COMPUTER SCIENCE EDUCATION IN SPAIN 2015

Google

GOBIERNO DE ESPAÑA

MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

FECYT FUNDACIÓN ESPAÑOLA PARA LA CIENCIA Y LA TECNOLOGÍA

everis an NTT DATA Company

April 2016

e-NIPO: 720-16-173-3

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This report has been developed by Google, in collaboration with the Spanish Foundation for Science and Technology (FECYT) and everis, in order to capture the current situation of Computer Science (CS) education in Spain, focusing on Primary and Secondary School education, leading up to a series of recommendations for the introduction, extension and improvement of the learning of this subject in the short and medium term.

FIELDWORK CONCLUSIONS

The main findings were obtained through surveys, telephone interviews and focus groups with key stakeholders of Primary and Secondary Education, as well as with the collaboration of an expert panel.

1

There is a general lack of knowledge amongst both parents and children of what CS is and what it entails, with around 60% of those surveyed confusing it for Digital Competency. Only 0.6% knew exactly what CS was. **This is one of the most critical factors that must be tackled before any other advancements are made in CS education, since this makes it difficult for key stakeholders of Primary and Secondary Education to understand its importance and the value of learning it from an early age.**

2

The study of CS at Primary and Secondary School is a novelty and has only recently been introduced in the curriculum of some regions in Spain. As a result, children aged 6-16 who study CS are a minority, only 5% of Primary School students and 16% of Secondary School students indicate they use their ICT devices (computers, smartphones, tablets, etc.) to program, and less than 25% recognize a programming language.

3

Parents and students have a positive perception of CS considering it a creative subject that is important to study as it is likely to be a required skill for future jobs, and consequently believing it should be taught at school. However, there is a **perception, by both parents and students, that it is too complicated for them to study.**

Parents show an ambivalent attitude towards their children learning CS, despite considering it important in the medium and long term; in the short term a significant percentage of them (32%) have their reservations, especially towards its instruction at Primary School. This is due primarily to the lack of knowledge regarding CS and the associated benefits of learning it, along with three other reasons: it is perceived as a **complex subject** and **not suitable for this age group;** there is a growing concern about the **excessive time devoted by some minors to the use of digital devices and the internet;** and finally, the apprehension regarding **cybersecurity and the safe use of the internet and digital devices has an impact.**

4

5

A majority of students are interested in studying CS, which seems to increase when the children start taking lessons (from 54% to 77%). The challenge ahead lies in capturing the interest of those who do not study CS and do not know what it is, for which it is **advisable to promote initiatives that expose students to CS and facilitate their initiation in its education.**

The perception that girls have of CS (its importance, the skills required to study it, and the probability of using it or related skills in their future jobs) is the same as that of boys. On the other hand **girls are less inclined to study CS than boys and perceive to a lesser extent than boys that their parents consider them capable of studying STEM[1]** subjects.

6

7

In general, Spanish children have access to the necessary infrastructure to carry out CS related activities (there is a high penetration in the use of ICT devices among young children and there exists a high access to the internet). How one must note that the majority of young children only use these devices as end users, and do not acquire knowledge or skills related to CS.

The cases where CS has been integrated into the curriculum has demonstrated that the **introduction of CS** into the educational system is complex and **requires teacher preparation,** for them to learn the fundamentals of the subject and the teaching know-how particular to this subject. **This is an essential first step that must be taken before a widespread integration of CS into the educational system can be made.**

8

[1] STEM: Science, Technology, Engineering and Mathematics.

RECOMMENDATIONS TO ENHANCE THE STUDY OF CS

The following recommendations have been developed based on the barriers and opportunities identified throughout the study. The recommendations target five different audiences: Public Administration, schools and teachers, parents, children, and industry.

- **Improve the understanding and awareness of what CS is,** detailing the elements that it involves, as well as its practical applications as a critical first step to ensure the success of any initiative aimed at promoting CS education.

- **Disseminate among parents the real benefits of learning CS,** focusing mainly on the skills and competencies that are developed by children and the importance of these in the future labor market, regardless of the profession or sector.

- **Establish a consensus framework among key stakeholders regarding the roadmap to follow to introduce CS into the educational curriculum of both Primary and Secondary School.** Families and educators have noted the need to integrate CS into the curriculum since otherwise a perception would exist that it is a low priority subject compared to others already taught at school.

- **Encourage and support the professional development of current and future teachers in the field of CS,** designing itineraries and specific content for both the continuous professional development and initial training of teachers.

- **Articulate collaborative mechanisms that enable CS professionals to participate in a productive manner in the education and training of students and teachers respectively.** Besides being one of the measures mentioned by students to increase their interest in the CS, it should also be noted that some of the initiatives of reference in Europe apply these so called collaborative models in which industry professionals provide additional support to educators.

- Given the lack of CS knowledge, related professions and practical applications, it is advisable to count on the **participation of professional associations, universities, companies and other organizations in the ICT industry in promoting and supporting the study of CS.**

- **Promote CS activities among young students, exposing them to the practical uses, fostering CS as a creative and collaborative subject.** The study found that students who have been exposed to CS and have practical experience in the field are more inclined towards studying it.

- **Address the existing gender gap, increasing the participation of girls in CS related activities,** thus equalizing the future opportunities of both boys and girls in participating in this field.

- **The strategy of integrating CS in the formal education should build on the experience of non-formal educational initiatives** in order to evaluate the effectiveness of different approaches and methodologies applied in teaching CS, as well as content design.

1 INTRODUCTION

1.1 - INTRODUCTION TO FIELD WORK RESULTS

Technology is increasingly present in our lives, transforming the way we share and communicate, how we buy or how we play, every business and every job. The digital economy is a driver for innovation and growth of nations, and offers many opportunities for entrepreneurs and companies in every sector. As such ICT and Computer Science (CS) professionals are in high demand.

Within this context, it is important for kids and youngsters to have a basic understanding of how technology works and how it is developed, attained through the study of CS. **Every student should have the opportunity to develop foundational CS skills** which go beyond the basic understanding of technology, attaining important skills needed in many fields of study which are increasingly being demanded in the labor market. CS promotes the development of skills such as logical reasoning, problem-solving and decision making, among others, in what experts call **Computational Thinking.** Additionally, these skills **stimulate children's creativity and encourage them to be innovative,** positioning them for the future needs of the labor market as a whole.

The European Commission has identified CS to be critical, classifying coding in particular as the "skill of the 21st century", highlighting that **by 2020 Europe will have 825,000 computational and ICT job vacancies.** For these reasons it is important to introduce CS to children from an early stage to prepare them for this new digital age.

Google, in collaboration with FECYT and everis, launched this study in order to capture the current situation of CS education in Primary and Secondary School in Spain, leading up to a series of recommendations for the introduction, extension and improvement of the learning of CS in the short and medium term.

This study follows other previous studies commissioned by Google carried out in the U.S.:
:

- *Searching for Computer Science: Access and Barriers in U.S. K-12 Education 2015.*
- *Women Who Choose Computer Science – What Really Matters 2014.*

This study examines the awareness of Spanish society, in particular the key stakeholders of Primary and Secondary Education (parents, students as well as school principals and teachers) of what CS is, its importance for the future of Spanish children, their perception and interest in CS. The study evaluates the current opportunities that students have to learn or become more involved in CS, identifying the barriers as well as the opportunities that exist to making CS education available to all Spanish students.

The results of the study lead to a series of **recommendations aimed at overcoming the barriers and leveraging the opportunities identified in order to boost CS education in Spain.**

1.2 - METHODOLOGY

The study carried out consisted of three main pillars:

1. **An initial context analysis to establish the current situation in Spain:** Analysis of the legal educational framework and curricula, both national and regional, as well as a general study into the situation in Europe as a whole.

2. The second pillar of the study was the **data gathering field work,** staged in three phases:

   - **Surveys to both parents and children** regarding the understanding and perception of CS and CS learning. 2,324 surveys were carried out, 1,210 to parents, and an additional 609 to parents regarding their 6-11 year old child, as well as 505 directly to children aged 12-16.

   - **Telephone interview** with public, private/charter schools principals and teachers from around the whole of Spain regarding the integration of CS into their education plans. More than 30 telephone interviews were conducted to gain their perspective and opinions on CS education.

   - **Focus groups** to delve into the results obtained in the surveys. Five focus groups were carried out with school principals and teachers, as well as with families, to contrast the results and gather qualitative aspects of both the demand for and offer of CS education. These focus groups were composed of people from: Madrid, Cataluña, Navarra, Andalucía, Aragón, Comunidad Valenciana, Castilla-La Mancha and Castilla y León.

Parent & student surveys

1,210 Surveys to parents

609 Surveys to parents regarding their 6-11 years old child

505 Surveys to children aged 12-16

Telephone interviews

~30 Interviews with school principals and teachers

Private

Públic

Charter

Focus groups

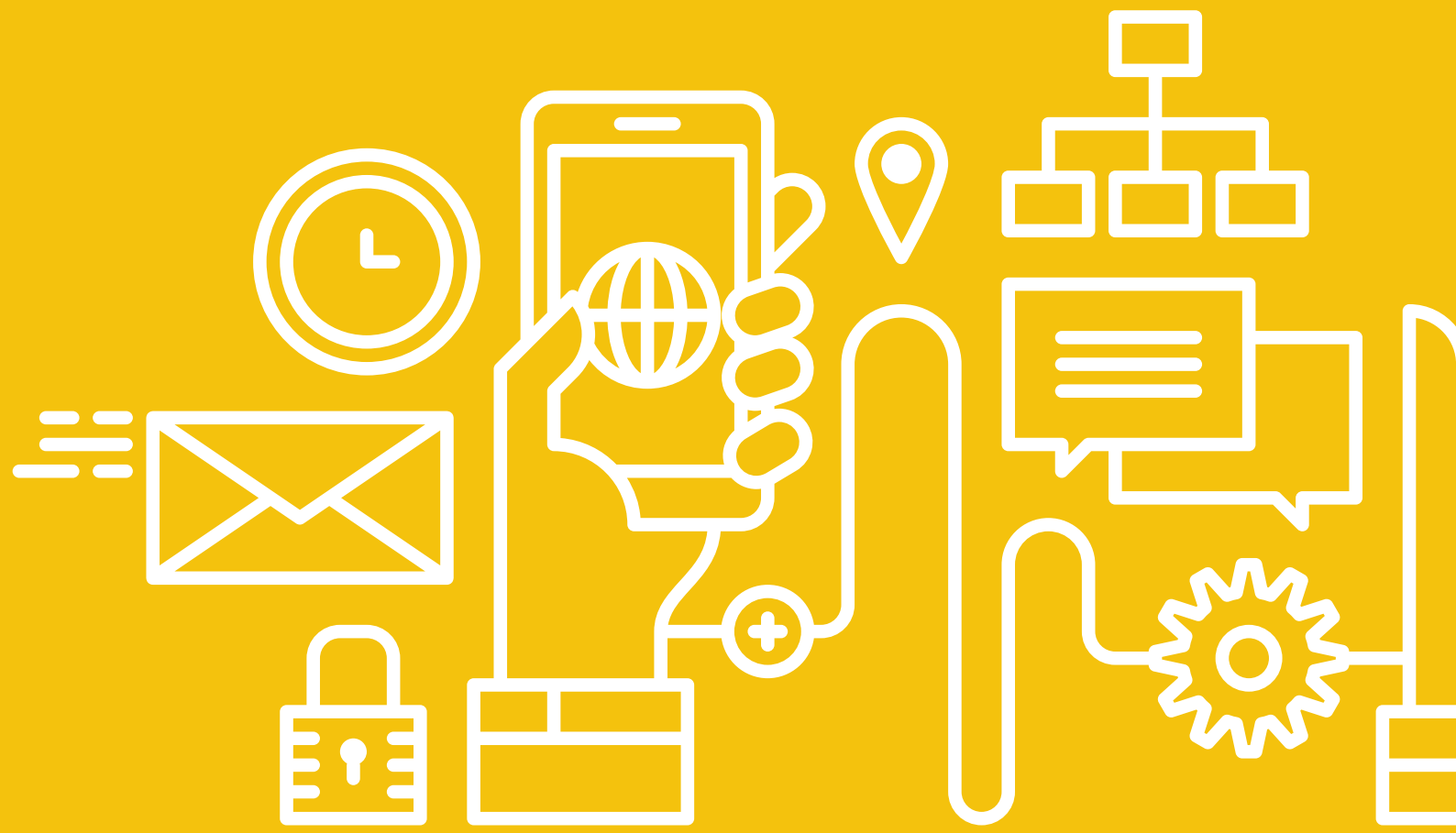
3 Focus groups with school principals and teachers

Madrid
Sevilla
Zaragoza

2 Focus groups with parents

Sevilla
Zaragoza

3. Finally the recommendations for the **introduction, extension and improvement of CS studies were developed with the collaboration of an expert panel.**



2 CS CONTEXT ANALYSIS

2.1 - DEFINITION – WHAT IS COMPUTER SCIENCE?

There is a big distinction between Information and Communications Technology (ICT) and CS (sometimes called Computing), however this distinction is not well known, as a general lack of knowledge of what CS exactly entails exists. For the purposes of this study, CS was taken to be the study of:

> **How computers are designed and how to write step-by-step instructions to enable them to perform / solve the tasks / problems at hand.**

The study of CS includes:

- **Computer programming or coding:** the process of developing and implementing various sets of instructions to enable a computer to perform a certain task, solve problems and provide human interactivity.
- **Computational thinking:** problem-solving approach applying decomposition strategies, pattern recognition, algorithm design and abstraction, as well as logical reasoning.
- **Design and development of digital systems.**

There are several activities related to the use of computers which are often mistakenly associated with CS. The activities which are not part of CS include:

- **Digital literacy:** the general ability to use computers (how to use office software or browse the Internet, for instance).
- **Online safety:** safe internet browsing, information sharing on social media and digital identity.
- **Robotics & electronics:** design and construction of electronic circuits and / or robots to solve practical problems (this could imply coding in some steps of the process).
- **Use of ICT devices and resources in education:** digital books, tablets, etc.

2.2 - CURRENT SITUATION OF CS EDUCATION IN THE EU

2.2.1 - CS integration into the curricula of the EU Members

In Europe the subject of CS is gaining importance. **The European Commission has classified coding in particular, as the "skill of the 21st century".** Statistics show that a talent shortage exists and that by 2020 Europe will have 825,000 ICT job vacancies. With more than 90% of professional occupations requiring digital competences, including programming, the European Commission is promoting the study of CS to enhance the digital competence of Europe.

The Ministries of Education of the EU Member States are responding by refocusing their curricula to integrate CS, either as a compulsory or optional subject, and / or are actively supporting the development of informal CS educational activities (e.g. extracurricular activities and summer camps). The rationale for integrating CS into the curriculum for most European countries is to foster logical thinking, problem-solving, programming/coding skills, as well as **attracting more students to study CS at higher education and fostering employability in the ICT sector.**

Table 1 summarizes the level of integration of CS in the curricula of 17 European countries, the educational level at which it is implemented and where in the curriculum it is taught[1][2].

	Level of integration			Integration by education level				Curriculum location		
	National level	Regional level	School level	Primary	Lower Secondary	Upper Secondary	Depends on regional or school curricula	Specific subject	Part of ICT / Technology	In other subjects as cross-curricular
Austria	Compulsory subject				Optional subject	Optional subject	Compulsory subject	Compulsory subject	Depends on regional or school curricula	Depends on regional or school curricula
Bulgaria	Compulsory subject					Compulsory subject		Compulsory subject		
Cyprus	Compulsory subject				Compulsory subject	Compulsory subject		Compulsory subject	Compulsory subject	
Czech Republic			Compulsory subject			Compulsory subject	Compulsory subject	Depends on regional or school curricula	Depends on regional or school curricula	Depends on regional or school curricula
Denmark	Compulsory subject				Compulsory subject	Optional subject		Depends on regional or school curricula	Depends on regional or school curricula	Compulsory subject
Estonia	Compulsory subject		Compulsory subject	Optional subject	Optional subject	Optional subject	Compulsory subject	Depends on regional or school curricula	Depends on regional or school curricula	Depends on regional or school curricula
France	Compulsory subject			Optional subject	Compulsory subject	Compulsory subject			Compulsory subject	Compulsory subject
Greece	Compulsory subject			Optional subject	Compulsory subject	Optional subject		Compulsory subject	Compulsory subject	
Hungary	Compulsory subject					Compulsory subject		Compulsory subject	Compulsory subject	Compulsory subject
Ireland	Compulsory subject		Compulsory subject		Optional subject		Compulsory subject	Compulsory subject		
Italy	Compulsory subject		Compulsory subject	Optional subject	Optional subject	Optional subject	Compulsory subject		Depends on regional or school curricula	Depends on regional or school curricula
Lithuania	Compulsory subject		Compulsory subject		Optional subject	Optional subject	Compulsory subject		Compulsory subject	
Malta	Compulsory subject					Optional subject		Compulsory subject		
Poland	Compulsory subject				Optional subject	Optional subject	Compulsory subject	Compulsory subject	Compulsory subject	
Portugal	Compulsory subject				Compulsory subject	Compulsory subject			Depends on regional or school curricula	
Slovakia	Compulsory subject		Compulsory subject	Compulsory subject	Compulsory subject	Compulsory subject		Depends on regional or school curricula	Compulsory subject	Compulsory subject
UK (England)	Compulsory subject			Compulsory subject	Compulsory subject	Compulsory subject		Compulsory subject	Depends on regional or school curricula	Depends on regional or school curricula

Compulsory subject · Optional subject · Depends on regional or school curricula

Table 1. Level of integration of CS in the curricula of 17 European countries, the educational level at which it is implemented and where in the curriculum it is taught.

[1] *Computing Our Future – Computing, Programming and Coding – Priorities, School Curricula and Initiatives Across Europe, European Schoolnet 2015.*

[2] *Computing Our Future – Computing, Programming and Coding – Priorities, School Curricula and Initiatives Across Europe, European Schoolnet 2014.*

UK case study - **Integration of CS into the educational system at both Primary and Secondary School**

In the UK (England), the **national curriculum was changed in 2013 in order to integrate CS in Key Stage 1 (5-6 year olds), Key Stage 2 (7-11 year olds) and Key Stage 3 (11-14 year olds)** as a new distinct subject[1], replacing the original ICT (Information and Communication Technology) class with Computing. This has made the UK the first G20 country to mandate the education of CS in Primary Education.

The purpose of this integration by the UK government is to **ensure pupils become digitally literate, preparing them to form part of the digital world** as active participants and close the "skills gap" between the number of technology jobs and the people qualified to fill them.

The aims of the UK national curriculum for computing, as stated by the Department for Education, are to ensure that students are responsible, competent, confident and creative users of information and communication technology, teaching them to:

- **Understand and apply the fundamental principles and concepts of CS,** including abstraction, logic, algorithms and data representation.
- **Analyze problems in computational terms,** and have repeated practical experience of writing computer programs in order to solve such problems.
- **Evaluate and apply information technology,** including new or unfamiliar technologies, analytically to solve problems.

Furthermore, CS was included as an additional science GCSE, which counts towards the English Baccalaureate (EBacc), Key Stage 4. Here students gain "practical experience of designing, writing, and testing computer programs, develop the ability to reason, explain and evaluate computing solutions, and develop awareness of current and emerging trends" (Specification from the Edexcel CGSE Exam Board).

The integration of CS into the national curriculum has lead to a surge **of initiatives aimed at preparing teachers** to impart these classes, such as **Computing At School (CAS)[2],** which provides "leadership and strategic guidance to all those involved in Computing education in schools". The Department for Education and the Computing At School working group are working together with other organizations to provide resources for teachers and students, and run pilots with schools across England, helping to start integrating programming into their classes.

[1] https://www.gov.uk/government/publications/national-currículum-in-england-computing-programmes-of-study/national-currículum-in-england-computing-programmes-of-study
[2] http://www.computingatschool.org.uk

Estonian case study - **CS education as a Nation wide digital strategy**

Estonia is one of the leading European countries when it comes to CS education.

- In **1996** the Estonian government launched the **Tiger Leap Program**[1] to **adjust the education system to the needs of the rapidly evolving information society** by equipping schools with modern information and communication technology, linking schools to the internet, providing ICT education to teachers and promoting development of teaching/learning software. In order to achieve these goals, the Tiger Leap Foundation was created in 1997 by the Ministry of Education and private sector ICT firms. As a result of the program, by the late 1990s, all Estonian schools were online (with computers and internet access). In recent year, the organization's focus has shifted to education initiatives.

- In **2012,** the Information Technology Foundation for Education (HITSA) launched the **ProgeTiiger program** which aims to enhance learners´ technological literacy and digital competence. The program is made up of volunteers (teachers) who are interested in learning and then teaching CS. For this purpose ProgeTiiger provides training packets for the volunteers to either learn in a classroom or in a 4-week e-learning course and prepare them to teach CS.

- The teachers and students are introduced to several different coding and programming platforms, such as Code Gameware and Scratch.

- As part of the ProgeTiiger program, the HITSA offers:

  » Educational resources and training opportunities (free teaching and learning resources available on the website).

  » Financial support for schools to acquire programmable devices.

Integration of CS into school curricula

CS education in Estonia has been integrated as optional at all levels of education (Primary, Secondary and upper Secondary School). There is a technology oriented subject called Informatics which, depending on the school, offers a combination of the following; ICT, Computers used in Research, 3D Modelling, Mechatronics and Robotics, Computer Theory, ICT in Global Society and Creating Apps and Programming.

[1] Tiger Leap Program As A Beginning Of 21st Century Education – Estonian Government Report.

2.3 - CURRENT SITUATION OF CS EDUCATION IN SPAIN

2.3.1 - CS integration into the Spanish national curricula

In the **Spanish education system,** according to the Fundamental Law of Education (Ley Orgánica de Educación)[1,2,3], which recently underwent a reform with the approval of the new organic law for the improvement of the quality of education in December 2013, **education is compulsory for all children between the ages 6 and 16,** which it classifies as Basic Education (Educación Básica):

- **Primary Education** (Educación Primaria) which comprises of six academic years – Ages 6 to 12.
- **Compulsory Secondary Education** (Educación Secundaria Obligatoria ESO) – Ages 12 to 16.

  Compulsory Secondary Education includes two cycles, the first comprising of three academic years and the second of one. In the second cycle, parents / legal guardians and students decide whether they will continue to study for a high school diploma *(Bachillerato)*, in which case they select subjects belonging to the *"Enseñanzas Académicas"*, or a Professional (Vocational) Development Diploma taking the so called *"Enseñanzas Aplicadas"* classes.

[1] Real Decreto 126/2014, de 28 de febrero, por el que se establece el currículo básico de la Educación Primaria.
[2] Real Decreto 1105/2014, de 26 de diciembre, por el que se establece el currículo básico de la ESO y del Bachillerato.
[3] Ley Orgánica 2/2006, de 3 de mayo, de Educación TEXTO CONSOLIDADO – 29 de Julio de 2015.
[4] Ley Orgánica 8/2013, de 9 de diciembre, para la mejora de la calidad educativa.

The Spanish National curriculum sets the guidelines the individual regional authorities must follow when establishing the regional curricula. **Related to CS the national curriculum establishes the following:**

- **Digital Competence,** taken to be the creative, critical and secure use of information and communications technology (developing skills mainly relevant to end users), must be developed in Primary and Secondary School by all students (Order ECD/65/2015, of January 21st, by which the relations between the competencies, content and the evaluation criteria of Primary and Secondary Education are established).

- In certain courses of ESO, such as optional subjects and within the educational program established by each regional administration, the curriculum may include subjects like **"Technology"** (in the first and second cycle) and **"Information and Communication Technology"** (only in the second cycle). The syllabus of these subjects may include some elements of CS, such as an introduction to software development. The depth and complexity of the elements of CS taught in these subjects varies depending on the region, and in many cases also depends on the school. For the most part, CS is not yet being taught at Spanish schools, and if done so, it is mainly in an introductory manner.

2.3.2 - CS integration into the Spanish regional curricula

As mentioned previously, CS education is being introduced in Spain at a regional level at different rates, with each region adopting different approaches.

According to the information collected at the beginning of 2015 from the Public Administration and from the plans of incorporating CS education announced by some regional education authorities (which may not be exhaustive and may not detail all the launched initiatives, especially since the data are prior to the application of the new curriculum, LOMCE), the cases where CS has been clearly integrated are few.

The case worth noting for CS integration at Primary School is the region of **Navarra,** where elements of CS have been integrated into the Mathematics syllabus, and teacher training is being provided by a new governmental initiative called **Código21** which provides resources for learning and teaching this subject.

In the case of Secondary Education (ESO), **Madrid** and **Catalonia** stand out, in this case integrating CS as a specific class, as well launching initiatives to provide the necessary teacher training.

In Madrid a specific subject called **Tecnología, Programación y Robótica** (technology, programming and robotics) was created, which includes programming elements of CS and has been introduced in the 1st and 3rd year of Secondary Education. Teacher training (online or attendance based) is provided by the initiative **CodeMadrid.**

In Catalonia the **mSchools** initiative has introduced programming of mobile applications in the ESO, in a project launched by public-private partnership between the Catalan Government, the City of Barcelona and the Mobile World Capital Foundation.

Other regional governments are beginning to carry out teacher training offering online resources such as **Código Octopus** platform in Galicia, or promoting initiatives such as **Creative Technologies in the Classroom (CTC)** of the Arduino Foundation, which has already been implemented in centers in Castilla-La Mancha, Andalucía, Madrid and Cataluña.

CS is not fully integrated into the Primary or Secondary School curriculum at a national level being left to the discretion of the regional authorities and the individual schools whether or not to include it in the regional and school curricula. Only a few regions have integrated CS into their curriculum so far, with most opting to include it only at Secondary School.

2.3.3 - Global, EU and national non-formal CS education initiatives

Although the formal education of CS in Spain has not been adopted extensively, there has been a surge of initiatives that have been formed to promote and / or offer CS programs / courses at all levels: global, european, national and regional. Below is a non-exhaustive list of some of the most prominent initiatives:

Global Initiatives

CS First is an open and free program developed by Google that increases student exposure to CS education through after-school, in-school, and summer programs.

Made With Code is a Google initiative aimed at getting young women interested in learning to code and closing the gender gap in the tech industry.

Code.org, launched in 2013, is a non-profit dedicated to expanding access to CS.

Code Club is a not-for-profit organization with the aim of giving children the chance to learn to code.

Khan Academy is a non-profit educational organization created in 2006 with the aim of providing free, world-class education for anyone, anywhere. The organization offers personalized learning resources for all ages (classes include CS).

CoderDojo is a global movement of free, volunteer-led, community based programming clubs for young people.

European initiatives

EU Code Week is an event to show how you can bring ideas to life with code, to make programming more visible, and bring motivated people together to learn.

'All you need is {C<3DE}' is a European coding initiative that promotes coding and computational thinking at all levels of education, as well as in more informal settings.

Spanish national initiatives

Genios is an initiative by Ayuda en Acción and Google.org to teach programming to students and teachers across Spain, promoting social and technological inclusion.

Programamos is a nonprofit whose objective is to promote the development of computational thinking from an early age.

At a Global, EU and National level, the initiatives identified varied in their objective. The majority focus on **teaching CS to students,** either via online courses (the most common option attributed to their global presence made easier without the need of having a physical presence), extracurricular activities, and / or by integrating CS into the school curriculum. The **professional development of the teachers** is also targeted, providing tutorials on how to teach CS and recommending the content and tools which should be included in the school curriculum. Some initiatives target parents to increase their awareness, and in some cases provide them with basic training with the aim that this will be transmitted to their children and / or encourage them to participate in the promotion of CS. Table 2 on the next page summarizes the target audience and activities of the initiatives previously described.

	Target			Activities			
	Students	Parents	Teachers	Promote & events	Online courses	Extra-curricular	Curricular (in school)
1. CS First	●	○	○	●	●	●	○
2. Made With Code	●	○	○	●	●	○	○
3. Code.org	●	○	●	●	●	○	●
4. Code Club	●	○	○	●	○	●	○
5. CoderDojo	●	●	○	○	○	●	○
6. Khan Academy	●	●	●	○	●	○	○
7. EU Code Week	●	●	●	●	○	○	○
8. All You Need Is Code	●	●	●	●	●	○	○
9. Genios	●	○	●	●	○	○	●
10. Programamos	●	●	●	●	●	●	●

● Global initiative ● European initiative ● Spanish national initiative

Table 2. Target audience and activities carried out by the global, EU and national initiatives identified.

2.3.4 - CS regional initiatives

In addition to the Spanish National level initiatives, in recent years, many academies, extracurricular activities and camps have emerged across Spain **to promote CS education in their respective communities,** some of which have been described below.

Regional Spanish initiatives

Etopia_kids is a Fundación Zaragoza Ciudad del Conocimiento project, in collaboration with Obra Social de Ibercaja and the City of Zaragoza, that promotes the social appreciation of science, technology, creativity and entrepreneurship.

Educaixa offers in the Cosmocaixa museum the activity **"Program your universe"** in collaboration with **Fundación everis and Udigital,** in order to boost CS among students, families and teachers.

UdiGitalEdu is an initiative of the University of Girona dedicated to the design and development of STEM experiences, which has also launched the **Inventors4Change** initiative devoted to the collaborative learning among children from different countries and cultures supported by creative technologies.

Robótica Educativa is an association part of the Government of Extremadura that promotes the culture of technology as a means to materialize ideas and achieve goals.

Google and FECYT offer a program to teach children between eight and eighteen years old some basics of programming languages.

Falling in Code is an initiative that offers creative and innovative resources for children and adolescents to learn how to program.

DIWO from BQ is an initiative of the Spanish producer of smartphones, tablets, electronic readers, and 3d printers, aimed at promoting the education of technology, including programming.

Girls in lab is an initiative that aims to inspire, educate and engage girls in tech and computing science.

An analysis of the regional initiatives identified showed that, **the majority of the initiatives target the education of students via extracurricular activities,** due to their local presence. Very few adopt the option of providing online courses preferring to have a physical presence to engage better with the students. Those that offer online courses are primarily targeting the professional development of teachers where the possibility of carrying out the course online is preferable due to their busier schedules. Parents are not a priority for the regional initiatives. Table 3 summarizes the target audience and the activities of these regional initiatives.

	Target			Activities			
	Students	Parents	Teachers	Promote & events	Online courses	Extra-curricular	Curricular (in school)
1. Etopia_Kids	●	○	○	○	○	●	○
2. Robótica Educativa	●	○	○	○	○	●	○
3. Falling in Code	●	○	○	●	○	●	○
4. Girls in Lab	●	○	○	●	○	●	○
5. UdiGitalEdu	●	○	●	●	●	○	○
6. EduCaixa	●	○	●	●	○	●	○
7. Google and FECYT	●	○	○	○	○	●	○
8. DIWO from BQ	●	●	●	○	●	●	●

Table 3. Target audience and activities carried out by the regional initiatives identified.

2.3.5 - Professional development of teachers in CS

One of the most important factors to take into account when introducing a new subject is **the preparation of the teachers to teach these classes.** Among the initiatives aimed at promoting CS and increasing society's awareness of the importance of its education there are a number of private initiatives of non-formal education which focus on training and preparing teachers and schools. In addition, the regional educational authorities have introduced programs and courses aimed at training teachers to teach CS, based primarily on software solutions such as Scratch or similar, although in most cases these are occasional training sessions available to a specific groups of teachers.

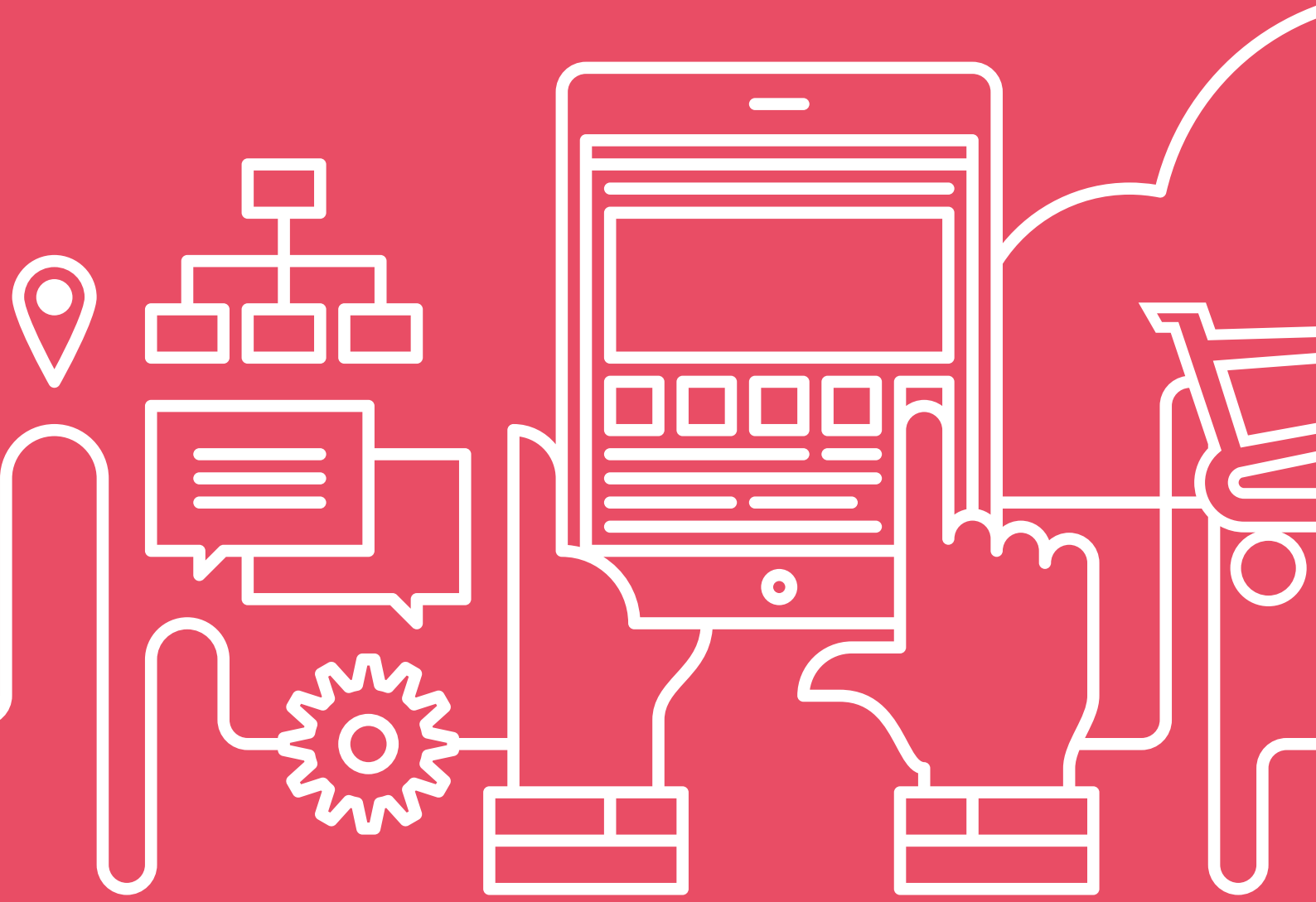
2.4 - CS CONTEXT ANALYSIS CONCLUSIONS

Countries around Europe are adapting their educational system in order to integrate CS, with each government adopting a different approach to this integration, as was seen in section 2.2. Below are the general observations made with respect to the current situation of CS education in Europe:

- The **leading countries** when it comes to integrating CS education are UK and Estonia (although they still have a long road ahead before perfecting its integration), where both have **introduced CS education at a national level with strong backing from the central government.**
  - » In the UK, CS has been established as a stand alone subject throughout the whole educational system, compulsory from Primary School to Secondary School (key stage 1 to 3), and optional in the English Baccalaureate.
  - » Estonia on the other hand, has integrated CS at all levels of education (Primary, Secondary and upper Secondary School) as an optional subject, taught in a technology orientated subject called Informatics.

- In contrast, **in Spain, the integration of CS is being carried out in a decentralized manner, with each regional government modifying their curricula as they see fit** (although always abiding to the national curriculum framework):
  - » Up till now, few regions have adapted their curriculum in order to integrate CS, and those that have done so adopting different approaches and different degrees of completeness.
  - » The integration has been for the most part concentrated in Secondary School, with the exception of Navarra where it has been integrated only in Primary School.
  - » There are initiatives which focus on providing teachers with the necessary training or at helping schools integrate CS progressively into their educational program.

- As for the current situation of **non formal CS education,** all around Europe initiatives (private, governmental and non profit) are forming aimed at **teaching young children** in particular, although some do target parents, the **fundamentals of CS,** most as either online courses or extracurricular activities.



3 CS FIELDWORK RESULTS

3.1 - INTRODUCTION TO FIELDWORK RESULTS

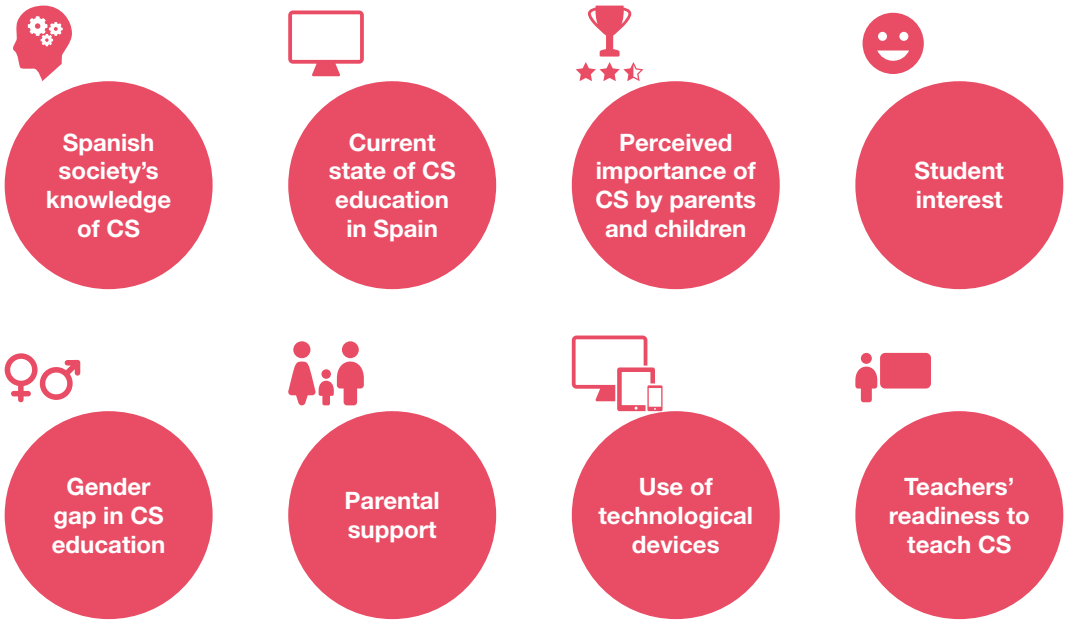
The fieldwork was carried out in October and November 2015, and consisted of three primary data gathering phases:

- **Parents and student survey** – Throughout the month of October 2,324 surveys were carried out, 1,210 to parents, and an additional 609 to parents regarding their 6-11 year old child, as well as 505 to children aged 12- 16.

- **Telephone interviews** – Approximately 30 telephone interviews with school principals and teachers around Spain were conducted to gain their perspective and opinion on CS education.

- **Focus groups** – Once the surveys had been implemented and the telephone interviews finalized, five focus groups were carried out with school principals and teachers, as well as with families, to contrast the results and gather qualitative aspects of both the demand for and offer of CS education.

The following chapter presents the results obtained throughout the three field work phases, where the subsequent topics are analyzed:

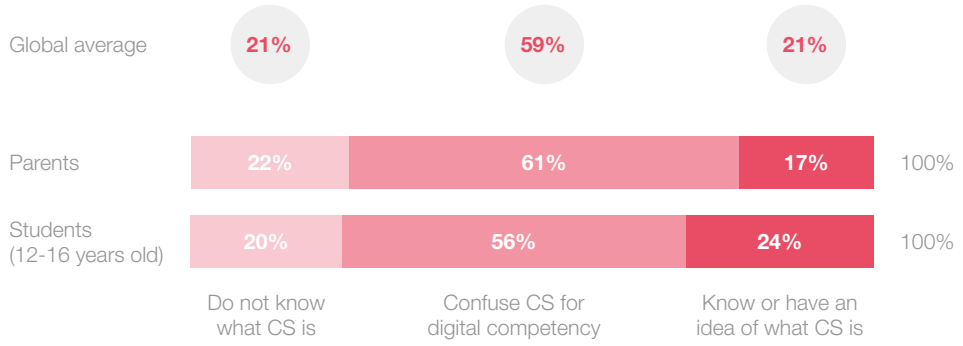


3.2 - SPANISH SOCIETY'S KNOWLEDGE OF CS

There is a general lack of knowledge amongst both parents and children of what CS is and what it entails, with many confusing it for Digital Competency. This is one of the most critical factors that must be tackled before any other advancements are made in the education of CS.

The term Computer Science *(Ciencias de la Computación)* is not extensively used in Spain, which presented one of the main barriers when gathering reliable information related to the concept *(Informatica* is the term generally used in Spain, although it includes many other activities outside CS). A lack of conceptual understanding was detected resulting in people relating CS to the other related concepts such as Digital Literacy or Digital Competency. This lack of knowledge has a knock on effect on the other results as those surveyed related the questions to ICT in general, rather than CS, and must be take into account throughout the report.

3.2.1 - Knowledge of the surveyed parents and students



The survey showed that a large portion of the Spanish society does not know what CS is, with around 21% of those surveyed directly replying that they had no idea which elements could form part of this concept. An additional 59% confused CS for Digital Competency (and Digital Literacy), while only 17% and 24% of parents and students respectively identified at least one element of CS without selecting those elements related to Digital Competency.

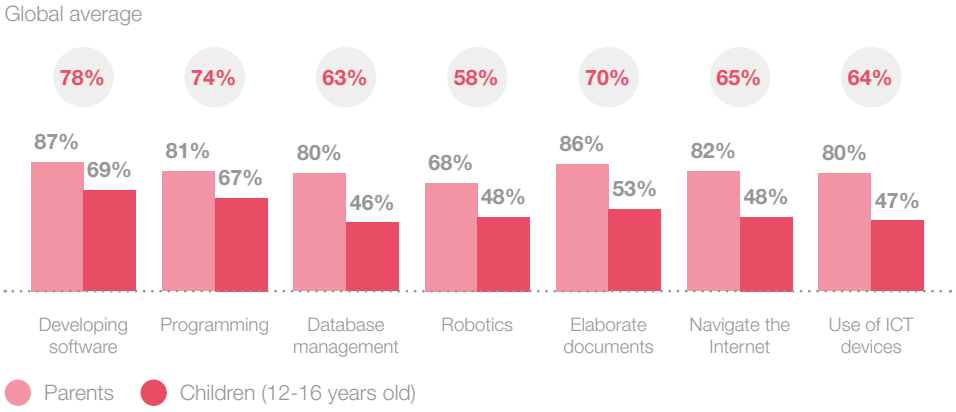
0,6%

Only 0.4% of parents and 0.8% of students knew exactly what CS was

Note – Programming, Software Development and Database Management are the elements taken to be part of CS, allowing in this case the response of Robotics as it involves, although limited in depth, the practical application of programming and computational thinking, which experts agree facilitate the engagement of students.

3.2.2 - Confusion between CS and digital competency and digital literacy

What activities form part of CS?



As mentioned previously, a large portion of those surveyed believe they know what CS is, however in reality mistaking it for Digital Literacy or Competency, including elements such as navigating the Internet (65%), using ICT devices (64%) and creating documents (70%).

Opinions of experts and focus groups

The term **Computer Science** *(Ciencias de la Computación)*, is not extensively used in Spain, resulting in a general confusion of what CS is. Experts concur that the principal barrier to boosting CS education is the understanding of what it is. A distinction must therefore be made between the three different levels of technological abilities:

- **Digital Literacy** – the ability to use information technology such as personal computers, internet browsing, and using software of various kinds. It focuses on how to manage hardware and software[1].
- **Digital Competency** – the ability to find and evaluate information (information processing), create content, share and communicate using information technologies and the internet safely, solving problems related to the use of these digital technologies[2].
- **Computer Science** – the discipline that involves the understanding and design of computers and computational processes[3].

[1] Alfabetización digital y competencias informacionales, 2012 – Fundación Telefónica.
[2] https://europass.cedefop.europa.eu/en/resources/digital-competences
[3] http://www.cs.bu.edu/AboutCS/WhatIsCS.pdf

3.3 - CURRENT STATE OF CS EDUCATION IN SPAIN

The study of CS at Primary and Secondary School is a novelty which has yet to be adopted by the majority of schools in Spain, with most regions in the process of adapting their academic curricula to the new Basic Education Act. As a result, the students aged 6-16 who study CS are a minority.

Most Spanish Primary and Secondary Schools are not offering CS classes as it is yet to be integrated into the curriculum of most regions. However, as seen in the context analysis, some regions have made the first steps towards integrating CS into their regional curriculum. The current situation implies that the initiative to study CS (in extracurricular activities or self-learning) has to be incentivized by the parents or come directly from the students' willingness to study the subject, which is currently relatively uncommon, due to the lack of knowledge and awareness. In this respect there has been a recent surge in initiatives aimed at tackling this problem and offering the necessary tools to study CS; nonetheless this is still at a premature stage, focused primarily in extracurricular education.

3.3.1 - Study of CS by children

The use of ICT for programming and the recognition of the most popular CS learning tools and programming languages are two key indicators that can be used to approximate the real portion of Spanish students who study CS. If children are studying something related to CS they would be familiar with the most popular CS learning software such as Scratch or App Inventor (in the questionnaire children were asked for Scratch, APP Inventor, Blockly, Alice, Python and HTML, among others). In addition, the question of whether children use their ICT device for programming purposes provides an indication of the percentage who practice, and therefore are learning CS. The results indicate that the number of students who study CS are a minority, especially in Primary School.

Use of ICT for programming

5% Primary School students (aged 6-11) use ICT devices for programming purposes

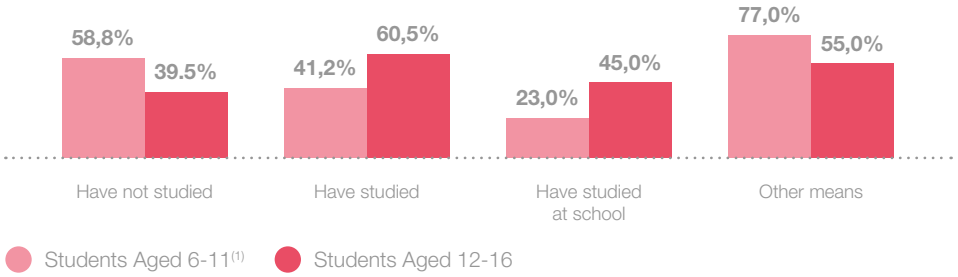
16% Secondary School students (aged 12-16) use ICT devices for programming purposes

Knowledge of CS software

24% Students who recognized Scratch as a CS learning software

23% Students who recognized App Inventor as a CS learning software

Have you studied CS and if so, where?

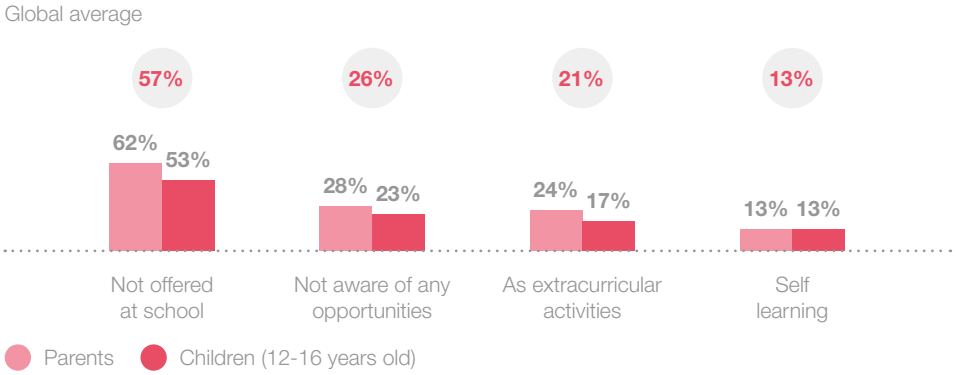


On the other hand, when asked whether they studied CS, a significant number of children answered that they have (41.2% of the parents said their child of 6 to 11 years old have studied and 60.5% of the children between 12 and 16 years old said they studied). Of those who said they have studied CS, 23% and 45% in Primary and Secondary School respectively, said they studied it at school, which suggests, when compared to the indicators mentioned previously, **that these results are inflated due to the confusion with Digital Literacy and Competency.**

In Secondary School especially, there is a large portion who say they are studying CS which is, as experts point out, a result of them not knowing what CS is in the first place. This leads students to believe they are studying it in their specific technology class, where in some cases, the students are introduced to programming languages and other elements of CS, but at a very high level, increasing their perception that they are studying it.

[1] In the case of the children aged 6 to 11, the questions were directed to the parents who answered for their children.

3.3.2 - Availability of means for students to study CS



CS may not be offered in the majority of schools, as indicated by the results where 57% say that their school does not offer CS studies, however there has been a significant increase in the number of initiatives that offer extracurricular activities, or initiatives aimed at increasing the interest in CS. One clear example is the tremendous increase in the number of **Hour of Code** events that have been celebrated in Spain in 2015 compared to the previous year, increasing from 490 to 1,892[1]. This is still at an early stage where most of these initiatives are mainly focusing on extracurricular activities.

Opinions of experts and focus groups

- **One of the factors that greatly influences whether or not students study CS is if the school they attend offers it.** The survey results, as well as experts and families spoken to, indicate that if the school does not offer CS, most parents and children do not even consider the option of studying it as an extracurricular activity, overlooking the opportunity entirely.
- In the current scenario where the majority of schools do not offer CS classes, **parents play an important role as they have an influence on the extracurricular activities the children undertake.** This issue will be seen in more detail later on in 3.7: Parental Support.

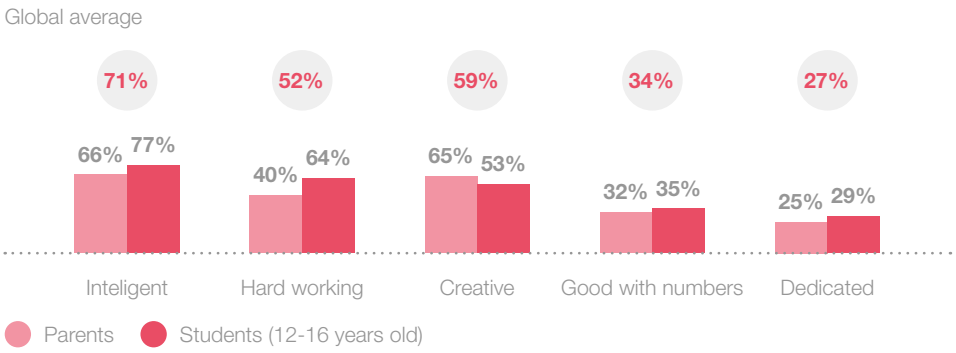
[1] https://hourofcode.com/es/events/all

3.4 - PERCEIVED IMPORTANCE OF CS BY PARENTS AND CHILDREN

Parents and students have a positive perception of CS considering it a creative subject that is important to study as it is likely to be a required skill for future jobs, and believe it should be taught at school. However, there is a general perception, that it is too complicated for students to be successful in the field.

Experts in the field are consistently reiterating the importance for young students to study CS, highlighting that a talent shortage exists, where according to the European Commission statistics, there will be 825,000 ICT job vacancies by 2020 in Europe[1]. However, even more important than the job prospects that CS offers is the competencies and skills one develops (such as computational thinking), which are often overlooked by the general public, and that are useful for any profession and activity in their future.

3.4.1 - Qualities used to describe someone who studies CS



The perception of both parents and students is that CS is complex, where one has to be hard working (52%), intelligent (71%) and good at math (34%) to excel in the subject. This is especially true for kids, where a greater portion have the impression that it is complex. Regardless, there is a general positive perception concerning technology and CS, with a majority believing it is a creative subject that will be beneficial to them in the future.

[1] http://ec.europa.eu/digital-agenda/en/coding-21st-century-skill

Expert opinions

With regard to the skills necessary to study CS experts believe that being interested and motivated to learn is the key. As such, the method of teaching is critical to ensure students are fully engaged and interested. Experts do not consider being good with numbers a necessity to study CS, however they do believe it to be a subject that has its complexities for which the student must be resilient if they wish to do well.

3.4.2 - Future advantages of studying CS

90% of parents and students consider the **study of CS** to be **important**

41% of parents and **46%** of students think it **improves employability**

36% of parents highlight the **greater variety of jobs**

46% of students believe that it offers **greater opportunities abroad**

When asked regarding the importance of studying CS more than 90% of the surveyed parents and students, although they are not fully aware of the benefits, consider it to be important, as they find it probable that their future jobs will require some degree of CS knowledge. The benefits related to future job prospects that most parents and students believe CS provides (when asked to select two out of a number of benefits), were: the improvement in employability, greater job variety and, opportunities abroad.

Opinions of experts and focus groups

- In addition to the benefits related to future job prospects, experts express the need to make society as a whole aware of the fundamental competencies and skills one develops, as well as a conceptual understanding of today's technology one attains through CS. The experts interviewed in the scope of the project express that it promotes **creativity, develops critical and logical thinking, problem-solving and team work.**
- Two additional indirect benefits which have been brought forward by those professionals teaching CS, attributed in part to the fact that it is taught in a different manner than more traditional subjects, are:

  The possibility of indirectly reinforcing knowledge or concepts learned in other subjects.

  Engaging with poor performing students.
- As will be seen later in the report in more detail, parents highlight that the importance of CS is such that it **should be offered as formal education in schools.** Otherwise, there is a risk of being perceived as less important compared to other knowledge areas.

3.5 - STUDENT INTEREST

A majority of students are interested in studying CS, which seems to increase when the children start taking lessons. The challenge ahead lies in capturing the interest of those who do not study CS and do not know what it is, overcoming their perceptions that it is too complicated for them to learn by increasing their exposure to elements of CS.

The interest in CS is highly dependent on the perception one has, which in turn is related to the knowledge in the matter. As a result parents play an important role as they have a great influence on the perceptions and interests of their children. When exposed to CS, the results suggest that student interest increases, indicating that the barrier to overcome is that of the perception of complexity and the knowledge gap.

3.5.1 - Interest in studying CS:

The survey results show that the majority of the students are interested in studying CS (60%), with only 26% replying that they have no interest. There is a significant portion (15%) who are not sure what CS entails and are therefore uncertain whether they would be interested in studying it or not.

The interest of students, as it will be seen in the next chapter but is worth mentioning here, is highly influenced by their parents. The results show that students whose parents have a profession or degree related to CS or Engineering have a much greater interest than those with parents who have no or basic ICT skills as is highlighted below.

Influence of parents on the interest

87%
Students with "tech savvy" parents are interested in studying CS

58%
Students with "non-tech savvy" parents are interested in studying CS

3.5.2 - Students' perception of CS and their willingness to study it:

77 %
Of children
Between 12 and 16 years old who study CS would like to continue

54 %
Of children
Between 12 and 16 years old who do not study CS would like to start

The results of the study indicate that there is a clear relation between the interest in CS and the understanding of what it is, reflected by the difference in interest between those who study CS and those who do not.

Opinions of experts and focus groups

- The consulted experts suggest that **those who do not study CS are less inclined to study it due to initial skepticism and lack of knowledge,** with a large majority considering it an individualistic activity which requires a lot of dedication. In contrast they highlight that those who study CS are highly motivated to continue. This was also identified in a previous study by Google, which found that the ability to participate in CS courses and activities accounts for roughly 22% of the explainable factors influencing the decision to study CS (this finding only applies to girls)[1].

- Experts emphasize that **students who have taken CS class are fully engaged with the subject,** highlighting above all, the possibility to:

  Work in teams and brainstorm possible solutions.

  Freedom to experiment and be creative.

  Practical learning, "learning by doing", solving problems via trial and error.

3.5.3 - Methods to catch the interest of students in CS

According to the students surveyed, the best method to catch the attention of young students and get them interested in CS would be to increase the interaction of students with professionals in the field, either by organizing seminars or talks at school, and having them introduce the subject, explaining with real life examples the benefits and possibilities it provides. In addition, a large number of students believe the application and learning of CS to be an individualistic activity which reduces their interest. It has been seen however, that most students who do study CS point out that one of the key elements they enjoy is the possibility to **work in teams.**

This requires communicating to the students new to CS that it actually encourages team work, which according to the survey would boost students interest, especially in girls. Table 4 on the next page shows the results of the survey regarding the methods students consider would most boost their interest in CS.

		GENDER		AGE					SCHOOL	
	TOTAL	Boys	Girls	12	13	14	15	15	Public	Private
If CS experts would visit your school to introduce the subject	39,8%	39,1%	40,5%	46,2%	33,3%	46,4%	31,5%	19,5%	37,6%	44,9%
If you were to study it with your friends	38,5%	36,7%	40,6%	50,1%	44,0%	29,2%	23,9%	31,6%	41,1%	32,4%
If the subject and its benefits were explained better	17,8%	17,3%	18,3%	12,5%	25,1%	18,4%	23,4%	13,8%	19,6%	13,6%
If you were given the practical uses of CS related to your hobbies and interests	11,4%	12,4%	10,1%	2,3%	10,4%	17,7%	18,7%	20,1%	10,8%	12,6%

Tabla 4. Survey results of students aged 12-16 on what they consider would most boost their interest in CS.

Additionally, the study found that the method of increasing interest in CS is dependent on the age of the child, where older children are more interested in the practical applications, and, being more aware of what CS is, are less interested in having talks to introduce the subject, than younger students who are unsure of what it is.

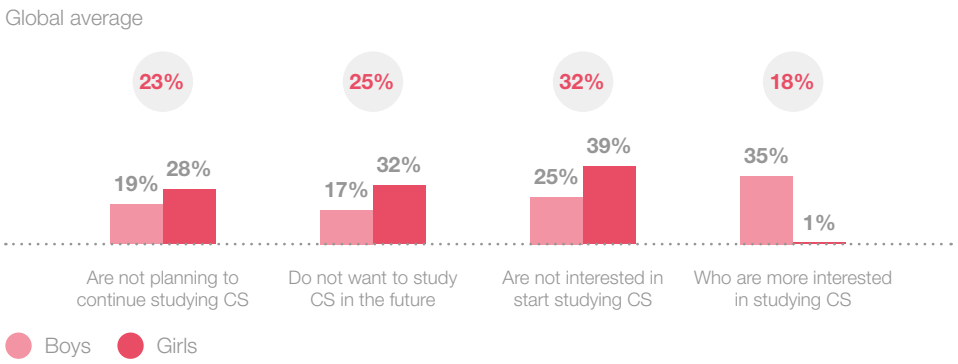
3.6 - GENDER GAP IN CS EDUCATION

The perceptions that girls and boys have of CS are very similar, however, when it comes to the interest in studying the subject differences occur, with girls being less inclined to study it than boys. The study identified several factors that potentially impact the level of interest in CS.

While girls are less interested in studying CS than boys, their perception of importance, required skills and probability of using CS skills in their future jobs is the same. The results indicate that this difference may arise due to the influence of their parents. According to a previous study by Google, social encouragement (i.e. the positive reinforcement from family) comprises 28% of the explainable factors influencing a young woman's decision to pursue CS[1].

3.6.1 - Perception vs real interest

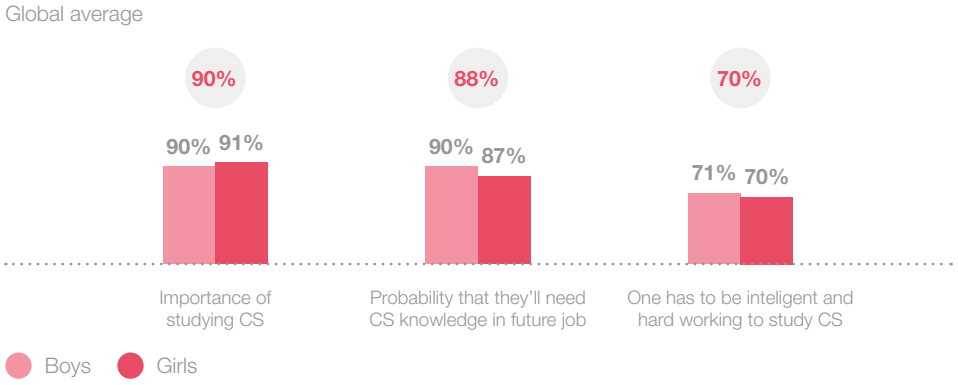
Interest in CS of girls vs. boys



The study found that more girls are not planning to continue studying CS (28 % versus 19% of boys). Even more significant was the number of girls who were not interested in studying CS in the future, almost double that of boys, 32% and 17% respectively. There is also a considerably larger portion of girls than boys who are not interested in giving CS a chance, and explicitly uninterested in studying it. When asked directly regarding who they think is more interested in CS, there was an overwhelming consensus that boys are more interested (35% to 1%).

[1] Women who choose CS – What really matters – The critical role of encouragement and exposure.

CS Perception of girls vs. boys

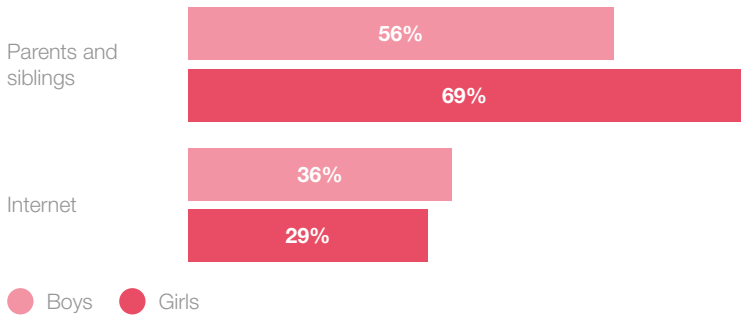


Although girls are less interested in studying CS than boys, their perceptions regarding CS are very similar, both concurring on the importance of studying CS, the probability of using CS in their future jobs and the skills required to be successful in the field.

This difference in interest in studying CS between boys and girls has already created a gender gap, where the study found that 28% fewer girls program/code than boys (19% boys versus 13% girls).

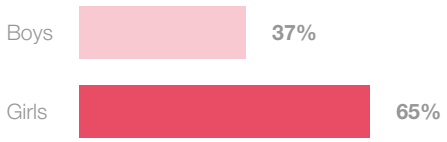
3.6.2 - Parents' influence on the interests of their children

Parents have a significant influence on the interests of their children, as was seen in the previous chapter. The survey results suggest that this is more so for girls, indicating that girls rely more heavily on parents or sibling for support compared to boys (69% to 56%), whilst boys are more self-reliant, opting on more occasions to consult the internet when confronted with a problem (36% boys, 29% girls).

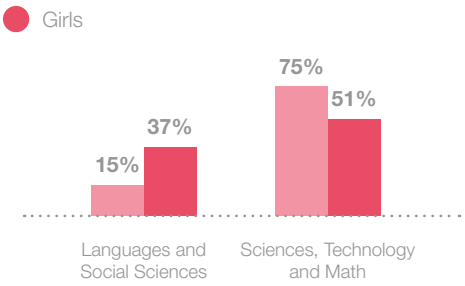


The influence of parents on whether a child (and even more so for a girl) studies CS is also reflected when analyzing the results of whether their parents have encouraged them to study CS or not. Girls who do study CS have a slightly higher percentage of parent support than boys (65% to 61%), whilst girls who do not study CS, receive significantly less encouragement than boys (12.9% versus 23.9% for boys).

Students who prefer language and social science related subjects:



Students perceptions of the capabilities their parents think they have:



This influence of the parents has an impact on the preferences of subjects the girls adopt as shown by the results; where a larger percentage of girls than boys who perceive that their parents think they are more capable at studying language related subjects is reflected in the preference of subjects, with girls preferring language related subjects. This indicates that parents play an important role in capturing the interest of girls in CS.

Opinions of experts and focus groups

- The fact that girls in general prefer language related subjects should not influence their interest in CS. However, the uncertainty of what CS entails makes them associate it with other technology related subjects where their interest falters. In order to **capture the interest of girls** into these technology subjects, **the content should be adapted to appeal to diverse interests both girls** and boys, such as focusing on the communication and social aspects of CS.
- **The influence of the image their parents have of them is significant.** Experts mention that it is embedded into society to indirectly influence boys towards sciences and girls towards humanities, arts and biohealth actitivies/careers, an example being the presents given to children and the activities their parents sign them up to.

3.7 - PARENTAL SUPPORT

The lack of knowledge of CS and its impact on society causes many parents to not prioritize its study, either because they believe that their children are already studying it at school (confusing CS with other ICT subjects) or they assume that the key subjects for the future of their children are taught at school (formal education).

A recurring factor influencing every aspect regarding the study of CS is the lack of knowledge. In the case of the parents, the fact that they are unaware of the possibility and benefits of studying CS results in them not encouraging their children to study it, which, as was mentioned previously, is a critical factor for children to start studying the subject. In this way, the lack of knowledge impacts in parents thinking that their children are learning CS in school, when in most cases this is not true.

In addition, and despite parents recognizing the importance of CS for the future of their children, some parents do not encourage their children to study CS as they consider their children too young to study it (even though this is not the case), as well as the growing concern that their children spend too much time using ICT devices, in most case for non educational purposes.

Finally, for parents to consider a subject as critical for the future of their children and hence prioritize its study it must be taught at school. As such, the integration of CS into the formal education is an essential step to consolidate the perceived importance of CS of parents.

3.7.1 - **Parental encouragement to study CS**

63 %

Of children

Between 12 and 16 years old who **study CS have been** encouraged by their parents

19 %

Of children

Between 12 and 16 years old who do **not study CS have been** encouraged by their parents

The results of the survey show that the students who are studying CS have been encouraged by their parents, regardless of their understanding of what CS is. On the other hand, only 19% of the students who have not studied CS have been encouraged by their parents to do so.

The encouragement of parents is therefore of the utmost importance for students to study CS, especially in the current situation, where there are limited opportunities to do this at school.

3.7.2 - **Ambivalent attitude of parents towards CS education**

Parents highlight that subjects important for their children's future should be taught at school (formal education), considering this the place where the fundamental skills and knowledge should be acquired. The results indicate that parents highly value CS and understand that it is important for the children´s future, as such they consider it should be included into the formal education and taught at school.

Means of study CS

73%

73% of the surveyed parents believe that CS should be taught at school

The results of the survey found that a majority of parents (68%), once made aware of what CS is, are interested in introducing their children to the subject. This is a positive result as it shows that there exists a general interest, which according to experts, was not the case a few years ago. However, 32% of parents with children in Primary School, even when explained what CS is, are not interested in having their children study it, despite considering it important in the medium and long term. This is due to the fact that in the short term there are a number of concerns that add to the lack of knowledge of what CS is and the benefits of learning it at an early age.

Parents interest

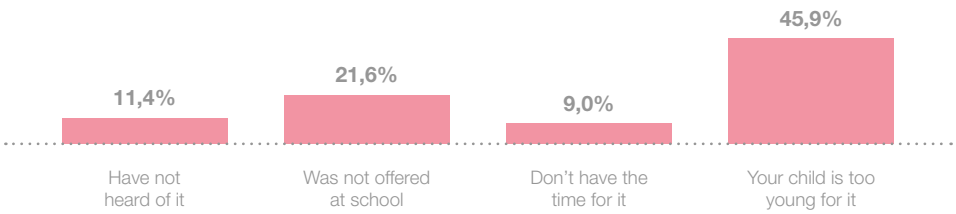
32%

Parents of children between 6 and 11 years old who are not studying CS do not want them to start studying CS

Three main reasons were identified for this lack of interest: CS is perceived as a complex subject not suitable for this age group; there is a growing concern regarding the excessive time devoted to the use of digital devices and the internet; and finally, the apprehension regarding cybersecurity and the safe use of the internet and digital devices impacts on their willingness to increase the exposure of their children to this environment.

In addition, as mentioned previously, the fact that it is not taught at school reduces the perceived importance of studying CS.

Reasons why parents are not interested in their child studying CS

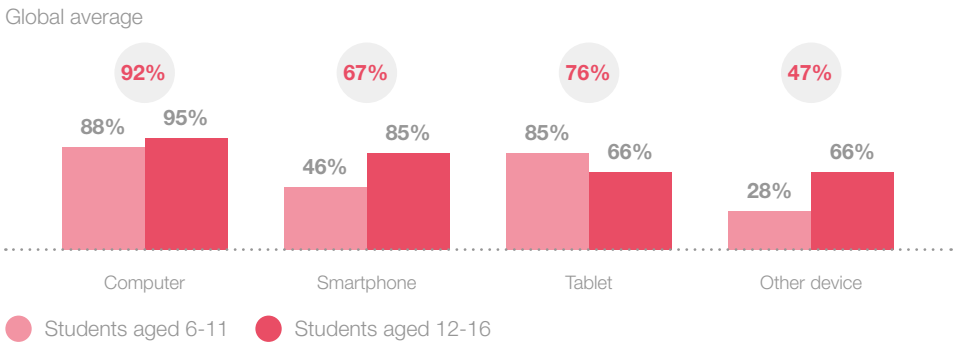


3.8 - USE OF TECHNOLOGICAL DEVICES

In general, Spanish children have the necessary infrastructure to carry out CS related activities (there is a high penetration in the use of technological devices among young children and there exists a high access to the internet). However one must note that the majority of young children only use these devices as end users, and they do not acquire CS knowledge or skills.

The use of technological devices by young students is vital for them to become from an early age confident with technology and develop digital literacy[1]. These devices together with the high access to internet (77.7% of the Spanish population)[2] provides students with the necessary infrastructure to take their technological knowledge a step further by learning CS, which is the main focus of this study.

3.8.1 - Market penetration of technological devices

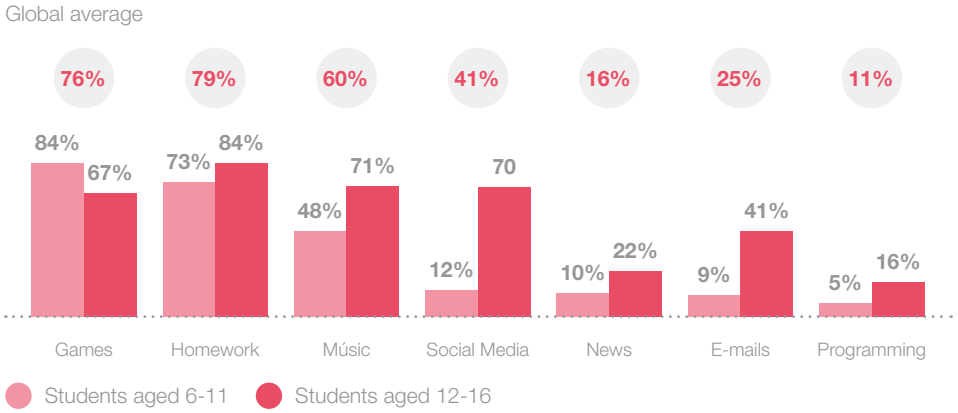


The device with the highest market penetration is the computer, averaging 92% (88% amongst Primary School students and 95% for Secondary School students).

There is a noticeable difference concerning the market penetration of smartphones and tablets between Primary and Secondary Schools students, with the latter having a significantly higher use of smartphones (85% versus 46% for Primary School students). The market penetration of smartphones increases with age (the results of the survey show it increases from 46% amongst 6-11 year old to 73% amongst 12 year olds and then to 96% amongst 16 year olds). On the other hand, students aged 6-11 use tablets more frequently, with the market penetration almost equaling that of computers for this age group.

[1] Searching for CS: Access and Barriers in U.S. K-12 Education – Google.
[2] Survey on the habits and cultural practices in Spain 2014-2015, Spanish Ministry of Education, Culture and Sports.

3.8.2 - Main uses of technological devices



The main use given to these devices by Primary School students is for games (84%) which is significantly higher than that of Secondary School students (67%). The popularity of tablets amongst Primary School students can be attributed to this difference in use, as a bigger screen is preferable for game playing. With age the variety of uses of these devices increases, including email, social media and reading the news, applications of little interest to most Primary School students.

For the most part however, children are only acting as end users. The number of students who use these devices for programming purposes is very low, only 5% and 16 % of Primary and Secondary School students respectively. The number of students who program increases with age where the results showed there was also a significant increase among Secondary School students (increasing from 7.3% to 23.9% between the ages of 12 to 16).

Opinions of experts and focus groups

- The **access to internet and market penetration of ICT devices,** especially smartphones **will continue to increase.** Smartphones amongst Primary School students will experience the greatest increase as they become more affordable and offer more applications oriented to the younger public (including educational purposes).
- Traditionally, **as children get older and become more responsible** and independent, parents consider it appropriate to give their children **mobile phones (smartphones),** as a way to keep in contact.

3.9 - TEACHERS' READINESS TO TEACH CS

The cases where CS has been integrated into the curriculum have demonstrated that the introduction of CS into the educational system is complex and requires teacher preparation, for them to learn the fundamentals of the subject and the teaching know-how particular to this subject.

When introducing a new subject into the educational system teacher preparation and training is critical in order to avoid overwhelming the teachers by having them teach a class they are not prepared for. The study has identified that there are several private and governmental initiatives that have been launched that provide professional development for teachers related to CS. However, most teachers are not signing up due to a lack of a long term implementation plan of the subject and clear support from Public Administrations.

3.9.1 - Teachers need to prepare themselves to teach CS

Initiatives that provide teacher training	Why teachers are currently not prepared to teach CS classes
Various private and governmental initiatives exist that provide teacher training aimed at introducing them to coding software such as Scratch and App Inventor, providing them with the tools necessary to teach CS classes using these software. More information can be found in the section "CS of the Context Analysis".	The training required to become a teacher does not include any elements of CS. A lack of time to dedicate to a training course on a matter which they are unsure of the benefits and that is not in the school curriculum. The current educational system does not incentivize teachers to undertake this training as is not part of the curriculum.

The lack of knowledge has resulted with a general unease amongst the teachers with respect to teaching CS in class, unsure how they would address it, and how they would adapt an already cramped curriculum to make room for it.

Despite lacking the necessary training, teachers have not prioritized this kind of professional development. The main reason identified is that they are not aware of the benefits that the integration of CS into their class could bring. Teachers also highlight that school principals are not encouraging them and as a result they are not incentivized to undertake what they consider an extra burden on their already limited time.

3.10 - MAIN FINDINGS

The analysis just covered of the data gathered during the field work phases, centered around 8 main topics, their main findings summarized below. These finding are the foundations on which the recommendations presented in the following section are based.

- There is a **general lack of knowledge amongst both parents and children of what CS is** and what it entails. This lack of knowledge makes it difficult for key stakeholders of Primary and Secondary Education to understand the importance and the value of learning CS from an early age.

- The study of CS at Primary and Secondary School is a novelty and has only recently been introduced in the curriculum of some regions in Spain. As a result, **children aged 6-16 who study CS are a minority.**

- **Parents and students have a positive perception of CS** considering it a creative subject that is important to study as it is likely to be a required skill for future jobs, and consequently believing it should be taught at school. However, there is a perception, by both parents and students, that it is too complicated for them to study.

- **Parents show an ambivalent attitude towards their children learning CS,** despite considering it important in the medium and long term. This is due primarily to the lack of knowledge regarding CS and the associated benefits of learning it, along with three other reasons: it is perceived as a complex subject and not suitable for this age group; there is a growing concern about the excessive time devoted by some minors to the use of digital devices and the internet; and finally, the apprehension regarding cybersecurity and the safe use of the internet and digital devices has its impact.

- **A majority of students are interested in studying CS,** which seems to increase when the children start taking lessons. The challenge ahead lies in capturing the interest of those who do not study CS and do not know what it is.

- The perception that girls have of CS is the same as that of boys. On the other hand **girls are less inclined to study CS than boys** and perceive to a lesser extent than boys that their parents consider them capable of studying Science related subjects.

- In general, **Spanish children avail of the necessary infrastructure to carry out CS related activities.** However one must note that the majority of young children only use these devices as end users, and they don't acquire knowledge or skills related to CS.

- The cases where CS has been integrated into the curriculum has demonstrated that the **introduction of CS into the educational system is complex and requires teacher preparation,** for them to learn the fundamentals of the subject and the teaching know-how particular to this subject.

4 RECOMMENDATIONS

4.1 - CS SKILLS: A SOCIAL NEED

In the new digital era society as a whole will require a certain level of digital skills. We are responsible for providing children with the proper tools and knowledge to be ready to form part of this new digital world.

In the future technology will be present in all areas of society, and in particular CS at the core of most of emerging technologies. Therefore, learning the basics of CS is becoming as important as other science or humanities subjects taught currently in schools, and will be of importance whatever career one may choose. It helps, in addition, to open more opportunities in the labor market for any student.

In order to be ready for their future, it is essential that children are exposed from an early age to CS at school. CS not only teaches children about technology, but also develops various key skills, particularly strategies for problem-solving, which are applicable in many fields. The introduction of CS into the education system would benefit young students in various ways:

Understanding how computers work

If we live in a digital world where machines are fully integrated, understanding how those machines work and communicate is essential.

Computational thinking

Computational thinking is a process that generalizes a solution to open ended problems. Open-ended problems encourage full, meaningful answers based on multiple variables, which require using decomposition, data representation, generalization, modeling, and algorithms. Computational thinking requires the decomposition of the entire decision making process, the variables involved, and all possible solutions, ensuring that the right decision is made based on the corresponding parameters and limitations of the problem.

Curiosity, self-confidence and teamwork

CS promotes teamwork among children as they share, compare and explain the different solutions to a particular problem to one another.

Access to future labor market

Children will need a core knowledge of CS to access the future labor market where a significant number of jobs will require a basic knowledge of coding; there is expected to be a vacancy of 825,000 ICT jobs by 2020 in Europe.

4.2 - RECOMMENDATIONS TO BOOST THE STUDY OF CS

Throughout the study various barriers and strengths have been identified for which different recommendations have been made in order to overcome them. The recommendations target five different audiences: Public Administration, Schools and Teachers, Parents, Children, and Industry.

Improve the understanding and awareness of what CS is, detailing the elements that it involves, as well as its practical applications as a critical first step to ensure the success of any initiative aimed at promoting CS education

Public Administration | Schools & Teachers | Parents | Children | Industry

The term Ciencias de la Computación, CS in Spanish, is not extensively used in Spain, with the broader term Informática being used for most subjects related to CS elements (although the term also includes various activities not associated to CS). The study revealed that there is a general lack of knowledge and conceptual understanding of what CS is and what it entails, leading to people mistaking CS for Digital Literacy or Digital Competency. This confusion between these concepts complicates the promotion of CS education as this results in the public believing that CS is already being taught when in reality this is not the case, losing sight of the associated importance and advantages.

The first step, building upon the increase in the number of CS initiatives in Spain is to inform the public (families, teachers, students and government officials) what is meant by CS. A differentiation must be made between CS and the already established Digital Literacy or Digital Competency before a widespread integration of CS into the educational system can be made.

Improve the understanding and awareness of what CS is, detailing the elements that it involves, as well as its practical applications as a critical first step to ensure the success of any initiative aimed at promoting CS education

Public Administration | Schools & Teachers | Parents | Children | Industry

The study of CS develops a set of competencies and skills that are applicable to any future profession, and are highly sought after in the labor market, not only those positions related to technology. These benefits must be made clear to the parents in order to gain their support in the promotion of CS education and overcome their current reluctance for their children to undertake CS classes.

Establish a consensus framework among key stakeholders regarding the roadmap to follow to introduce CS into the educational curriculum of both Primary and Secondary School

Public Administration | Schools & Teachers | Parents | Children | Industry

Families and educators have noted the need to integrate CS into the curriculum since otherwise a perception would exist that it is a low priority subject compared to others already taught at school. Some regions have started to integrate CS into their regional curricula. This trend should continue with other regions following suit, and using the best practices of those already familiar with the process, incorporating CS into both Primary and Secondary School. A prior assessment on how to introduce CS into both Primary and Secondary Education at a national and regional level should be made with the consensus of all involved stakeholders. The introduction of CS education should then be complemented with continuous support from the Public Administration as well as from industry, providing the provision of content and teaching materials as well as coordinating communities of best practices.

Encourage and support the professional development of current and future teachers in the field of CS, designing itineraries and specific content for both the continuous and initial training of teachers

Public Administration | Schools & Teachers | Parents | Children | Industry

When introducing a new subject such as CS into the education system a critical first step is to ensure the teachers are well prepared to teach the subject, ensuring they have the specific knowledge both on the content to be taught and the teaching methodology. To introduce CS properly into the formal education it will be necessary to provide this professional development to teachers in both initial teacher training and in the continuous education for practicing professionals.

Articulate collaborative mechanisms that enable CS professionals to participate in a productive manner in the education and training of students and teachers respectively

Public Administration | Schools & Teachers | Parents | Children | Industry

In order to increase the knowledge and interest of students in CS, students have demanded greater contact with professionals in the field. Designing mechanisms to increase the participation of these professionals is not only appropriate for the education of students but also for the professional development and support of teachers. Some of the initiatives of reference in Europe apply these so called collaborative models in which industry professionals provide additional support to educators.

Given the lack of CS knowledge, related professions and practical applications, it is advisable to count on the participation of professional associations, universities, companies and other organizations in the ICT industry in promoting and supporting the study of CS

Public Administration | Schools & Teachers | Parents | Children | Industry

Due to the lack of CS knowledge, the involvement of all stakeholders in the ICT sector in promoting and supporting the study of CS is critical. Both professional associations, universities, research and innovation centers, and industry should collaborate with the Public Administrations to inform and communicate to all educational field participants the applications and social usefulness of CS, such as CS professions and associated sectors.

Promote CS activities among young students, exposing them to the practical uses, fostering CS as a creative and collaborative subject

Public Administration | Schools & Teachers | Parents | Children | Industry

The image the public has that CS is too complicated to learn and that it is an individualistic activity must be overcome to increase the interest of students. The study has found that those students who have been exposed to CS and have practical experience in the field are more inclined towards studying CS. For this reason it is recommended to increase access to CS educational activities, such as non-formal education online initiatives (cs-first.com, code.org, scratch.mit.edu) as well as offline ones, where students can discover the reality of what CS education involves.

Address the existing gender gap, increasing the participation of girls in CS related activities, thus equalizing the future opportunities of both boys and girls in participating in this field

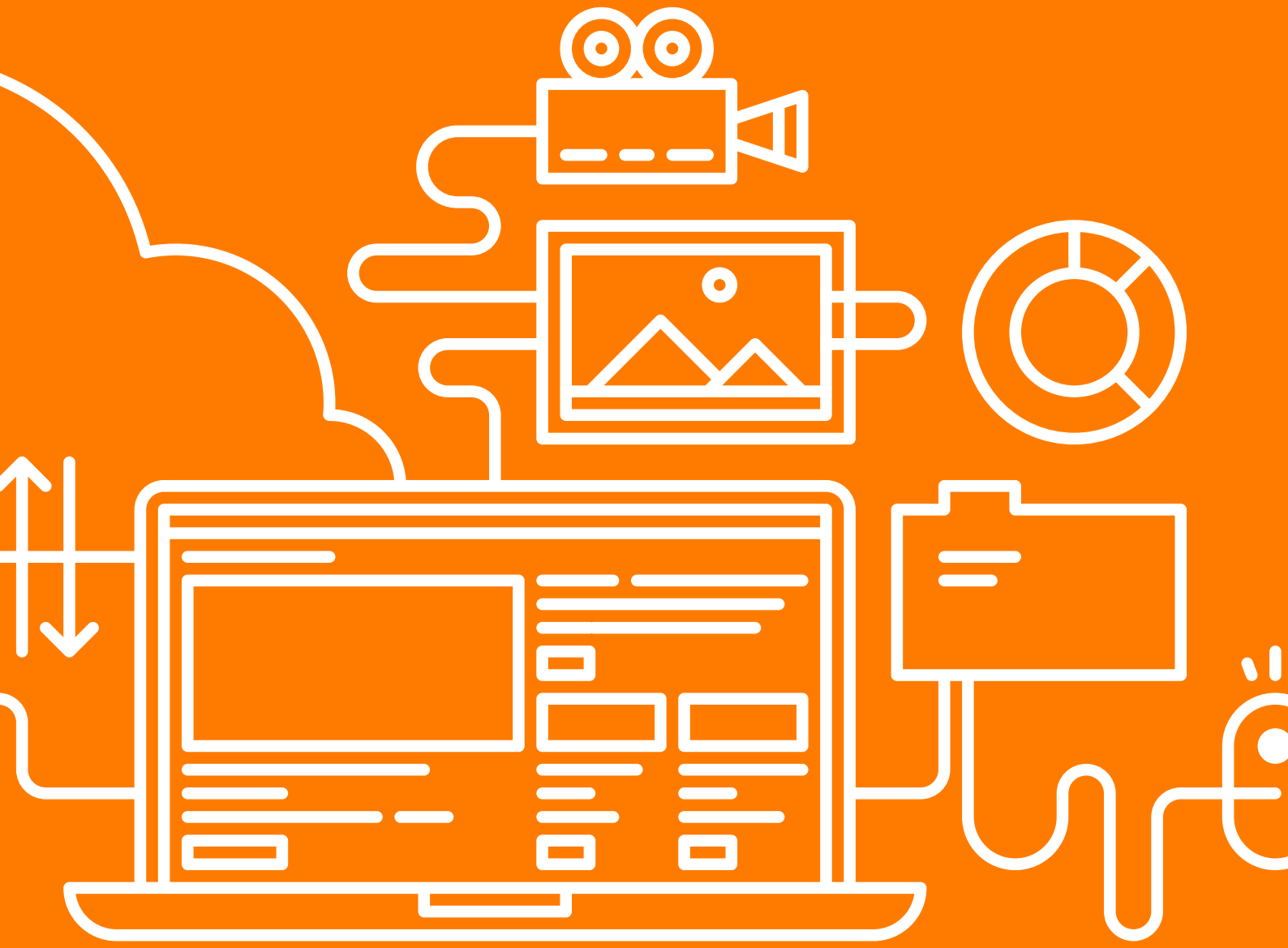
Public Administration | Schools & Teachers | Parents | Children | Industry

Whilst the perception of CS is the same for both boys and girls, when it comes down to the interest in studying it a gender gap exists where fewer girls are interested. This should be addressed by making women role models in the field of CS and the social impact that CS has more visible (such as in madewithcode.com). In addition actions to break gender stereotypes that affect the image assigned by parents of students should be promoted. The gender gap should be taken into consideration in the design stage of the curriculum, developing class activities and content that generate a greater involvement of girls.

The strategy of integrating CS in the formal education should build on the experience of non-formal educational initiatives in order to evaluate the effectiveness of different approaches and methodologies applied in teaching CS, as well as content design

Administraciones Públicas | Colegios y docentes | Padres y Madres | Niños y Niñas | Industria

The report has identified that most existing CS initiatives focus on the non-formal education. As such, it is recommended take into account these experiences when planning the integration of CS into the formal education, as well as the experiences of previous integrations, both in Spain and abroad. An initial evaluation of the effectiveness of different approaches and methodologies, as well as the identification of the most appropriate content could provide substantial benefits and increase the likelihood of success of the integration.



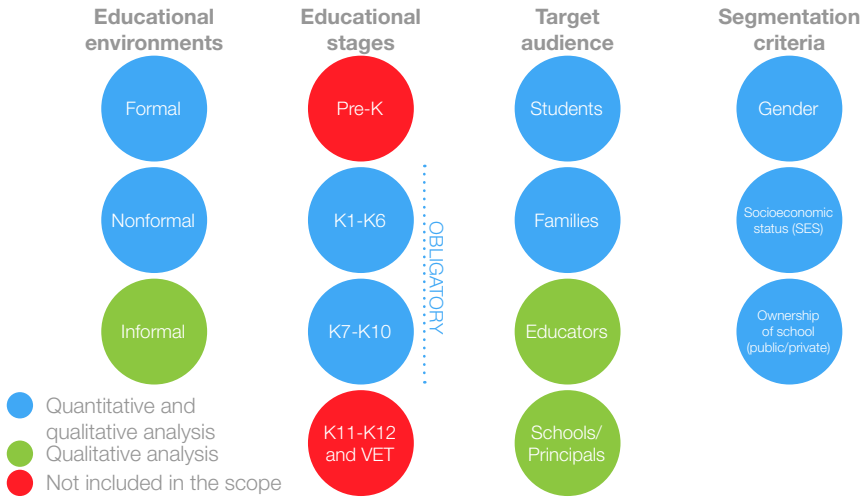
5 APPENDIX I: REPORT METHODOLOGY

5.1 - METHODOLOGY

The study methodology was designed to ensure the gathering of reliable quantitative and qualitative information and produce well-founded results.

- **Objective:** Create a report analyzing the current situation concerning CS education in Spain, and leading up to a series of recommendations for the introduction, extension and improvement of these learning skills in the short and medium term.

- **Scope:** The scope of the study was the following:



- **Topics of analysis:** The analysis carried out focused on various different topics in order to achieve a holistic view of CS education in Spain, highlighting the following:

The methodology of the report has been structured in three different phases. The surveys gathered quantitative information whilst the interviews & focus groups gathered the qualitative information.

- **Phases:** The methodology followed had three different information gathering stages:

Parent & student surveys

1,210 Surveys to parents

609 Surveys to parents regarding their 6-11 years old child

505 Surveys to children aged 12-16

Telephone interviews

~30 Interviews with school principals and teachers

Private

Públic

Charter

Focus groups

3 Focus groups with school principals and teachers

Madrid
Sevilla
Zaragoza

2 Focus groups with parents

Sevilla
Zaragoza

Note (1):The survey has been conducted by SIGMA DOS as technical partner.

Note (2):Despite the location of focus groups, they were composed of people from: Madrid, Catalonia, Navarra, Andalucía, Aragón, Comunidad Valenciana, Castilla-La Mancha and Castilla y León.

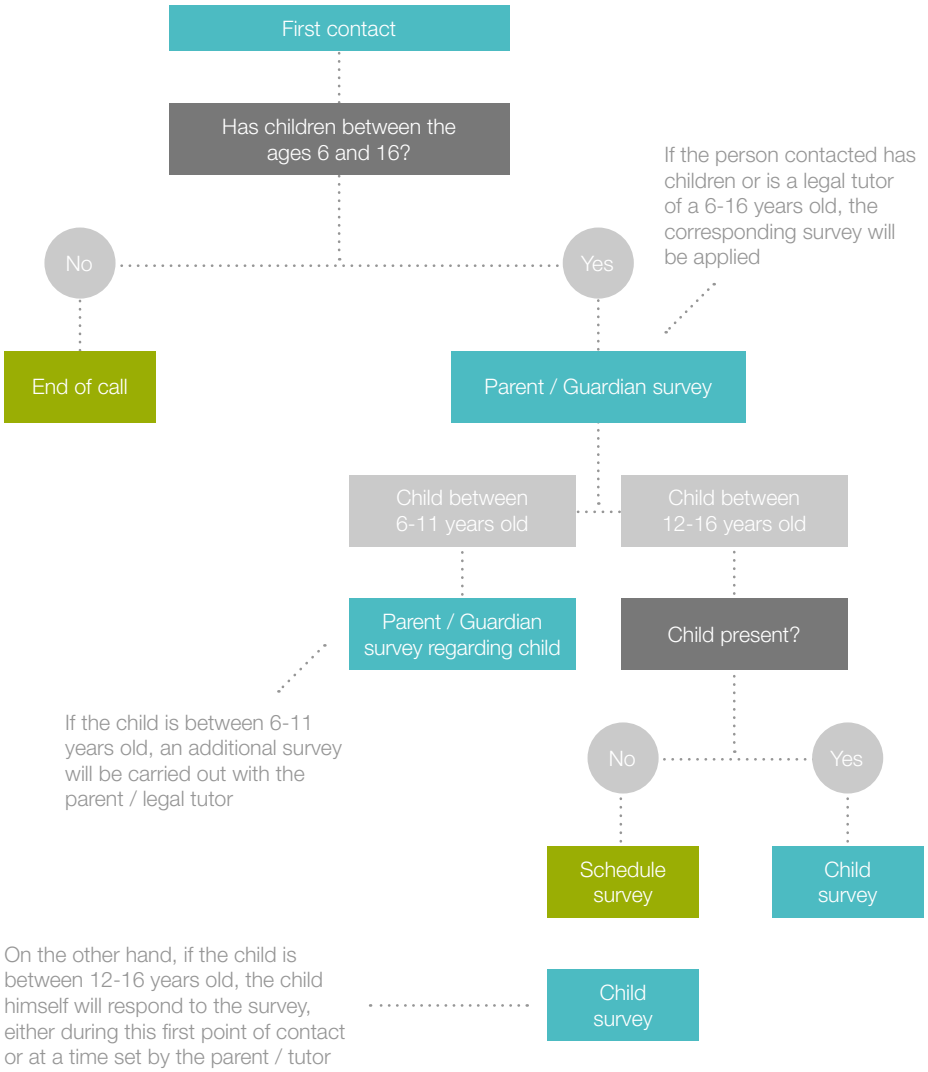
5.2 - SURVEY METHODOLOGY

SIGMA DOS has surveyed more than 1,200 parents and 500 children between 12 and 16 years old in order to understand the actual situation of CS education in Spain.

The first phase of the research was the phone surveys. The aim of these surveys was to obtain the following quantitative information regarding CS education in Spain:

- **Conceptual understanding of the Spanish society** of what CS is and their **depth of knowledge** in said area.
- The **use of technology** by Spanish students and their **views on people who study CS.**
- The **extent to which Spanish students study CS** and their thoughts on the associated **benefits.**
- **Awareness of opportunities available to study CS** and the extent to which schools offer these opportunities.
- The importance given and the **interest of Spanish students in CS.**
- **Thoughts given to future studies.**

The survey was conducted with the following methodology:



The survey questionnaire was adapted for the target respondent. The questionnaire was restricted to a duration of 10-12 minutes

In order to develop the best questionnaire possible, a pretest was carried out to validate the duration and the general understandability of the questionnaire. After the pretest, some questions were modified and some were deleted to assure the final objective of the survey.

The final questionnaire, along with profile and sociodemographic questions, had four main topics:

General thoughts on Computer Science

- Which activities do you consider to be part of CS?
- Which adjectives best describe someone who studies CS?
- Do you think your child would be good at CS?
- Who do you think is more interested / successful in learning CS?

Future and importance of CS

- How important do you consider having a university degree is in succeeding in the future?
- How likely is it that your child will end up having a job requiring a certain degree of knowledge of CS?
- Which advantages do you think studying CS offers?

Knowledge, availability and resources

- In your opinion, how important is it for children to study CS?
- Should the study of CS be compulsory for children?
- That you are aware of, which of the following means are available for you to study CS?

Study of Computer Science

- Where did you learn CS?
- What led you to study CS?
- What benefits does the study of CS contribute to?
- Are you planning to continue studying CS?
- Would you like to study CS in the future at university or as a professional development?

5.3 - INTERVIEW METHODOLOGY

The interviews with school principals, head of studies and teachers provided qualitative information regarding CS education, the perception of principals and teachers, as well as some insight into the readiness of schools and teachers.

- **Objective:** Discuss and enrich data and findings gathered from surveys of families and students through the opinions and points of view of key stakeholders in formal and non-formal education (teachers, educators, principals, etc.), as well as going deep into "educational system readiness" items.
- **Method and duration:** 60-minute long telephone / videocall interview, following a specific questionnaire comprised of a review of results gathered through surveys and questions related to the topic of "educational system readiness".
- **Main topics developed:** Every topic developed in the interviews was adapted and focused around the educators, in order to understand their opinion regarding:

Understanding of CS.

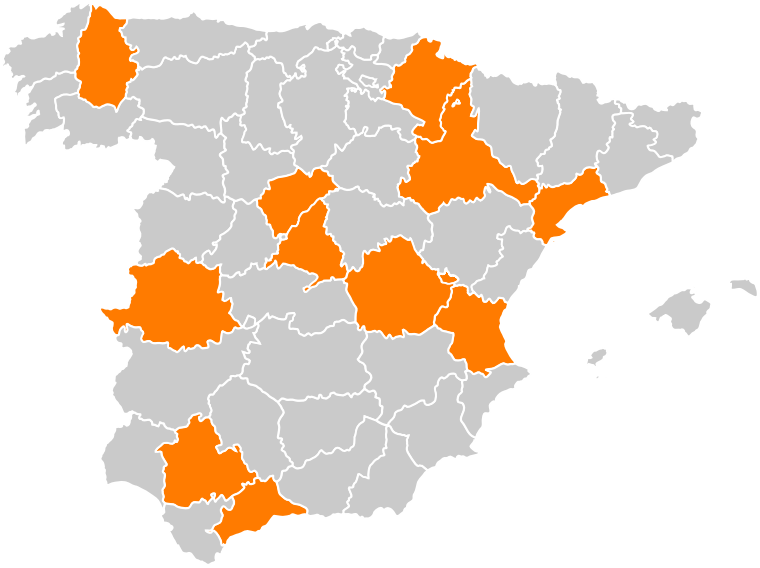
CS educational activities and programs.

Professional guidance and career opportunities.

Interests and motivations.

Educational system readiness.

- **Sample:** 28 interviews with educational environment key stakeholders (principals, teachers, non-formal activities educators and heads) were conducted.



Professionals from eleven **regions** have been interviewed

Professionals from **charter school**

Professionals from **private school**

Professionals from **public school**

Heads of studies

Heads of ICT

Non-technology teachers

Technology teachers

Principals

5.4 - FOCUS GROUP METHODOLOGY

The focus groups provided valuable qualitative information regarding barriers to studying CS and recommendations to boost CS education in Spain.

- **Objective:** collect qualitative information through the opinions and perceptions of the different stakeholders identified on the current situation of CS education and perspective from the presentation of the preliminary results of the fieldwork and opinions from in-depth interviews.

  The main value of the focus groups was the interactions between the participants, where the response of one participant stimulated other participants, generating an exchange of responses with better results than if participants of the same group had made their contribution independently.

- **Content:** The focus group agenda was:

  1. **Objective** of focus groups (5 minutes):
     This section of the focus group had a target to clarify the reason why all the participants were in the session and the final objective of the focus group.

  2. Project **context and methodology** (10 minutes):
     Definition of project objectives and explanation of the methodology implemented in the project. Project timeline and phases.

  3. Survey **key findings** (20 minutes):
     Explanation of survey key findings focusing on: CS concept understanding, CS educational activities and programs, interests & motivations, etc.

  4. Guided **debate** (85 minutes):
     Debate about the survey figures oriented to: reasons or origin of results, needs / barriers to study CS, educational system readiness, recommendations and initiatives, etc.

- **Method and duration:**
  - » 8-10 participants per Focus Group.
  - » One moderator introduces participants to the preliminary results of the field work and raises related questions, moderating the debate; one or more observers take notes of the discussion and resulting interaction.
  - » Duration: 2-3 hours maximum.
- **Sample:** In order to cover the whole scope of analysis, five focus groups were carried out, two of which were with parents and three with school principals and teachers.

Focus groups composition

Education professionals focus groups

5 **Technology** professors

2 **Principals** or **Head of studies**

1 **Non-technology** professors

2 Professionals from **non formal education per FG**

Ownership of school and educational stage will be also considered

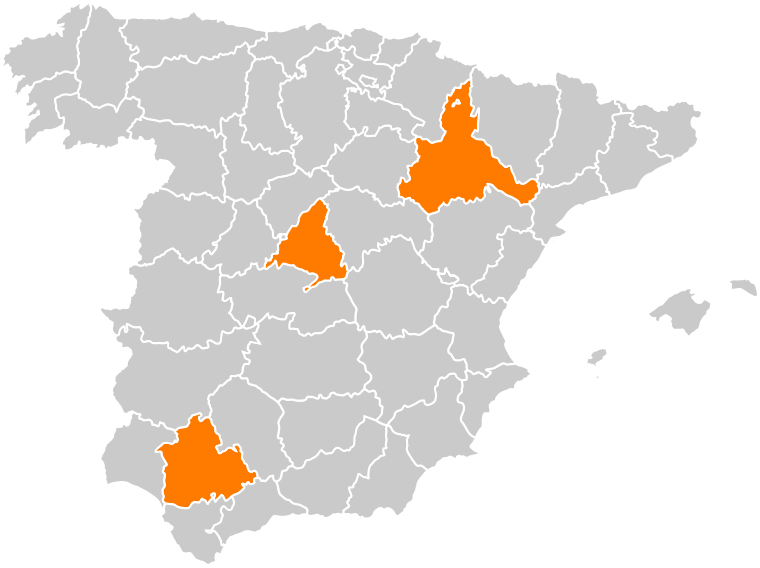
Families focus groups

5 Parents with kids between **6 and 11 years old**

5 Parents with kids between **12 and 16 years old**

Gender, ownership of schools and socioeconomical status will be also considered

- **Location:** The focus groups were carried out in Madrid, Sevilla and Zaragoza to cover as much of the Spanish geography as possible.



Place	Type	Participants
Madrid	Professionals & children	Madrid, Castilla-León, País Vasco, C. Valenciana
Sevilla	Professionals & families	Andalucía, Extremadura, Castilla-La Mancha
Zaragoza	Professionals & families	Aragón, Navarra, Cataluña, La Rioja

Despite the location of focus groups, they were composed with people from: Madrid, Cataluña, Navarra, Andalucía, Aragón, Comunidad Valenciana, Castilla-La Mancha and Castilla y León.

6 ACKNOWLEDGEMENTS

We would like to **express our gratitude to those who have participated in the study,** answering the questions posed in the survey and in the interviews, as well as those who attended the focus groups. A special thanks goes out to the experts who collaborated and provided critical insights, enriching the study:

Pilar Olivares de Julián
Chief of Digital Resources (INTEF)

Alfonso Ruíz Oliva
Teaching Technical Advisor (INTEF)

José Luis Zimmerman
Director of Asociación Española de la Economía Digital

José Andrés Mateos
Member of Asociación Andaluza de Profesores de Informática

Frank Sabaté Salazar
Teacher at Escola Projecte (Barcelona)

Jesús Moreno León
Co-director of Programamos

Eduard Muntaner Perich
UdiGital (University of Girona)

Andrés Gómez Ortega
Founding Member of Zagales Hacklab

Google

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