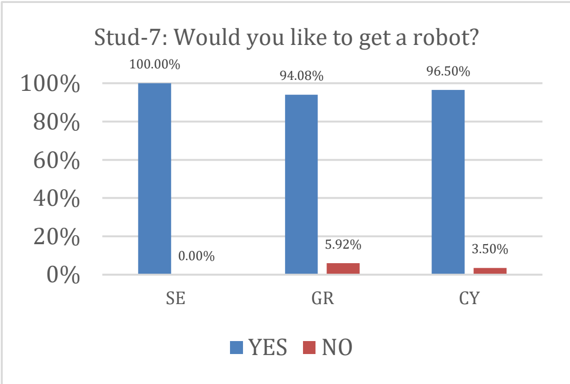


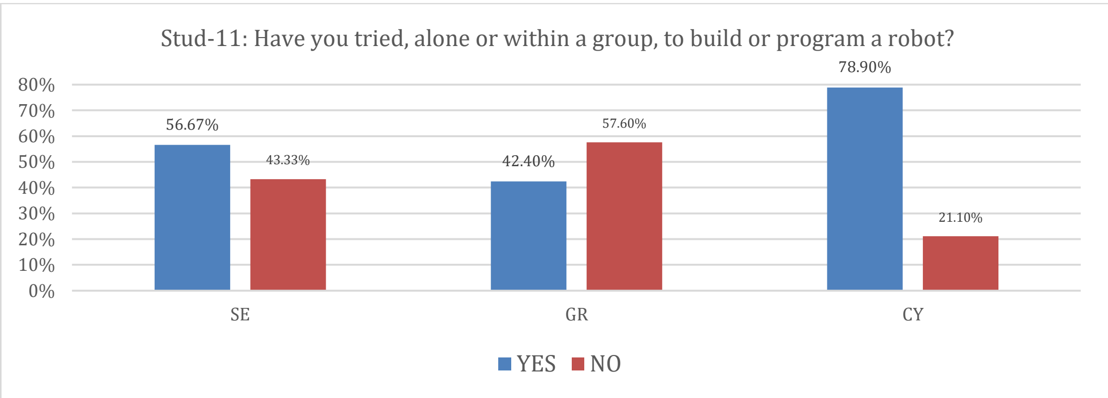


Students in the survey were also asked about a hypothetical robot they would like to build and what capabilities it would have. A significant number of students proposed the construction of a robot that would be able to aid the elderly and people with special needs or diagnose and propose a treatment for diseases. Many participants would want to construct a robot that would help with housework or that would transform itself into a means of transportation.

Although almost all students are very interested in Robotics (Stud-6), only half of the participants have already tried to build or program a robot (Stud-11). This implies that more Educational Robotics kits must be given to schools (Stud-7) and the constructionist approach can be used by teachers to design and implement robotics projects to engage their students in exploring new concepts and learning different ways of thinking i.e. improve their STEM skills.



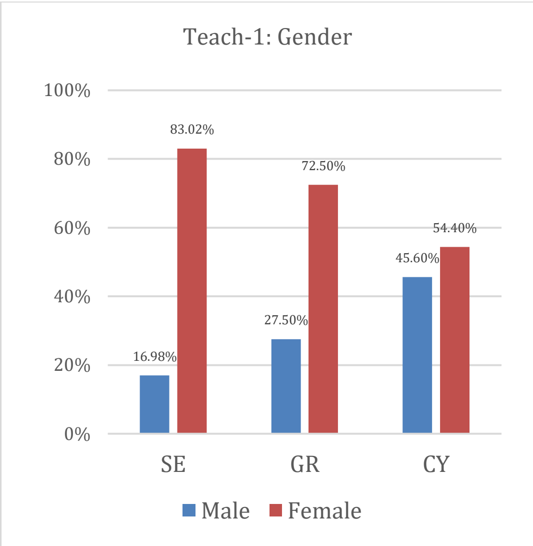


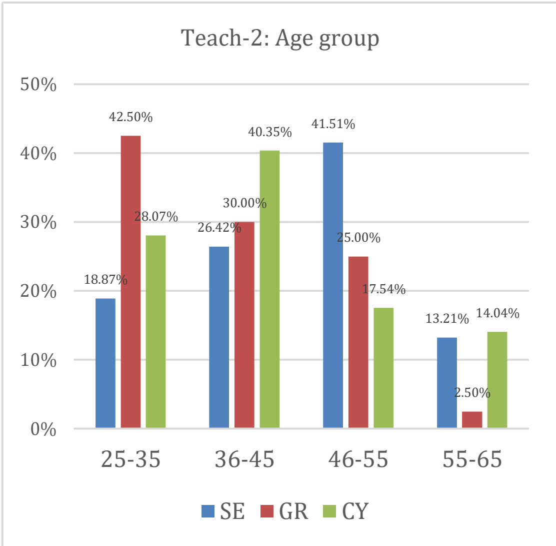


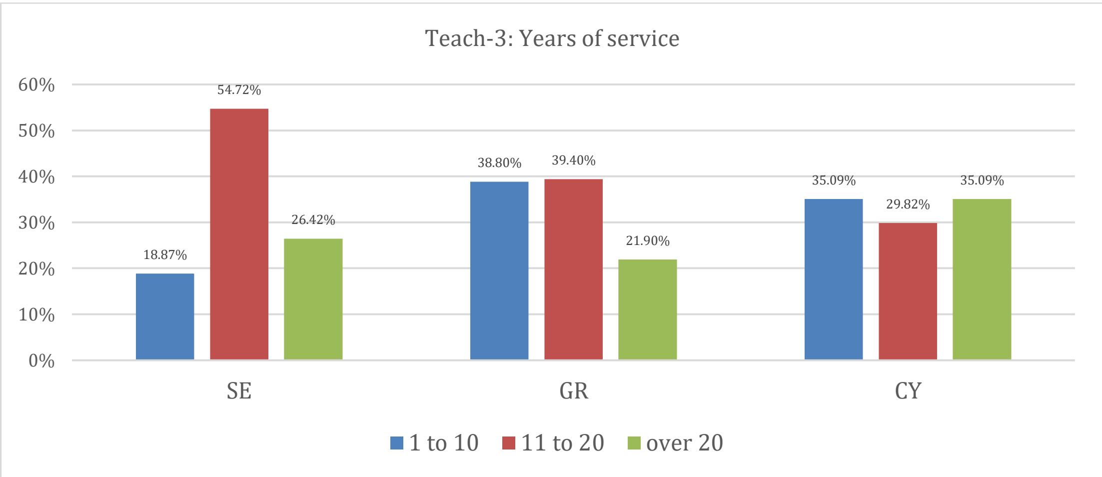
Overall, all the above results show that educational robots attract the interest of the students and can be used to teach students how to program and also how to practice their STEM skills.

5.3 Results of the Teachers' Survey

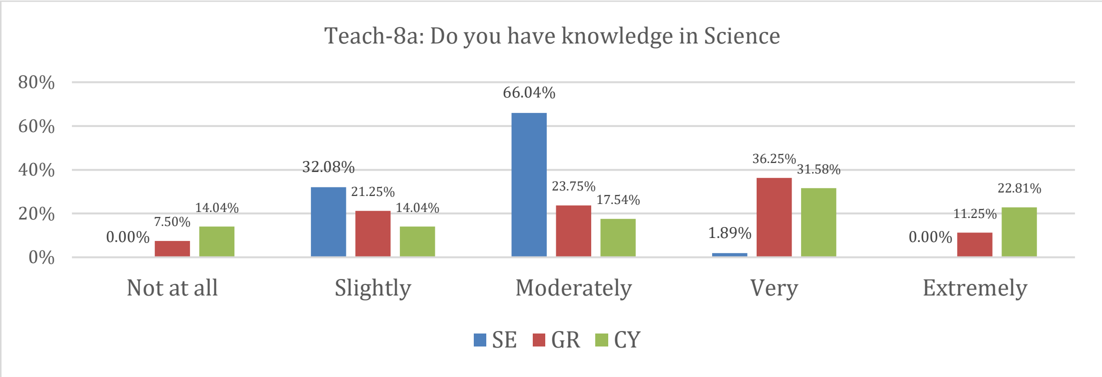
The teachers' survey involved 160 teachers from Greece, 57 teachers from Cyprus and 53 teachers from Sweden. Most of them were female for all three countries (Teach-1), for Greece and Cyprus between 25 and 45 years of age, and for Sweden between 35 and 55 years of age (Teach-2). The majority of teachers from Greece had between 1 and 20 years of service, while most of the teachers from Sweden had at least 10 years of service. The sample from Cyprus was equally balanced in the ranges of 1-10, 11-20, and over 20 years of service (Teach-3).

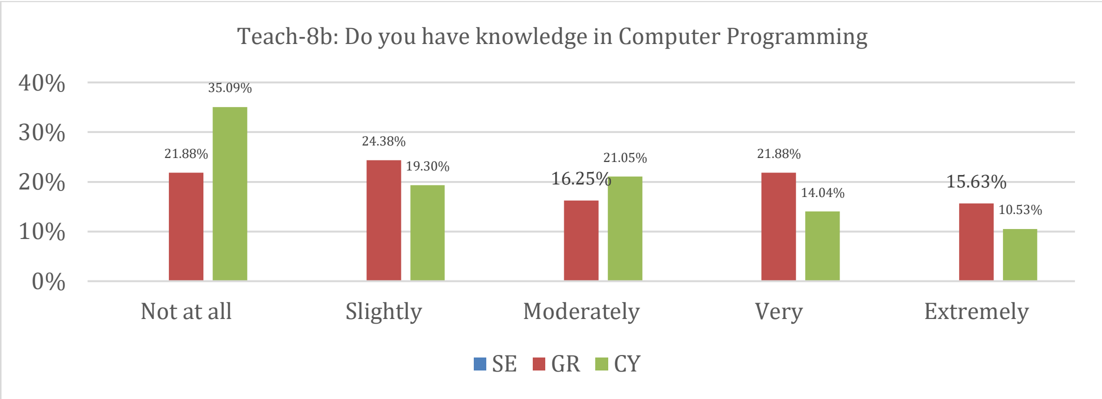


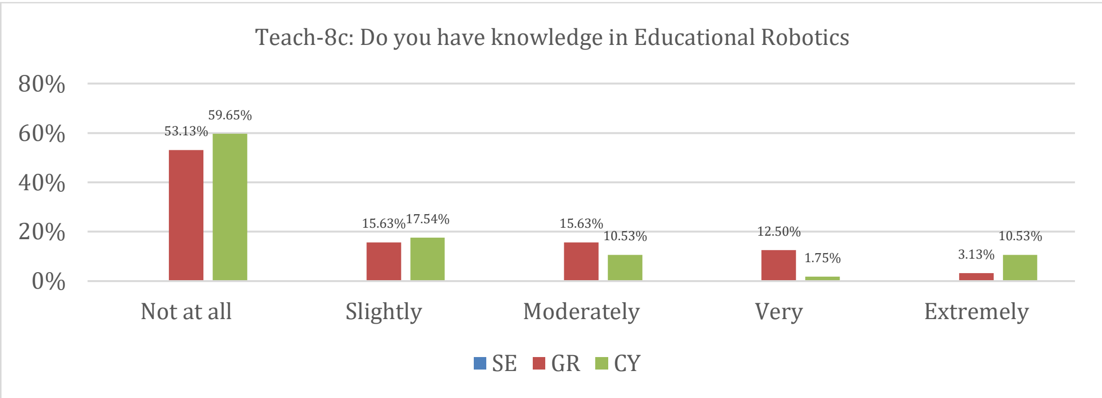




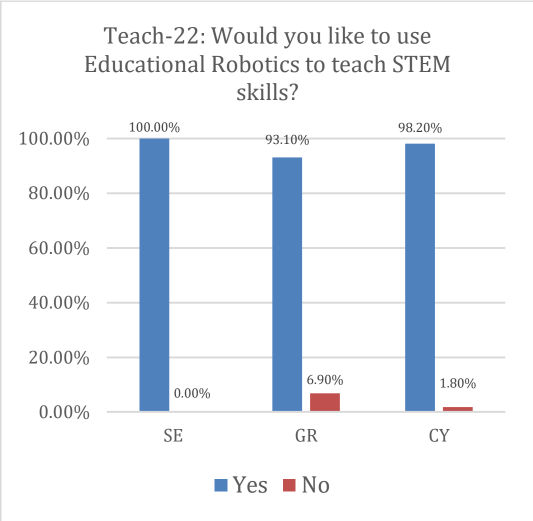
The teachers' background with respect to their knowledge of Science, Computer Programming and Educational Robotics is summarized in (Teach-8a:c).

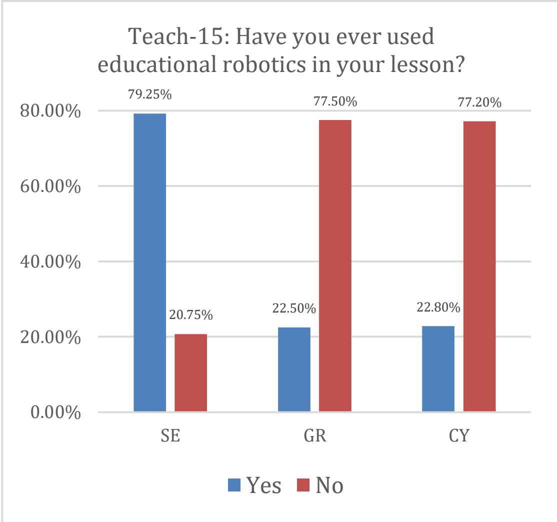


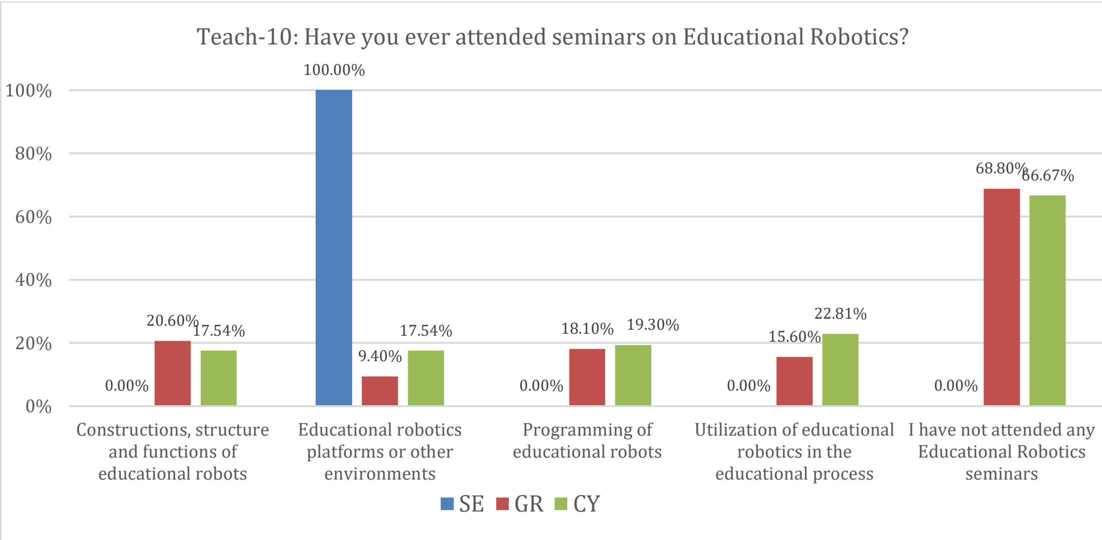


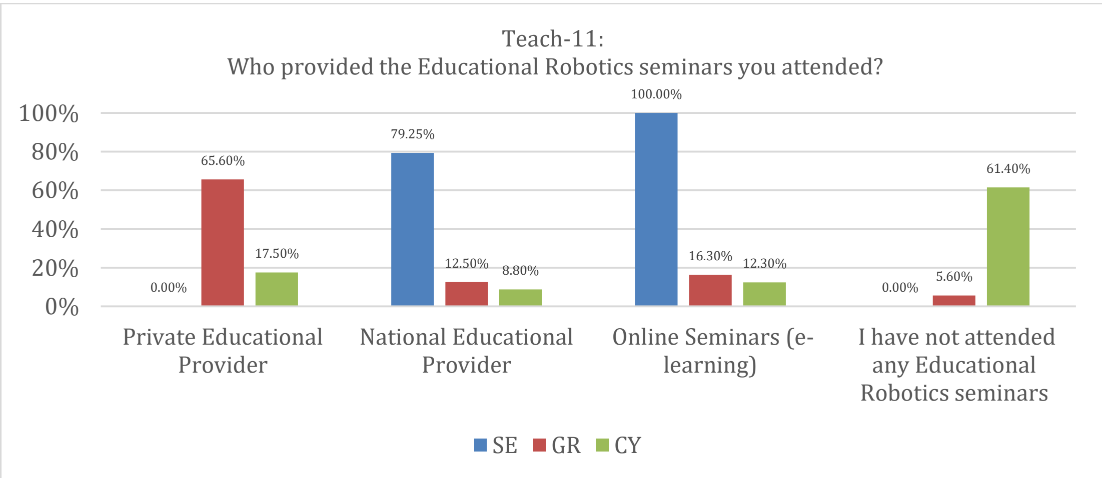


Probably the foremost finding to emerge from the teachers' survey is that their vast majority (over 93% in all three countries) expressed a keen interest to employ Educational Robotics to teach STEM skills (Teach-22). However, for Greece and Cyprus in particular, there is a distinct gap with the existing situation since less than 25% (Teach-15) of the teachers from these countries have used Educational Robotics in their lessons (the corresponding percentage for Sweden in significantly higher, nearing 80%). Along similar lines, the majority (around 70%) (Teach-10) of teachers from Greece and Cyprus have not attended any seminars on Educational Robotics, in distinct contrast to the survey's results for Sweden, where teachers have attended seminars by national educational providers and e-learning organizations (Teach-11).

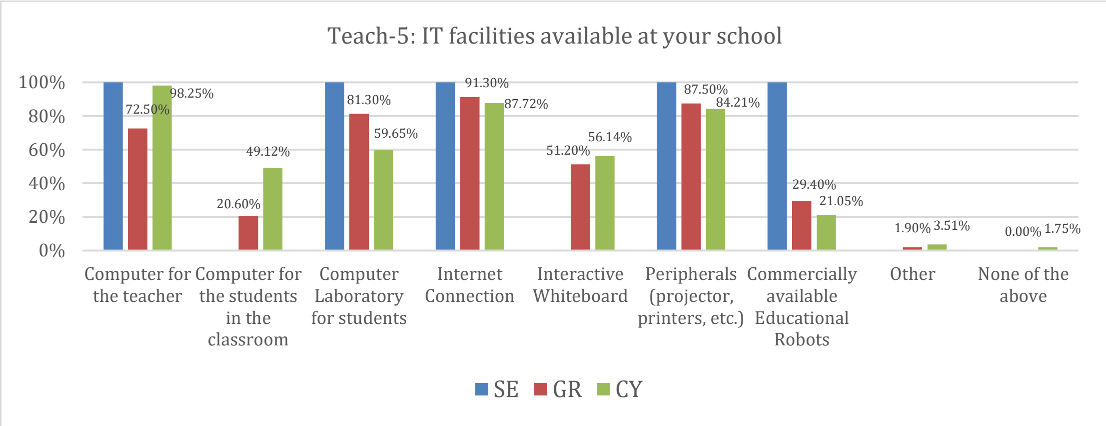




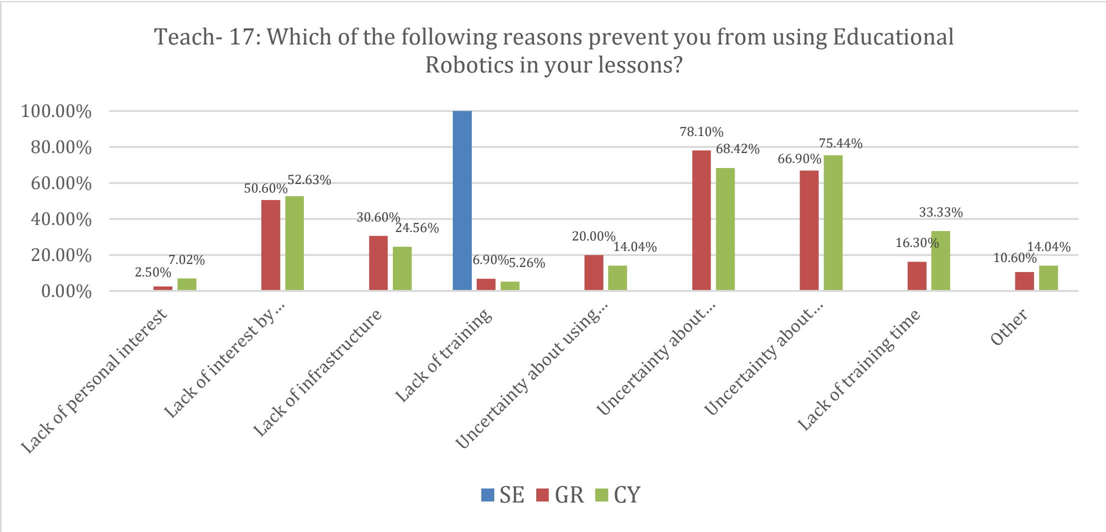




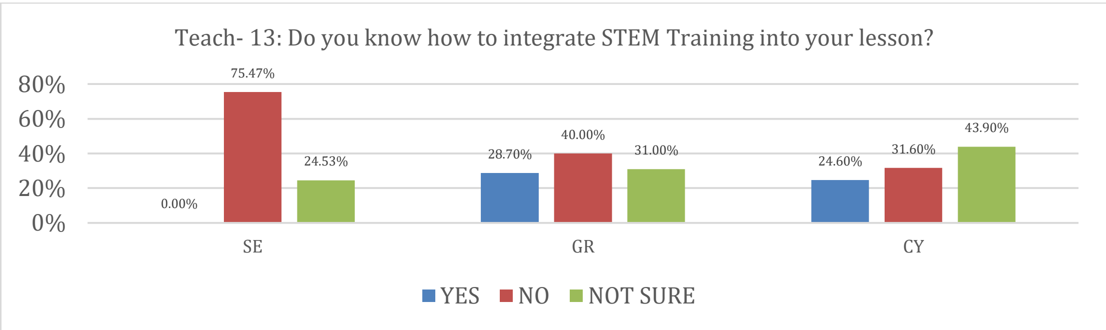
These findings are consistent with the survey's results for the schools' facilities, where, although general IT infrastructure can be deemed adequate for all three countries, only a small percentage of schools in Greece (30%) and Cyprus (21%) have access to educational robotic platforms, in contrast to schools in Sweden (Teach-5).

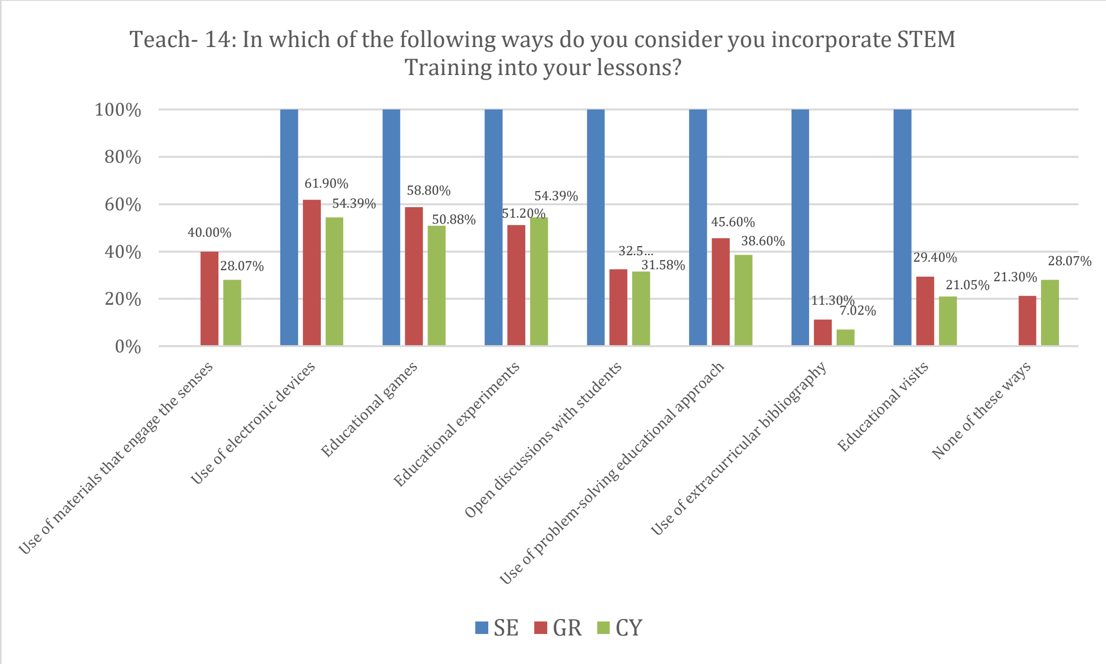


In Greece and Cyprus uncertainty about motivating/engaging students and uncertainty about technical issues, followed by a claimed lack of interest by the school's management, are the most prominent reasons preventing teachers from using Educational Robotics (Teach-17). According to the Swedish survey, lack of training is the sole limiting factor for teachers from Sweden.

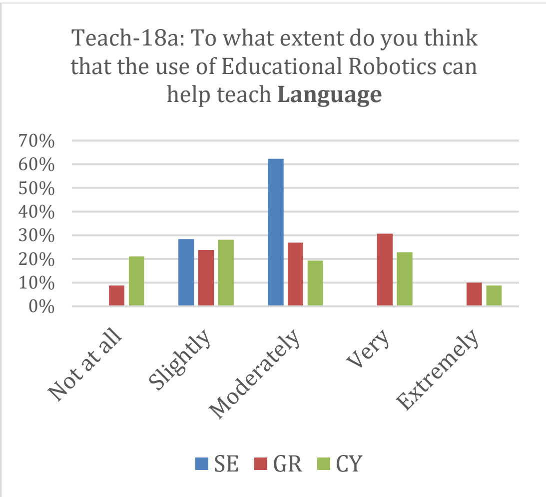


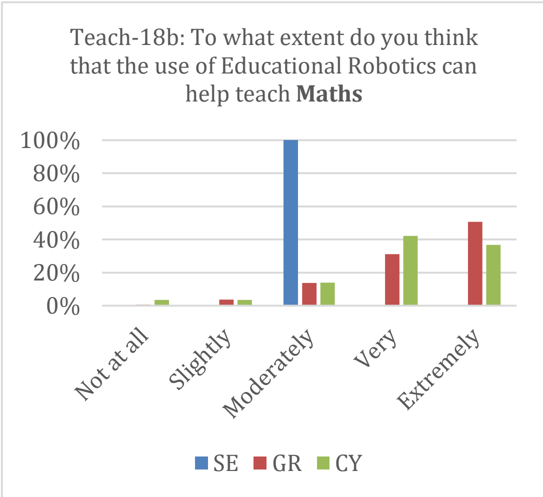
It is also worth noting that integrating STEM training in the lesson is deemed quite challenging for teachers from all three countries (Teach-14), while the use of electronic devices (tablets, computers), educational games, and educational experiments are considered as the most appropriate means for incorporating STEM training into their lesson (Teach-17).

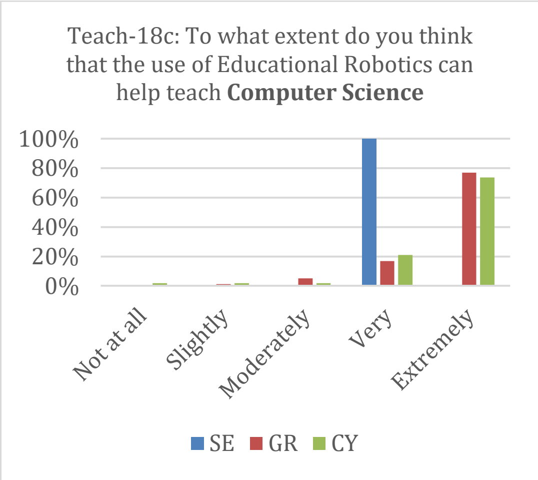


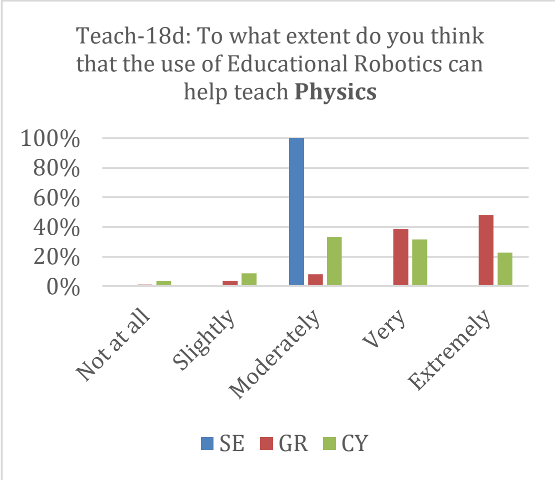


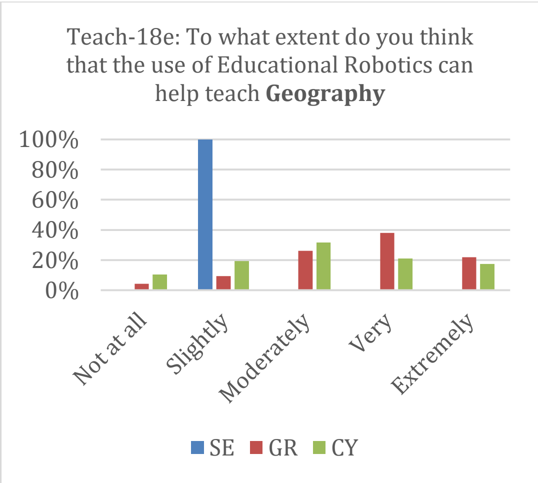
As seen in (Teach-18a:h), Computer Science, Maths and Physics are the lessons identified by teachers from all three countries as the most likely to benefit from the use of Educational Robotics, whereas Language, History and Art are considered as the least likely ones. Notable discrepancies between the teachers' views on this particular question concern the lessons of Foreign Language, Art and Geography, which teachers from Greece and Cyprus consider to be more likely to benefit from Educational Robotics as compared to teachers from Sweden.

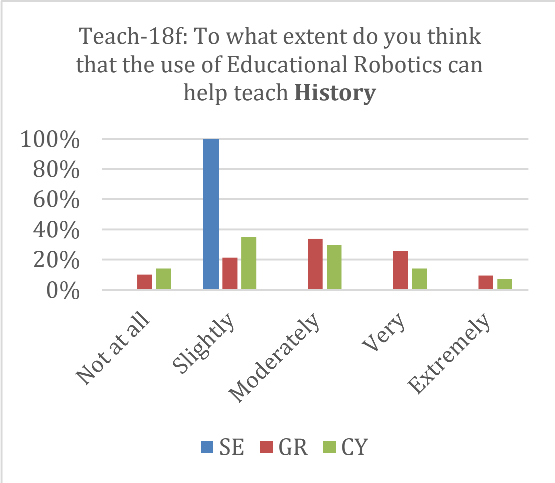


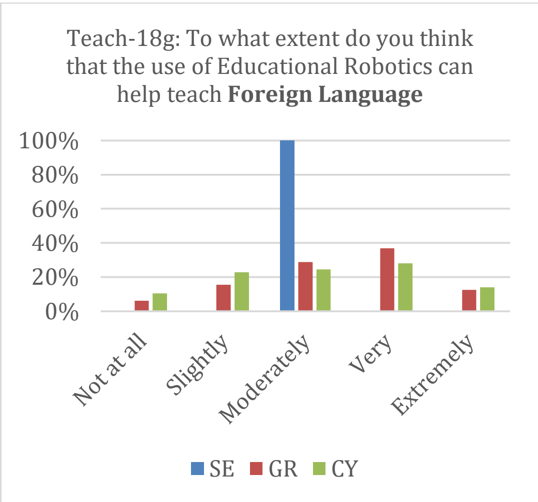


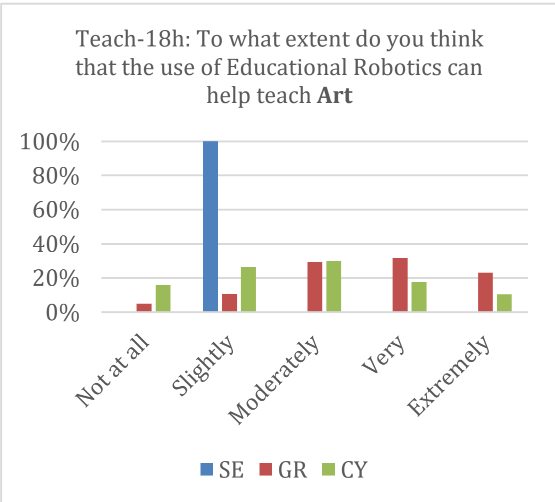






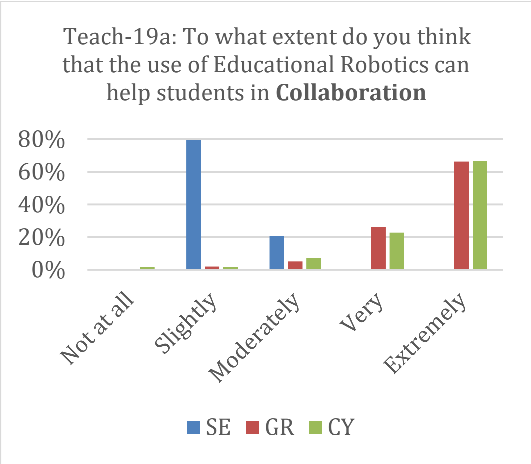


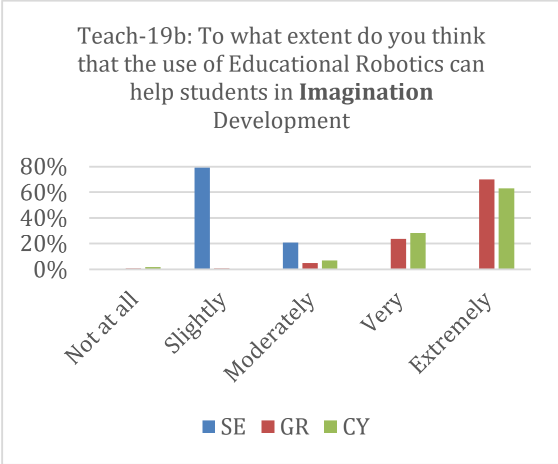


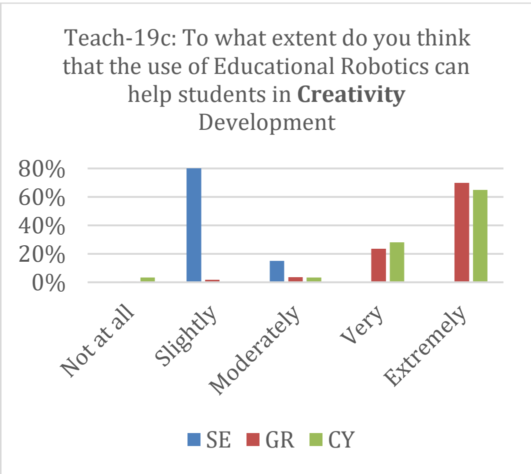


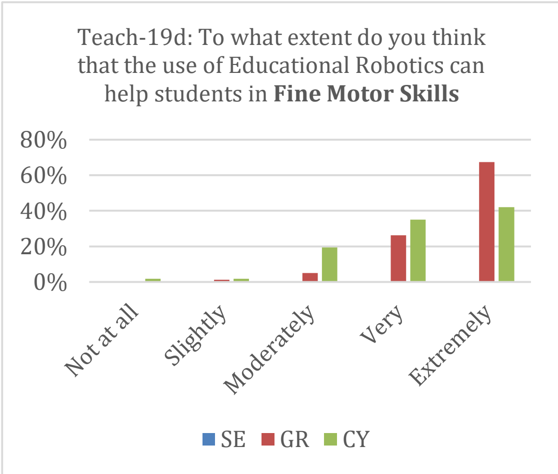
In addition, teachers from Greece and Cyprus consistently appear to be very positive about the potential of Educational Robotics to help students develop their skills in terms of collaboration, imagination, creativity, inventiveness, fine motor, problem solving, data analysis and presentation, as well as aid in the development and enrichment of learning strategies, enabling of expression of ideas and opinions, and active engagement of students in the learning process. By contrast, the results of the

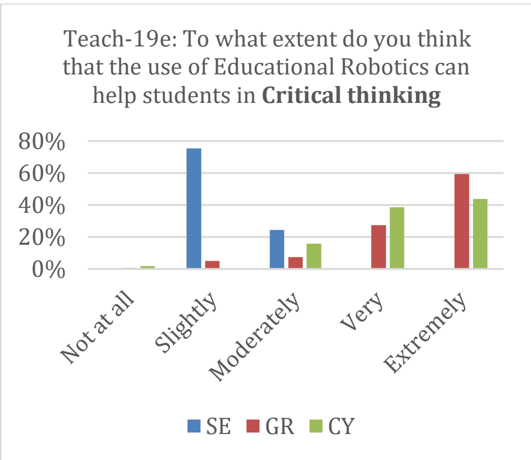
Swedish survey suggest a far more skeptical attitude towards this potential, expecting only slight or moderate contributions in these areas and skills by the use of Educational Robotics (Teach-19a:l).

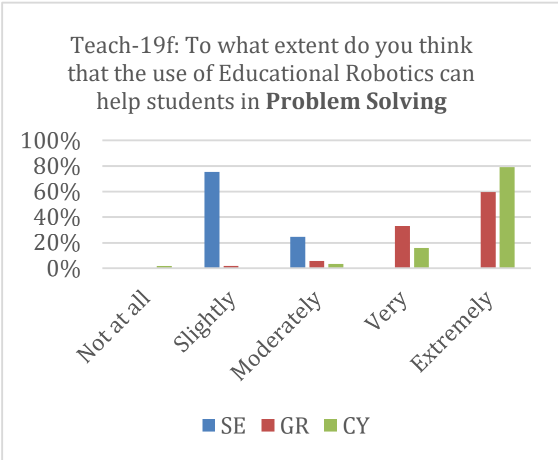


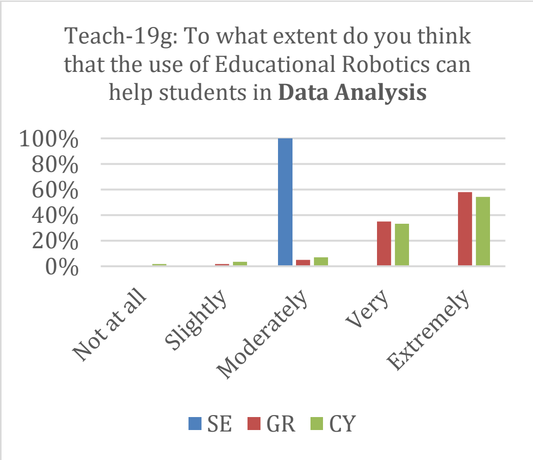


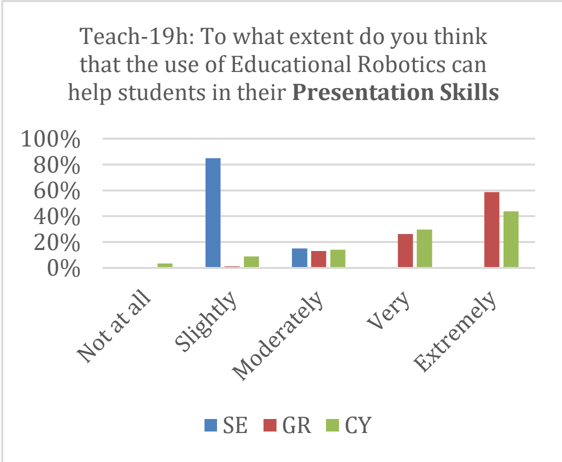


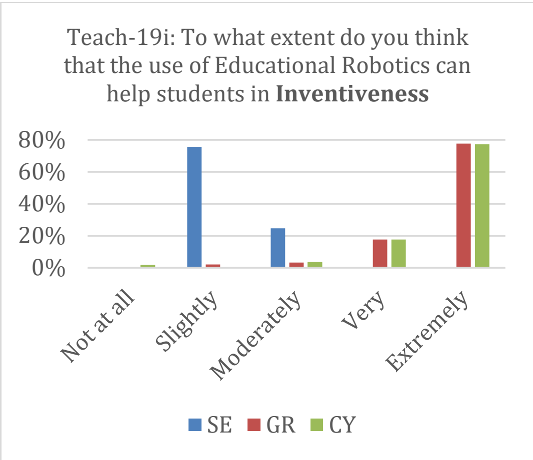


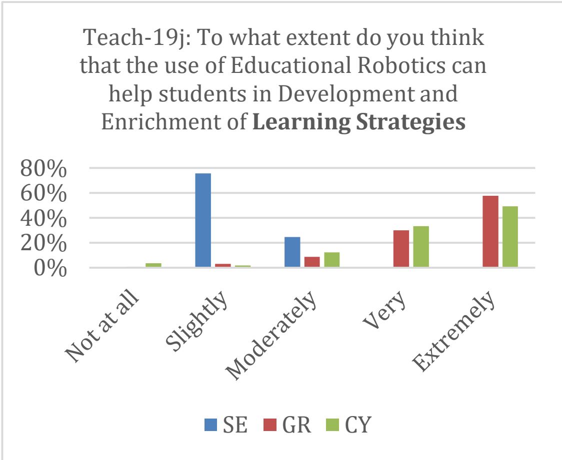


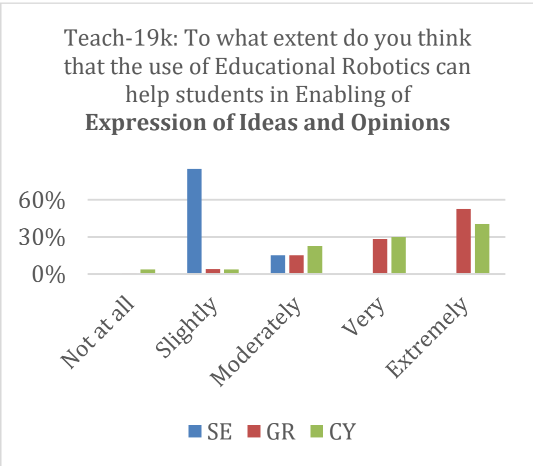


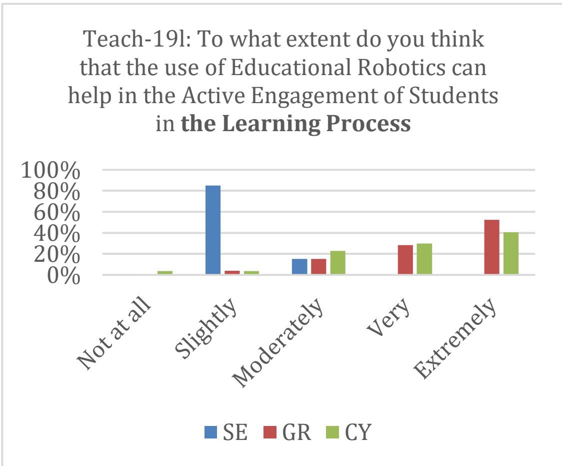




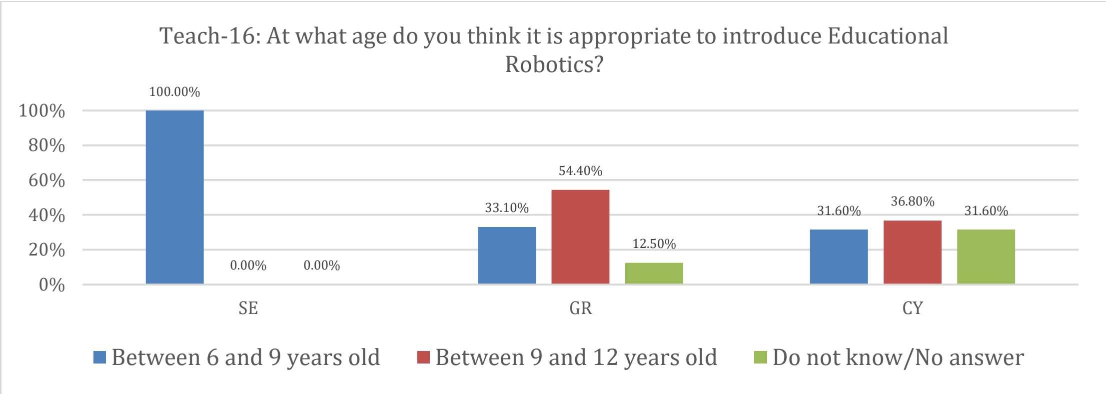


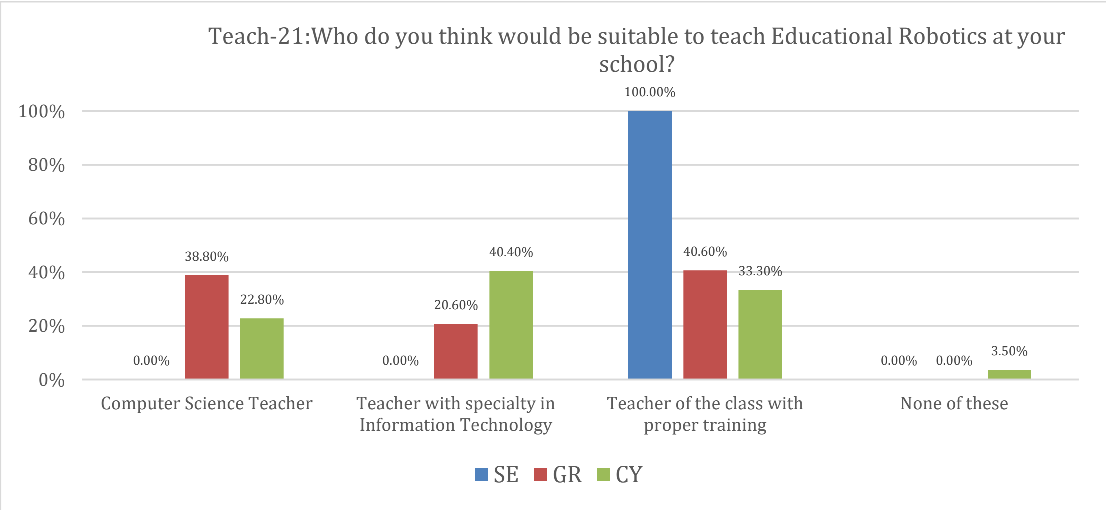


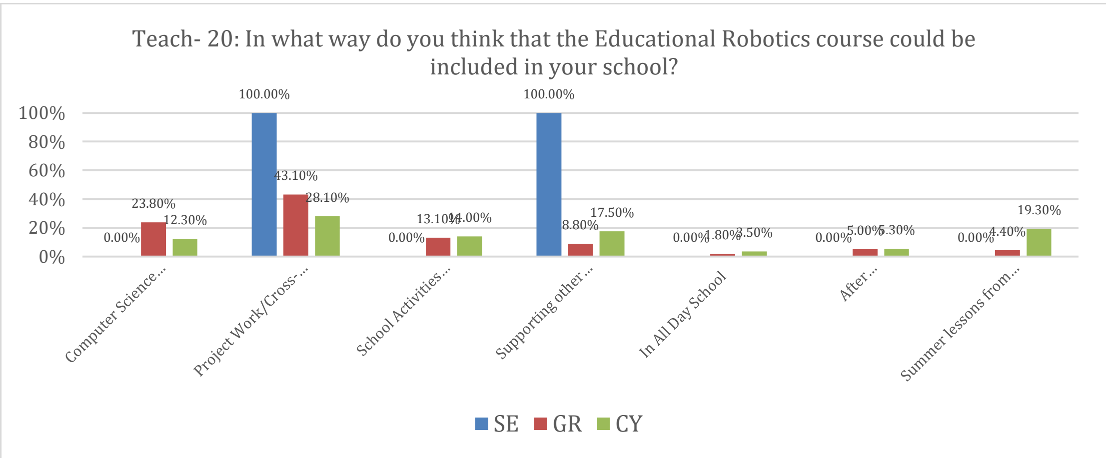




Teachers from Sweden believe that Educational Robotics should be introduced to pupils at a younger age (i.e. between 6 and 9 years old), compared to teachers from both Cyprus and Greece where the majority thinks that the appropriate age is between 9 and 12 years old (Teach-16). In Greece and Sweden, the majority of the teachers believe that Educational Robotics should be taught by the teacher of the class with proper training, whereas in Cyprus a teacher with specialty in IT is thought to be the most appropriate option (Teach-21). In all three countries, project/cross-curricular work appears to be the most preferred way for the teachers to incorporate Educational Robotics in their lesson (Teach-20).







The answers from teachers in Cyprus and Greece exhibit, for the most part, similar trends, most probably due to similarities in the educational system and the mentality.

6. Results and Conclusion

The issue of digital skills is not new to the European policy agenda and has been discussed in different policy documents since the late 1990s, when computers and the Internet first started to influence the economy, the labor market and society as a whole. As far as the implementation of such policies is concerned, the present report shows that the use of digital technologies to support teaching and learning enjoys widespread support from national authorities in Europe, since all partner countries, more or less, have formulated national policies for ICT in education, either as standalone policies or as part of a wider national strategy.

The strategic emphasis of these policies remains on fostering the students' digital competences, as justified by future economic benefits. Their operational aspects focus mainly on teacher training and on the provision of up-to-date technology and infrastructure for schools. Overall, policy direction and vision are found to be developed largely by national administrations while operational policy decisions are often taken in a decentralized way, allowing freedom for local administrations and schools to experiment with and shape their own policies within some top-down parameters.

However, this distinction is in favor of imparity so not all students or teachers can benefit from digital education policies. Hence, a significant implementation gap between national-level strategic objectives and their local-level operationalization persists. For example, while at strategic policy level teacher training is a priority, in most countries teachers' attendance at ICT training is not compulsory. However, this gap is obvious not only within the administrative borders of a country, but also between the partner countries. For example, the Mediterranean partners from Greece and Cyprus seem to be behind in educational infrastructure and equipment compared to the north European partners from Sweden and Belgium. This unbalanced situation in Europe regarding digital skills in education is inevitably found also in STEM and robotics education. The latter inherits the aforementioned issues of the former, since educational policies, students' education and teachers' training formulate a triangle that seems not to be very well shaped yet. This landscape is illustrated in the results from the empirical research survey that was conducted in Greece, Cyprus and Sweden in order to identify the gaps of the existing curriculum in primary schools along with the weaknesses of teachers in the educational process of ICT, STEM Skills and robotics. Two different questionnaires were designed; one for students-pupils and another for primary school teachers.

As far as the survey of the students is concerned, it seems that most of the students have already understood the importance of programming and would like to attend an educational robotics class in their school to build and program a robot or learn new things about science and technology. However, more emphasis should be given to explain the term of Educational Robotics. Although students seem to be considerably interested in Educational Robotics and perceive it as a creative, exploratory way of learning that favors cooperation, they have not been given the chance to experiment in that field. Therefore, more educational robotics kits must be given to schools and the constructionist approach can be used by teachers to design and implement robotics projects to engage their students in exploring new concepts and learning different ways of thinking i.e. improve their STEM skills.

The survey also revealed the interest and motivation of teachers, from all three countries, to employ Educational Robotics in their lesson, identifying its potential for significant positive contributions in the teaching of a wide variety of lessons (e.g., Maths, Physics, Foreign Languages and even Geography) and skills (e.g., problem solving, creativity, collaboration, inventiveness and presentation ability) that transcend the STEM fields. However, this enthusiastic attitude is counterbalanced mainly by a lack of training regarding not only technical aspects but also how to best integrate Educational Robotics in the classroom. For Cyprus and Greece (but likely also for other European countries) additional factors such as support from the school's management and access to resources (educational robotic platforms) should also be addressed in order to realize the potential of Educational Robotics.

CODESKILLS 4ROBOTICS

References

[1] COM(2015)408 - Draft 2015 Joint Report on the implementation of the Strategic framework for European cooperation in education and training (ET2020)

https://www.eumonitor.eu/9353000/1/j9vvik7m1c3gyxp/vjwz4owo0oxk

[2] Digital Education Action Plan (17 January 2018), retrieved from:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:22:FIN.

[3] National Report: Country Greece, CODESKILLS4ROBOTICS Project No.: 2018-1-EL01-KA201-047823, March 2019

[4] National Report: Country Cyprus, CODESKILLS4ROBOTICS Project No.: 2018-1-EL01-KA201-047823, March 2019

[5] National Report: Country Belgium, CODESKILLS4ROBOTICS Project No.: 2018-1-EL01-KA201-047823, March 2019

[6] National Report: Country Sweden, CODESKILLS4ROBOTICS Project No.: 2018-1-EL01-KA201-047823, March 2019

[7] https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm

[8] http://www.aic.lv/ace/ace_disk/Bologna/contrib/EU/e-learn_ACPL.pdf.

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016DC0381

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0607(01)&rid=2

[11] https://ec.europa.eu/jrc/en/digcomporg/framework

[12] https://codeweek.eu/

[13] McEwan, P. J. (2015). Improving Learning in Primary Schools of Developing Countries: A Meta-Analysis of Randomized Experiments. Review of Educational Research, 85(3), 353-394; mentioned in Digital Education Policies in Europe and Beyond – Key Design Principles for More Effective Policies (European Commission, Joint Research Centre, 2017), p. 14, retrieved from:

https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/digital-education-policies-europe-and-beyond-key-design-principles-more-effective-policies

[14] OECD report Students, Computers and Learning – Making the Connection (2015); retrieved from:

http://www.oecd.org/publications/students-computers-and-learning-9789264239555-en.htm

[15] https://epale.ec.europa.eu/en/content/klascement-oer-platform

[16] (Dekret zur Festlegung von Kernkompetenzen und Rahmenplänen im Unterrichtswesen) of June 16, 2008 see:
http://documents.dgparlament.be/dltdownload/ezgQLGtDid5oap81AxA_wIMG4KmkbS40535rOVCnS_Df.pdf

[17] Baromètre 'Education et numérique 2018'; see

https://www.digitalwallonia.be/fr/publications/education2018

Appendix

Educational Robotics Questionnaire for Students

This research is being carried out under the Erasmus + Programme "Coding and STEM Skills through Robotics: Supporting Primary Schools to develop inclusive Digital Strategies for All (CODESKILLS4ROBOTICS)". The project is funded by the European Union and has a duration of 28 months (September 2018 - December 2020). The project includes six partners from Belgium, Cyprus, Greece and Sweden.

The project attempts to design and implement an innovative training program for primary school pupils and teachers, aiming at the introduction of educational robotics and the necessary programming concepts in schools. The results of the project are expected to enhance students' ability to develop analytical and algorithmic thinking as well as to solve problems while cultivating skills such as ingenuity and collaboration.

This questionnaire aims to explore students' attitudes towards Educational Robotics at school.

The questionnaire is addressed exclusively to primary school pupils aged 9 to 12. In order to fill in the questionnaire more effectively we suggest that a parent or a teacher is present.

Your contribution by completing the questionnaire is very important for the successful and effective implementation of the project aiming at the greatest possible benefits for primary school pupils and teachers.

DEMOGRAPHICS

1) **Gender**
    - o Boy
    - o Girl

2) **Age**
    - o 8 - 9
    - o 10 - 11
    - o 12 - 13

3) **School**
    - o In an urban center
    - o In the province

PERSONAL INTEREST - ATTITUDES

4) **Do you know what Educational Robotics is?**
    - o Yes
    - o No

5) **How did you get informed about Educational Robotics?** (You can choose one or more)

- I am not informed about Educational Robotics
- I found information on the Internet
- A friend of mine informed me
- Through Computer Science classes at school
- I participated in a Robotics program at school
- I participated in afternoon classes of Robotics (offered by the Municipality, the Parents Association, etc.)
- I participated or attended Robotics or Informatics Competitions or a Digital Creation Festival.
- I attended private Robotics classes
- Other

6) **Are you interested in Robotics?**
- Yes
- No

7) **Would you like to get a robot?**
- Yes
- No

8) **Are you afraid or robots?**
- Yes
- No

9) **In your opinion, could a robot have feelings?**
- Yes
- No

10) **Do you think the robots are smarter than humans?**
- Yes
- No

11) **Have you tried, alone or within a group, to build or program a robot?**
- Yes
- No

12) **Which of the following verbs express your relationship with robotics?**
- Play
- Learn
- Explore
- Assemble
- Construct

- Think
- Count
- Imagine
- Create
- Other

13) **Which of the following sciences are, in your view, linked to robotics?** (You can choose one or more)

- Engineering (Mechanics)
- Graphic design
- Physics
- Medicine
- Anthropology
- Computer Science
- Biology
- Math
- Architecture

14) **For which of the following reasons would you suggest to your friends to engage on robotics?** (You can choose one or more)

- Entertainment
- Knowledge
- Development of thinking
- Collaboration
- Development of creativity

EDUCATIONAL ROBOTICS AND SCHOOL

15) **Do you attend Robotics classes at your school?**

- Yes
- No

16) **Who teaches the Robotics classes?** (You can choose one or more)

- I am not attending any Robotics classes at schools
- Teacher of the class
- Computer Science teacher
- Other

17) **How often do you attend Robotics classes at school?**

- 1 - 2 hours per week
- 3 - 4 hours per week
- More than 4 hours per week

- I am not attending any Robotics classes at school

18) **In which of the following courses do you use Robotics?** (You can choose one or more)

- Language
- Math
- History
- Computer Science
- Physics
- Social and Politic Life
- Religion
- Geography
- Other
- None of the above

19) **Why would you attend a Robotics class at school?** (You can choose one or more)

- To learn new things
- To find out more abour robotics
- To build a robot
- To learn how to program a robot
- To impress my friends
- To work with other students
- To improvise
- To participate in a student competition or festival on Robotics or Informatics
- To win a robot
- Other

20) **A robot I would like to construct will … (optional)**
(Fill in your own idea…) ……………………………………………………………

Educational Robotics Questionnaire for Teachers

This research is being carried out under the Erasmus + Programme "Coding and STEM Skills through Robotics: Supporting Primary Schools to develop inclusive Digital Strategies for All (CODESKILLS4ROBOTICS)". The project is funded by the European Union and has a duration of 28 months (September 2018 - December 2020). The project includes six partners from Belgium, Cyprus, Greece and Sweden.

The project attempts to design and implement an innovative training program for primary school pupils and teachers, aiming at the introduction of educational robotics and the necessary programming concepts in schools. The results of the project are expected to enhance students' ability to develop analytical and algorithmic thinking as well as to solve problems while cultivating skills such as ingenuity and collaboration.

This questionnaire aims at exploring the existing situation in schools regarding infrastructure, teachers' knowledge, culture, etc. in relation to educational robotics and its use for educational purposes.

The questionnaire is addressed exclusively to active primary school teachers.

Your contribution by completing the questionnaire is very important for the successful and effective implementation of the project aiming at the greatest possible benefits for primary school pupils and teachers.

DEMOGRAPHICS

1) Gender

- Male
- Female

2) Age

- 25 - 35
- 36 - 45
- 46 - 55
- 56 - 65

3) Years of service

- 1 - 10
- 11 - 20
- 20+

4) School

- In an urban center
- In the province

EDUCATIONAL ROBOTICS IN YOUR SCHOOL - INFRASTRUCTURE

5) Which of the following facilities do you have at your school? (Choose what applies)

- Computer for the teacher
- Computer for the students in the classroom
- Computer Laboratory for students
- Internet Connection
- Interactive Whiteboard
- Peripherals (projector, printers, scanners, etc.)
- Commercially Available Educational Robots
- Other
- None of the above

6) In what ways is educational robotics taught in your school? (Choose what applies)

- Supporting other lessons
- In the lesson of Computer Science
- In all day program
- After school/afternoon courses from various institutions (e.g. Municipality, Parent Associations, etc.)
- Summer lessons from various institutions (e.g. Municipality, Parent Associations, etc.)
- It is not taught

7) In what ways is IT (ICT) incorporated into your school? (Choose what applies)

- Use of IT through other lessons
- Teaching computer use at regular intervals in the classroom
- Teaching computer use at the Computer Laboratory
- In the context of homework (eg search for information, preparation of presentation)
- It is not incorporated at all

KNOWLEDGE CONCERNING STEM EDUCATION AND EDUCATIONAL ROBOTICS

8) Do you have knowledge in any of the following areas?

	Not at all	Slightly	Moderately	Very	Extremely
Science					
Computer Programming (e.g. excel/scratch/programming language)					

Educational Robotics					

9) How did you acquire this knowledge? (Choose what applies)

- Seminars
- Undergraduate studies
- Postgraduate studies
- Personal interest (e.g. studying educational material available online or watching videos on YouTube)
- I do not have knowledge on Educational Robotics

10) Have you ever attended seminars on Educational Robotics? (Choose what applies)

- Constructions, structure and functions of educational robots (sensors, commands, etc.)
- Educational robotics platforms or other environments
- Programming of educational robots
- Utilization of educational robotics in the educational process
- I have not attended any Educational Robotics seminars

11) Who provided the Educational Robotics seminars you attended?

- Private Educational Provider
- National Educational Provider
- Online Seminars (e-learning)
- I have not attended any Educational Robotics seminars

12) Have you ever come into contact with STEM Education term (Science, Technology, Engineering, Mechanics)?

- Yes
- No

13) Do you know how to integrate STEM Training into your lesson?

- Yes
- No
- I am not sure

14) In which of the following ways do you consider you incorporate STEM Training into your lessons? (Choose what applies)

- Use of materials that engage the senses
- Use of electronic devices (computers, tablets etc.)
- Educational games
- Educational experiments

- Open discussions with students
- Use of problem-solving educational approach
- Use of extracurricular bibliography (magazines, books, etc.)
- Educational visits
- None of the above

INTEGRATION OF EDUCATIONAL ROBOTICS IN THE CLASSROOM

15) Have you ever used educational robotics in your lesson?

- Yes
- No

16) At what age do you think it is appropriate to introduce Educational Robotics?

- Between 6 and 9 years old
- Between 9 and 12 years old
- Do not know/No answer

17) Which of the following reasons prevent you from using Educational Robotics in your lessons? (Choose what applies)

- Lack of personal interest
- Lack of interest by management
- Lack of infrastructure
- Lack of training
- Uncertainty about using it effectively
- Uncertainty about motivating and engaging students
- Uncertainty about technical issues (constructions, functions, connections, etc.)
- Lack of training time
- None of the above

18) To what extent do you think that the use of Educational Robotics can help teach the following lessons?

	Not at all	Slightly	Moderately	Very	Extremely
Language					
Math					
Computer Science					
Physics					

Geography					
History					
Foreign Language					
Art					

19) To what extent do you think that the use of Educational Robotics can help students in the following areas?

	Not at all	Slightly	Moderately	Very	Extremely
Collaboration					
Imagination development					
Creativity development					
Fine motor skills					
Critical thinking					
Problem Solving					
Data analysis					
Presentation skills in front of audience					
Inventiveness					
Development and enrichment of learning strategies					
Enabling of expression of					

ideas and opinions					
Active engagement of students in the learning process					

20) In what way do you think that the Educational Robotics course could be included in your school?

- Computer Science lessons
- Project Work/Cross-curricular Work
- School Activities Program
- Supporting other lessons
- In All Day School
- After school/afternoon lessons from various institutions (e.g. Municipality, Parent Associations, etc.)
- Summer lessons from various institutions (e.g. Municipality, Parent Associations, etc.)

21) Who do you think would be suitable to teach Educational Robotics at your school?

- Computer Science Teacher
- Teacher with specialty in Information Technology (e.g. postgraduate or other curriculum)
- Teacher of the class with proper training
- None of the above

22) Would you like to use Educational Robotics to teach STEM skills?

- Yes
- No

23) Add a comment (optional) ………………………………………………………….

For more information contact us on codeskills4robotics[at]gmail.com