CHOICE - INCREASING YOUNG PEOPLE'S MOTIVATION TO CHOOSE STEM CAREERS THROUGH AN INNOVATIVE CROSS-DISCIPLINARY STE(A)M APPROACH TO EDUCATION

A2.1 mapping of local and regional initiatives and existing best practices in Catalonia, Spain

Blue Room Innovation SL

Contents

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NATIONAL REPORTS ON LOCAL AND REGIONAL INITIATIVES, BEST PRACTICES, STUDENTS' ATTITUDES AND TEACHERS' APPROACHES TO STE(A)M EDUCATION IN CATALONIA, SPAIN"

1. Introduction

The aim of this report is to analyse the initiatives that schools and their educators (teachers and counsellors) take in Spain and those European initiatives which have been implemented in Spain as a country partner.

The results of the mapping of local and regional initiatives and best practices (A2.1) and the analysis of students' attitudes and teachers' approaches to STEM subjects (A2.2) will be summarized for each implementing country in a **National report.**

2 Background information

1.1 Information about Catalonia, Spain

Spain is a country in Southwestern Europe with 505.990km^2 with a population exceeding 46 million. There are 4 official languages: Spanish, Catalan, Bask and Galician. Due this project is going to be implemented in Catalonia the report has both, specific information about Catalonia and Spain.

Catalonia is a northeast region of Spain, bordered by France, and Andorra to the north, the Mediterranean Sea to the east, and the Spanish regions of Aragon and Valencia to the West and South respectively. The official languages are Catalan and Spanish.

Catalan is the common language used at school and its use is standardising the media, financial world and cultural productions. A survey carried out in 2018 by the Statistical Institute of Catalonia[1] (IDESCAT) indicate; 94.4% of the population of Catalonia above 15 years of age understood Catalan, 81.2% were able to speak it, 85.5% were able to read it and 65.3% were able to write it.

[1] https://www.idescat.cat/novetats/?id=3329&lang=en

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Catalonia has four provinces: Barcelona, Girona, Lleida, and Tarragona. The largest city and the capital of the region is Barcelona, the second-most populated municipality in Spain and the core of the sixth most populous urban area in the European Union. As of 2017, the official population of Catalonia was 7,522,596 which 1,194,947 residents did not have Spanish citizenship, accounting for about 16% of the population.

Most of the Catalan population is concentrated in 30% of the territory, mainly in the coastal plains. Intensive agriculture, livestock farming and industrial activities have been accompanied by a massive tourist influx (more than 20 million annual visitors).

Catalonia's economy is based on a long-standing industrial tradition, which has experienced a progressive transition to a new economic model. For instance, in the metropolitan area of Barcelona there is a dense and innovative industrial community of small and medium-sized companies and an active presence of large multinationals, particularly in the biomedical, agro-food, automobile and telecommunication sectors. In addition, Catalonia has a long tradition of scientific research. It currently stands out in the bioscience field, although all fields of research are represented in Catalonia to some degree, both in the generation of knowledge and in its application.

3 Statistics

Market needs and STEM education reality

The Spanish educational system is compulsory up to the age of 16, and it is organized by cycles: Infant Education, Primary Education, Secondary Education (which includes Compulsory Secondary Education, Baccalaureate and Middle Grade Vocational Training), Upper Grade Vocational Training and University Education.

In the first three years of secondary education, i.e. among students aged 12 to 14 years, science subjects account for 21% of class hours. In the stages of primary and nursery education science has a far lower presence in the classroom. In the upper secondary stage (16 to 18 years), it depends on the track chosen. These conditions will change with the entry into force of the Spanish Law for the Improvement of Educational

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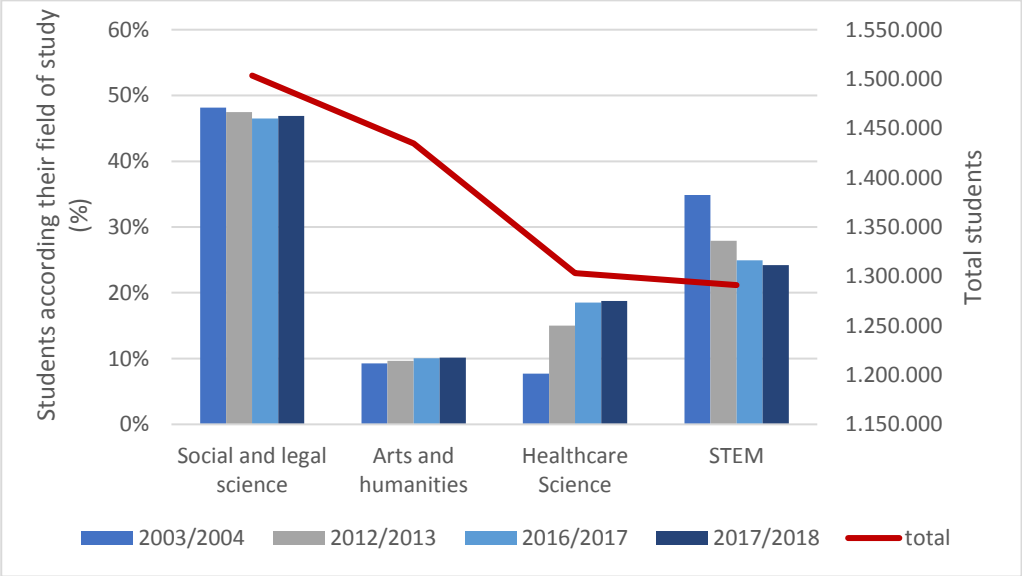
Quality (LOMLOE[2]) which will focus on the improvement of STEAM motivation on students, especially among girls[3].

According to a recent DigitalES[4] study, there are at least 10,000 vacant jobs in the technology sector in Spain due to lack of qualifications. The report reveals between 2017 and 2022 digitization will be responsible for the creation of 1.3 million jobs in Spain. Technology companies are not the only ones which demand these profiles. The energy sector, banking or healthcare also seek this talent. But despite the job potential, the reality is these facts does not come up with an increase on students in STEAM careers. As we can see in the graphic, STEM students have dropped sharply in the last 15 years. Representing 35% of the total students in 2002-2003 to 24% in 2017-20018. This means a diminution of the 40% in absolute terms. See Annex I for more details.

Figure 1: Students Third education according the field of study



Source: Compilation based on information supplied by the Spanish National Statistics Institute[5] (INE).

[2] https://www.boe.es/diario_boe/txt.php?id=BOE-A-2019-3307
[3] http://www.educacionyfp.gob.es/dam/jcr:babf11e0-696f-41e4-b278-81cd89c24d68/10-dossier-de-infografias-lomloe.pdf
[4] El desafío de las vocaciones STEM: https://www.digitales.es/wp-content/uploads/2019/09/Informe-EL-DESAFIO-DE-LAS-VOCACIONES-STEM-DIGITAL-AF-1.pdf
[5] https://www.ine.es/dyngs/IOE/es/operacion.htm?numinv=44025

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This situation is extended around Europe and there is a broad consensus about the need in the coming years for the population to have sufficient knowledge of science and technology topics to ensure social progress and the high levels of international competitiveness that each country requires[6].

In the Europe 2020 strategy, the European Union has proposed to increase the human resources employed in teaching science, technology, engineering and math (STEM) as part of the efforts to strengthen innovation and to ensure that there will be enough graduates in mathematics and engineering. It has been estimated that Europe will need at least one million more researchers over the next decade to achieve the objective of investing 3% of EU GDP in R&D in 2020[7]. On the understanding that education is key for achieving these goals, the Europe 2020 strategy recommends that Spain implement reforms of the national education system to correct the weaknesses of the current system and that it should set this objective.

In addition, The Recommendation 2006/962/CE of the European Parliament and of the Council, from December 18, 2006, on the key competences for lifelong learning, includes the digital competence as one of these key competences and indicates that it requires good comprehension and a wide knowledge of the nature, the function and the opportunities that digital technologies provide in daily situations, whether it be private, social and/or professional.

Current efforts to improve digital skills in Spain

Despite an increasing number of Spaniards going online, the share of individuals aged 16-74 with basic digital skills, at 55% in 2017, is still below the EU average (57%) (Digital Scoreboard, 2019[8]). Some regions have implemented the Digital Competence Framework and recognized the level of digital skills of citizens. Digital inclusion seems to be highly linked to income levels, as only 2% of the high-income households have never used internet, compared to some 30% of low-income households. While the number of science, technology, engineering and mathematics (STEM) graduates is on the rise (21.6 higher education graduates per thousand inhabitants aged 20-29, against 19.1 in the EU, but with a significant gender gap), information and communication technology specialists still represent a low share of the workforce (2.9% vs 3.7% in the EU). In 2018, the Government launched a Training Plan in Digital and Technological Competencies to help science,

[6] European Commission (2010). Europe 2020. A strategy for smart, sustainable and inclusive growth: https://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

[7] Innovation Union. Key initiatives (https://op.europa.eu/en/publication-detail/-/publication/0487b7b9-b5d6-11e5-8d3c-01aa75ed71a1/language-en/format-PDF/source-71238593).

[8] https://ec.europa.eu/digital-single-market/en/countries-performance-digitisation

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technology, engineering and mathematics graduates better meet employers' demand for information and communication technology specialists. The Government has also launched initiatives to increase the number of these graduates, with a focus on computer programming and the aim to achieve a higher involvement of schoolgirls in this field. ICT graduates in Spain account for 3.9 % of the total. Female ICT specialists account for a mere 1% of total female employment. See Annex II for the country profile in terms of digital indicators.

Country Special Recommendations from European Commission[9]

1. Spain made limited progress in increasing public investment in research and innovation so far. The level of public investment in R&D remains unchanged in the absence of a new Budget Law for 2019. There have been limited steps to enhance the evaluation of research and innovation policies.

2. Cooperation between universities and businesses remains weak, albeit improving, with initiatives to increase business participation in the decision-making process. Despite the high tertiary education attainment, skills supply is not sufficiently aligned with labour market needs. Matching initial vocational education and training (VET) with labour market needs is still a challenge in Spain. Spain lacks enough skills for smart specialization, industrial transition and entrepreneurship.

STEM Policy framework in Catalonia and Spain

Taking in account this recommendations Spanish Ministry of Education, has elaborated a *Proposal for a common digital frame-work for teachers* in line with the proposal generated by the center of investigation *Joint Research Centre*, from the European Commission which published in June 2016 the 2.0 version of the DigComp Project results, within the European framework on citizens' digital competence[10].

- **Legislation on education in Catalonia.** The Law of Education of Catalonia (12/2009) establishes in article 2.2 the principle guidelines of the Educational System. Amongst them, (2.2.G) establishes the digital competence for the use of autonomy and creativity of digital systems and (2.2.i), on the competence for the analysis[11].

[9] Commission Staff Working Document: Country Report Spain 2019: http://www.thespanisheconomy.com/stfls/tse/ficheros/2016/2019_european_semester_country_report_spain_en.pdf
[10] Digital Competence Framework: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC101254/jrc101254_digcomp%202.0%20the%20digital%20competence%20framework%20for%20citizens.%20update%20phase%201.pdf
[11] Digital Agenda for Catalonia 2020: http://smartcatalonia.gencat.cat/web/.content/01_SmartCAT/documents/Digital-Agenda-for-Catalonia-2020.pdf

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- **Core competences of students in the digital field.** Among the key competences that students must attain before the end of their compulsory studies, we find digital competence as a cross-curricular issue. From the year 2013, and instructed by the Department of Education, high schools have been deploying 10 competences in the digital field, grouped into 4 different dimensions. This forms part of the official curriculum from both primary and secondary compulsory education since 2015.
- **Initial Teacher Training regulations.** Orders from the Ministry establish the requirements for revising Primary Education degrees (Ministerial Order ECI/3857/2007), Early Childhood degrees (Ministerial Order ECI/3854/2007) and the Masters in teaching Secondary, Vocational Training and Language degrees (Ministerial Order ECI/3858/2007) which all hold elements of the digital competence amongst all the other competences that teachers must attain.

4 Integration of STE(A)M in schools

4.1 Good practices and ongoing national and international projects, resources, initiatives related to STE(A)M

International Projects

Being aware of the challenge about having skilled population, the European Commission has invested more than 90 million euros from the Framework Program since 2014 to subsidize initiatives that are dedicated to increasing the attractiveness of science education and scientific careers, as well as increasing the interest of young people in STEM[12].

MASDiV[13]

Is a European high-level educational research project focused on evaluation (Erasmus + Key Action 3), whose fundamental objective is to implement effective measures based on research evidence in Europe, in response to social needs derived from the increase in diversity in classrooms and the need to guarantee scientific and mathematical literacy for all, including minorities and disadvantaged groups. European institutions of recognized prestige in Science, Technology, Engineering and Mathematics (STEM) participate in the project,

[12] https://ec.europa.eu/research/swafs/index.cfm?pg=policy&lib=education
[13] https://icse.eu/international-projects/masdiv/

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with the collaboration of 11 Ministries of Education. In the case of Spain, work is carried out in tandem with the University of Jaén. One of its objectives is the development, implementation and systematic evaluation of professional development courses for teachers in these fields. The peculiarity of these courses is that they are based on research and specifically designed to, on the one hand, promote scientific and mathematical literacy in all students (including those disadvantaged by cultural and social environments) and, on the other hand, promote the learning of core values in multicultural settings. The effect of these courses on teacher competencies and student learning will be rigorously evaluated through mixed research methodologies, combining pre-test / post-test designs with a control group together with case studies. Professional development course for teachers in Spain was offered under the title Tools to improve STEM education in various classrooms in the 2018 summer course call organized by the MEFP in collaboration with the UIMP to download the course modules

STEM PD Net[14]

Is a European cooperation project for innovation and the exchange of good practices (Erasmus + Key Action 2), whose main objective is the creation of a European network of teacher training centers for teachers in the STEM field. The European Network of Professional Development Centers (STEM PD Net) arose from the idea that training centers in different countries should be connected internationally as they have similar goals and agendas: invest in teacher professional development to substantially improve STEM teaching delivered daily in schools. Comprised of 14 prestigious European institutions in the STEM field, this network will support high-quality teacher education through mutual learning, innovation and international exchange, so that teachers can deal with complex realities ace and diverse in the classroom. On the other hand, it will make it possible to strengthen leadership roles in education, to design the necessary changes and improvements at the institutional level, giving training centers a common European voice.

Its actions are framed in the promotion of European programs to publicize professions in the scientific and technological fields, the compilation and conduct of workshops and training activities for disseminators, the prospecting of professionals needed to carry out tasks of research and innovation in the European Union. It has an educational content platform with services such as the translation of teaching materials into official EU languages and has national representation in about 30 countries.

[14] http://stem-pd-net.eu/en/

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National Projects

At a local level we find examples such as the Community of Madrid, which launched STEMadrid last year, an initiative to promote the student vocation of the STEM disciplines in 28 public educational centres. The Catalan Government also approved at the end of 2019 the STEMcat Plan, a joint program of the departments of Education, Digital Policies and Public Administration, and Business and Knowledge aimed at promoting scientific, technological, engineering, and mathematical vocations.The creation of the STEMcat Plan, along with other programs already in place, such as *mSchools*[15], *donaTIC.cat*[16], *Ciència i* Aula (Science and Classroom)[17], *Impulsem la robòtica*[18] (Fostering Robotics), *Formació permanent del professorat en CTM*[19] (Teacher's Training in Science, Technology and Mathematics), are in compliance with the specific educational policy objectives included in this legislature's Government Plan.

The national Government has a strategy and initiatives focused on women in the STEAM world, in which regional programs such as Inspira STEAM in the Basque Country is its flagship. Also, there is an initiative focused on increasing computational skills of the students. Both projects are described below.

Inspira STEAM[20]

In June 2017, the regional education department of the Basque Country adopted the UniversityBusiness strategy 2022. Its objectives are to generate knowledge based on scientific excellence and apply it in the business sector, and to train highly skilled people with the skills needed in the business sector. The strategy is aligned with the regional smart specialization strategy (RIS3- Euskadi). The Cluster 4Gune was created in 2017 to foster collaboration between academia and education and training bodies in STEM areas. In 2019, the Plan for the Basque University system 2019-2022 was adopted to strengthen cooperation between the three Basque universities (UPVEHU, Mondragón University and Deusto University) and research, innovation and business organizations (BERCs, Ikerbasque, Unibasq, Clúster 4Gune and Euskampus). In 2018/2019, the universities offer 25 dual-university degrees (bachelor and master's levels), including training in companies (accounting for 25-50% of credits). Almost 500 students are currently enrolled and 600 private-sector bodies

[15] http://xtec.gencat.cat/ca/projectes/mschools/
[16] https://web.gencat.cat/ca/actualitat/detall/Premis-Dona-TIC
[17] https://www.fundaciorecerca.cat/ca/ciencia-i-aula/sessions-i-tallers-de-ciencia
[18] https://serveiseducatius.xtec.cat/terraalta/general/robocat-2020/
[19] https://agora.xtec.cat/cesire/categoria/projectes/ctm/
[20] https://inspirasteam.net/

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involved. The goals by 2022 are to reach 1 750 students, to increase the share of female STEM students from 32-52%, and to increase the number of jobs in companies for highly qualified workers by 25%.

The Basque Country adopted in 2018 the law on vocational training and in 2019 the 5th Basque vocational training plan 2019-2021. Around 1 500 companies are involved in vocational training. Dual-VET graduates (around 20% of all VET students) have an employability rate of 96.2%. The Basque VET system is widely acknowledged as one of most successful and innovative in Europe[21]. The next figure shows the increasing of people involved in this project, only in Basque Country.

Table 1: Inspira Steam in numbers

	2016-17	2017-18	2018-19	2019-20
Mentors	17	102	159	250
Schools	11	44	81	80
Groups	19	124	188	366
Boys	-	1.246	2.062	2.145
Girls	220	1.354	2.078	2.135

The School of Computational Thought[22]

It is a project of the Ministry of Education and Vocational Training which is developed in collaboration with the Councils and Departments of Education of the Autonomous Cities and Communities. The objective of the school is to offer open educational resources, training and technological solutions that help Spanish teachers to incorporate this skill into their teaching practice through programming and robotics activities.

With a sample of over 8,000 students, the research developed is probably the largest worldwide research to date on the development of this skill in education. The results show the following[23]:

Primary Education: The students participating in the project, who have worked on the mathematical competence through computer programming activities, have developed this competence to a greater extent than the students who have done it with other habitual activities and resources in the area of mathematics.

Mid Secondary Education: The results show that it is possible to develop computational thinking skills through creative technology projects made possible by free computer and electronic material kits sent to participating centres. It should be noted that better results have been obtained in educational centres that

[21] https://ec.europa.eu/education/sites/education/files/document-library-docs/et-monitor-report-2019-spain_en.pdf
[22] https://intef.es/tecnologia-educativa/pensamiento-computacional/
[23] https://intef.es/wp-content/uploads/2019/12/Impacto_EscueladePensamientoComputacional_Curso2018-2019.pdf

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had the opportunity to participate in a trade fair in which students share projects carried out during the course with classmates and teachers from other institutes.

High Secondary Education: especially in the 2nd year, the results show that it is possible to use a simulator of robots, drones and autonomous cars -without having physical devices- so that not only is there no penalty in learning regarding computational thinking, but Results are even better than working with programming languages and robotic physical equipment usual for this educational level. The use of this solution, therefore, lowers and democratizes the teaching of this type of technology, also allowing access to (simulated) equipment, which would not otherwise be available to educational centres.

4.2 National level

Teaching Science with Science[24]

Target group: students, teachers

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

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

Teaching strategies: In order to evaluate the success of the scientific dissemination actions carried out and improve its impact, the FECYT, the Obra Social "la Caixa" and Everis have led a project for the definition and implementation of an impact evaluation system that has allowed to objectify the degree to which manages to increase interest in studying STEM of the students participating in these activities and identify key influencing factors in youth vocational decision.

Procedural information: The project has been implemented for two years and it has reached 2.500 students form 12 – 16 years old. The impact it has been quantitatively evaluated conducting only two outreach activities, one workshop of experiments and a conference-dialogue with a scientist, about ESO students, just

[24] https://www.fecyt.es/es/publicacion/ensenando-ciencia-con-ciencia

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before these make the decision to follow a future STEM training or not STEM. The main result has been an increased interest in studying STEM of the participating students (5.63%).

mSchools[25]

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

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

Resource and activity:

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

- Scratch Challenge: Modular course that uses the free programming language Scratch, addressed to Higher Primary and Secondary Education.
- TechCamp: An immersive workshop experience in app design and development. Students can put their creative power to work conceiving and building apps while learning more about the business of software development and marketing strategies.

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

Teaching strategies:

There are different initiatives to improve teacher's knowledge about STEAM good practices such as Eduhack[26] which is a large scale co-creative process for schoolteachers that connects and allows the educational community to develop innovative classroom experiences for all levels and subjects. Furthermore, Mobile Learning Awards[27] acknowledge innovative teachers and school-led projects. Finally, there is One-day

[25] https://mschools.mobileworldcapital.com/es/iniciativas/
[26] https://projectes.xtec.cat/eduhack/que-es-edu-hack/
[27] https://mschools.mobileworldcapital.com/our-initiatives/mobile-learning-awards/

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seminar[28] for school administrators and policy makers where representatives from education community and mobile industry discuss the role of technology in education, digital citizenship and the future of work.

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

Through the capacitation achieved by Eduhack teachers reached 800 students last year using innovative techniques and mobile devices to improve students' digital skills, problem solving and critical thinking. The main tools used are Mobile history map: geo-positioning app that allows students to collaboratively create content on points of interest close to their schools. In addition, there is available Toolbox[29]: an online repository of validated and tested mobile education content for schools, teachers and parents, designed to increase the availability and usage of educational mobile content.

4.3 International level

Eurosteam[30]

Target group: Students, teachers and school support partners from UK, Belgium, Italy, Portugal and Spain.
Aims: improve STEAM skills for students offering educational resources and open and free source materials to be used across Europe to motivate young people in STEAM subjects.

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

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

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

[28] https://mschools.mobileworldcapital.com/our-initiatives/changing-education-together/
[29] https://mschools.mobileworldcapital.com/our-initiatives/mschools-toolbox/
[30] http://www.eurosteamproject.eu/

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The STEAM Alliance – inGenious Education[31]

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

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

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

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

Procedural information: with the support of major industries and private partners, the STEM Alliance for inGenious Education and Industry activities promote STEM jobs in all industrial sectors and contribute to build a STEM-skilled workforce. The STEM Alliance will join forces to improve and promote existing industry-education STEM initiatives (at national, European and global levels) and contribute to innovation in STEM teaching at all levels of education.

- 31 different countries involved
- 3 Face to face Activities (workshops)
- 3 webinars and 1 chat
- 12 Major companies supporting STEM Alliance
- 2 European networks coordinating STEM Alliance: 52 companies' resources and 3 communication kits

Actively Engaged Acrross Euorpe

- 997 teachers
- 13.000 students
- 120 companies
- 719 schools

Scientix[32]

Is an open community platform for teaching science in Europe that aims to distribute and improve the quality of science while making it more accessible to society. Created in 2010 by the network of Ministries of

[31] http://www.stemalliance.eu/
[32] http://www.scientix.eu/

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Education of the Member States and is supported by the Horizon 2020 program of the European Commission of the European Union and coordinated by the European Schoolnet.

4.4 Other projects

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

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5. ANNEXES

5.1. ANNEX I: University students per field

	Academic year				Percentage change		
	2002-2003	2012-2013	2016-2017	2017-2018	Anual	2017-18 / 2012-13	2017-18 / 2002-03
Social and legal science	724.117	680.759	605.787	605.176	-0,1%	-11,1%	-16,4%
Engineering	410.378	316.670	244.395	231.335	-5,3%	-26,9%	-43,6%
Arts and humanities	139.442	138.437	130.836	130.801	0,0%	-5,5%	-6,2%
Healthcare Science	115.963	215.318	241.542	242.376	0,3%	12,6%	109,0%
Science	113.576	83.545	80.692	81.456	0,9%	-2,5%	-28,3%
Total	1.503.476	1.434.729	1.303.252	1.291.144	-0,9%	-10,0%	-14,1%
STEM (Engineering+ Science)	**523.954**	**400.215**	**325.087**	**312.791**	**-3,8%**	**-21,8%**	**-40,3%**

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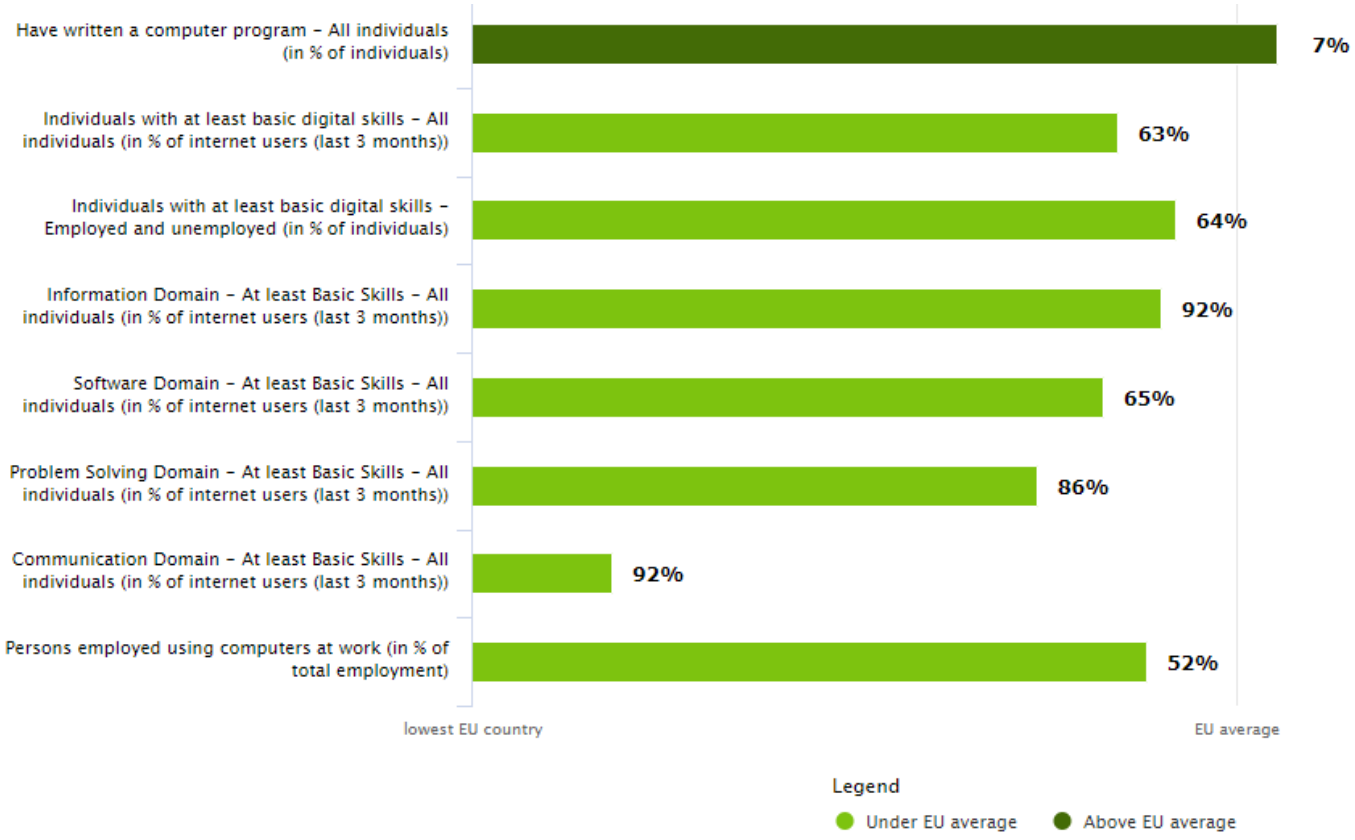
5.2. ANNEX II: Country profile for Spain, Digital skills indicators, 2019



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