

Computing our future

Computer programming and coding

Priorities, school curricula and initiatives
across Europe



Update

2015

Publisher:

European Schoolnet
(EUN Partnership AIBSL)
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Belgium

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Published:

October 2015

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This publication has been funded with support from the Executive Agency for Small and Medium-sized Enterprises (EASME). Neither the European Commission, the EASME or other European institutions nor any person acting on their behalf is responsible for the use which might be made of the information contained herein or for any errors, which, despite careful preparation and checking, may appear. The views in this publication are those of the author and do not necessarily reflect the official position of the EASME, the European Commission or other European institutions.



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Preface

Marc Durando, Executive Director of European Schoolnet

Digital competences and skills are one of the main conditions for the success of the digital transformation in Europe, its growth, and the wellbeing of citizens and society as stated in the Digital Single Market Strategy launched by Vice President Andrus Ansip on 6 May 2015.

The challenge for the Education sector is to upskill the future workforce, but more importantly to empower young people with the competences to master and create their own digital technologies, and thrive in the society of today. We believe that teaching and learning how to code, in formal and non-formal education settings, will play a significant role in this process. In May 2014, DG CONNECT invited European Schoolnet to take the lead of an industry driven coalition and set up a neutral platform for the promotion of teaching and learning programming and coding. The result of this call to action was the founding of a European Coding Initiative.

In October 2014, the former Vice President of the European Commission Neelie Kroes officially launched the Initiative and the [all you need is {C<3DE}](#) website for students, teachers and adults who want to try out coding for the first time, and to discover what opportunities it can open up for them.

The Coding Initiative contributed to supporting the political momentum for a stronger integration of coding in K12 education. In 2014 European Schoolnet launched a survey with its member Ministries of Education to get a more consistent picture of how and where coding was already in national, regional or school curricula. The 2014 report has now been reviewed and updated

on the basis of data gathered during summer 2015. It contains information from 21 European countries, 16 of which have already integrated coding in the curriculum as well as links to initiatives, pilots and best practices per country.

In parallel to the advocacy action, teachers have also been supported directly in teaching programming and coding through the provision of open online courses via the [European Schoolnet Academy](#) and the collection and curation of teaching materials, tools and lessons plans.

A year on, the funding members of the programme – Facebook, Liberty Global, Microsoft, SAP, and Samsung, coordinated by European Schoolnet – are intensifying their effort and commitment in support of the Initiative.

How is coding currently integrated into curricula, and how can we further advocate for coding as a key skill for a thriving and ever-innovative digital society and economy? These questions have set the scene for the development of this new report and to the renewal of our commitment to the promotion of coding teaching and learning.

Executive Summary

Many educators, as well as parents, economists and politicians in Europe and worldwide are starting to think that students need some computing and coding skills.

One rationale is the shortage of ICT-skilled employees: By 2020, Europe may experience a shortage of more than 800,000 professionals skilled in computing/informatics. Another important rationale is that coding skills help to understand today's digitalised society and foster 21st century skills like problem solving, creativity and logical thinking.

In October 2014, European Schoolnet published its first major report providing an overview of a wide range of coding initiatives across Europe, in both formal and informal learning environments. In the last year, coding in schools continued to be a worldwide trend and major European countries like France and Spain have just introduced it in their curricula this year. This report represents an updated overview of the formal integration of coding in school curricula across Europe, illustrated with examples of curricula integration by country. The report also looks at training provisions for teachers and highlights a broad spectrum of formal and informal coding initiatives offered to students. The findings are based on a [survey](#) with 21 Ministries of Education (from 20 European countries and Israel), which gave an overview of their current initiatives and plans.

COMPUTER PROGRAMMING

Computer programming is 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. These instructions (source codes which are written in a programming language) are considered computer programs and help the computer to operate smoothly.

In this report the terms computer programming and coding are used interchangeably, and are in general referred to as coding. They refer to activities that enable children not only to know how to use specific programmes but to learn how to programme computers, tablets, or other electronic devices.

Computational thinking is typically associated with coding and computer programming, but is more than that, involving “solving problems, designing systems, and understanding human behaviour”, according to the Carnegie Mellon University.

PARTICIPATING COUNTRIES

21 Ministries of Education, or organisations nominated to act on their behalf, contributed to this overview of current initiatives and plans: Austria (**AT**), Belgium Flanders (**BE (NL)**), Belgium Wallonia (**BE (FR)**), Bulgaria (**BG**), Czech Republic (**CZ**), Denmark (**DK**), Estonia (**EE**), Finland (**FI**), France (**FR**), Hungary (**HU**), Ireland (**IE**), Israel (**IL**), Lithuania (**LT**), Malta (**MT**), the Netherlands (**NL**), Norway (**NO**), Poland (**PL**), Portugal (**PT**), Slovakia (**SK**), Spain (**ES**) and the United Kingdom (**UK (England)**).

Key Data from the study

Coding skills in relation to other ICT skills?

Digital Competence is still a key priority

The survey sought to investigate the importance of coding in relation to other ICT skills priorities, such as digital competence, ICT user skills or as a skill to develop key competences and as a tool for learning.

- Most of the countries have usually adopted several priorities, in the range of 2 to 5, for developing ICT competences. Developing students' digital competence was put forward as a priority by almost all countries (19 countries). Using ICT as a tool for learning was one of the main priorities for the majority of countries (16 countries).
- Developing ICT user skills and using ICT for developing key competences also play a prominent role (13 countries/14 countries).
- Coding is mentioned as a main priority only by ten countries. Whilst this is relatively low, it illustrates the approach taken by countries: Integrating coding in the curriculum is given greater importance and a higher priority by some countries in addition to the other ICT skills priorities; it is not a single and separate focus of the curriculum. Obviously, the teaching of coding skills implies the development of digital literacy and the competent use of ICT.
- Countries such as Belgium Flanders, the Czech Republic, Ireland, Malta and Poland mention, in addition to the competences stated above, computational thinking as a key competence to be acquired when integrating coding in the curriculum.

Which countries do actually integrate formally coding in the curriculum?

A higher profile for coding in the curriculum

- 16 countries integrate coding in the curriculum at national, regional or local level: Austria, Bulgaria, the Czech Republic, Denmark, Estonia, France, Hungary, Ireland, Israel, Lithuania, Malta, Spain, Poland, Portugal, Slovakia and the UK (England).
- Finland and Belgium Flanders have plans to integrate it in the curriculum. Finland has defined coding in the core curricula for 2016.
- Belgium Wallonia, the Netherlands and Norway have not integrated coding yet and currently have no plans to do so.
- Progress in the integration of coding in the curriculum between 2014 and 2015 has been made especially by France and Spain*, which have now integrated coding in the curriculum for the first time. Countries which had already integrated coding in the curriculum to some extent for a longer time, like the Czech Republic, Lithuania, Malta and Poland, have now developed more concrete plans for further curriculum integration.

Why integrate coding in the curriculum?

Countries aim to enhance 21st century skills when integrating coding

- The majority of countries aim to develop students' logical thinking skills (15 countries) and problem-solving skills (14 countries), thus addressing 21st century skills. More than half of the countries, namely 11, focus on the development of key competences and/or coding skills. Attracting more students to studying computer sciences is also a rationale for 11 countries. The aim to foster employability in the sector is key for only eight countries.

* In Spain, the implementation of coding/programming measures and actions in Education depends both on the National and the Regional Educational Administrations, thus not every measure affects the whole country.

At which levels?

Coding is mainly integrated at secondary level, but also increasingly in primary education

- Coding is integrated or will be integrated by more than half of the countries (13) at upper secondary school level in general education. Eight of these countries also integrate or plan to integrate it at upper secondary level in vocational education.
- More countries than in 2014, namely ten integrate (Estonia, France, Israel, Spain, Slovakia, UK (England)) or will integrate (Belgium Flanders, Finland, Poland, Portugal) coding at primary level.
- Estonia, Israel and Slovakia integrate coding at all levels of school education.
- In Poland, a new informatics (computing/computer science) curriculum (to be adopted in 2016) will replace existing computer activities and informatics subjects with learning rigorous computer science, including programming at all school levels K-12.

Compulsory or optional?

In one third of the countries coding is already compulsory, but at different levels of education

- In seven countries (Bulgaria, Czech Republic, Denmark, Portugal, Slovakia, Spain, UK (England)) it is compulsory for specific levels of education and mainly integrated as part of a computer course. In Denmark to know about simple programming is a compulsory part of the Physics, Chemistry and Maths curriculum.
- In the UK (England) and Slovakia coding is a compulsory subject in primary education.

- Malta and Poland are planning to make coding compulsory for all students, as “computational thinking is a fundamental skill for everyone, not just computer scientists”.
- In Slovakia, coding is integrated at all levels of school education as a compulsory element. Hence, all students learn it during their entire school education.

A separate subject, as part of the ICT course or cross-curricular integration?

Coding as part of computer science and informatics is already a separate subject in 12 of the countries

- 12 countries have already established a specific coding/computing subject in the curriculum, but also at regional or school level only.
- Moreover, 13 countries integrate coding in a general ICT/technology course, 7 of them depending on regional or school curricula.
- Increasingly coding or computing is also integrated in other subjects, mostly mathematics, in a cross-curricular approach, e.g. in Denmark, Estonia, Finland, Slovakia, Spain and France. Finland will be the first country to introduce coding in a purely cross-curricular approach.

Is coding assessed and how?

Assessment of coding skills is mostly part of students' general assessment:

- Most countries (Austria, Bulgaria, Denmark, France, Hungary, Ireland, Israel, Lithuania, Malta, Poland, Portugal, Slovakia and Spain) assess coding competences as part of the general assessment of students (during ICT-related exams or project work). If it is integrated as a cross-curricular

lar approach, coding is assessed as part of the subject skills (Portugal, France or Finland in the future).

- In the UK (England), students at key stage four (14-16) and beyond may choose to pursue formal qualifications that will be assessed, for example the new computer science GCSE.

What type of teacher training is provided?

There is a variety of support for teachers (formal and informal) provided by universities and other stakeholders

- 13 of the countries which integrate coding in the curriculum already offer in-service and/or pre-service training to support teachers in teaching computer coding at various levels (Austria, Bulgaria, France, Estonia, Hungary, Ireland, Israel, Malta, Poland, Portugal, Slovakia, Spain, UK (England)). This training is offered mainly by universities, but also companies and non-profit organisations.
- In most countries, a variety of bottom-up initiatives exists to support teachers and students, e.g. summer schools and programming courses, competitions and coding clubs.

Working with key stakeholders is the common scenario

- 13 countries (Austria, Belgium Flanders, Bulgaria, France, Estonia, Israel, Ireland, Lithuania, Poland, Portugal, Slovakia, Spain, UK (England)) report on their collaboration with a variety of key stakeholders in the field through mechanisms such as industry partnerships, sector organisations, teacher and subject associations, computer society clubs, IT/media literacy foundations, and through activities to raise awareness (e.g. campaigns, competitions and media coverage). Finland plans to collaborate with key stakeholders.

Evaluation of coding initiatives is still rare among countries

- Only in the Czech Republic, Denmark, Hungary, Israel, Malta and Spain, evaluations of coding initiatives/pilots are already carried out, but results of the evaluations are not yet widely shared, and small-scale.
- In Malta, a strategy group gave recommendations on the further curriculum integration in 2014, based on an evaluation by the group of the current situation.
- Interesting research projects are carried out in Spain where the region of Navarra collaborates with university researchers to measure to what extent students are prepared to learn coding at early ages and its impact on the learning of other subjects.

Are countries piloting the integration of coding?

- Only a few countries (Austria, Estonia, Finland, Israel, Poland and Portugal) run school pilots in this area.
- In the Netherlands, an initiative is organised where interested schools will create their own coding curriculum; the results will be shared with all schools.

Conclusions:

This is a report on a large amount of complex data which has to be set against extremely varied national and regional education contexts. There are nevertheless some “big picture” conclusions to be drawn.

Coding continues to play a prominent role in the education agenda. The rationale for integrating coding in school curricula is twofold: to equip all students with skills that are increasingly perceived as important in today’s digital society, such as problem-solving and logical thinking skills, and, but to a slightly lesser extent, to respond to the lack of IT-skilled labour force in Europe.

In order to encourage more students to pursue IT careers, particularly interested or talented students need to be provided with opportunities to excel. Competitions that are offered in several European countries are one way of rewarding excellence in that area. Likewise, and in parallel to offers to interested or gifted students, students with a general interest should also be attracted by providing more general courses. Moreover, the goal should be to make more students, especially girls, curious about coding, and to build their confidence to pursue scientific careers. More needs to be known about the decisive factors for young people to opt for scientific careers in this area. The role of formal qualifications or certifications that can be obtained during school, e.g. the offer of specific computer science school-leaving exams, might play a role for students to continue with higher studies.

The focus of the report is on steps taken by countries to integrate coding in formal school curricula, on ways of providing training to teachers and on highlighting interesting initiatives in the area beyond formal education. However, as the integration of coding in school curricula will remain high on the education agenda beyond the short term, other questions beyond formal curricula requirements need to be addressed soon, including more concrete insights into the actual integration and real uptake of coding in schools as well as the educational practices related to it.

Important pedagogical questions to tackle are:

- How to design effectively the learning processes and outcomes involving coding? Which concrete activities (and programming languages) are most appropriate for different students, according to their age, interests and capacities;
- What are the particular merits (and limits) of adopting a cross-curricular approach to teaching coding or a discrete computer science subject?
- How to refine assessment, in particular where coding is integrated in a cross-curricular approach in other subjects.

Some interesting developments are already taking place in this regard. For instance, the concept of computational thinking has recently gained importance when integrating coding into the curriculum. It describes a take

on computer science education that puts computer science techniques in the forefront to enhance 21st century skills like problem-solving and logical thinking skills that matter even beyond the digital world. This new focus also suggests a conscious shift in some countries away from a focus on students' ICT user skills in traditional ICT subjects, towards an approach as part of computer science subjects that focuses on teaching underlying computer and design principles and puts students in a role where they create their own programs. However, developing students' digital competence more generally, ICT user skills and ICT as tool for learning continue to be priorities for many countries. In this light, it will be interesting to investigate whether the new approach taken for example by Poland and the Czech Republic is also suited to fostering students' digital skills more widely. In other words: are students who better understand how computers work also more competent users?

The picture as regards supporting teachers in teaching coding is diverse: official training as part of initial or in-service training exists but to various extents and is often coupled with offers from industry – but is this sufficient? In some countries, such as Israel, to teach computer science teachers must have a degree in teaching computer science education. In most countries, not all the primary teachers who now have to integrate computing in their teaching have a computing background. There is not much evidence as to how far teachers really manage to integrate coding effectively in their teaching and the problems they face.

Based on the findings above, it will be important to support teachers in the implementation of the new curriculum requirements and in providing students with the best approaches to learning how to code, to consider new assessment approaches and to develop more awareness activities on the importance of coding in all schools in Europe, as well as promoting and scaling up any other initiative aiming at supporting coding activities in schools. The European Commission itself might review the support given to this important area by considering and/or strengthening actions such as:

- Promoting and scaling up initiatives from industry and NGOs and any other stakeholder active in teaching coding and supporting coding activities;

- Supporting teachers and students in coding activities, as part of both formal and informal education;
- Offering a dialogue platform with policy makers in coding and developing a major awareness programme on coding;
- Supporting the gathering of evidence in this area by monitoring and analysing research studies and evaluations in the field.

Finally, a European exchange should be encouraged between countries that already integrate coding and those that still intend to do so. Discussions should not only address the question why coding is a useful skill but also provide answers to more specific questions like: which basic, possibly wider, computational skills does every student need to be prepared for tomorrow's digital world? How do we make coding exciting for students, in particular girls? How can gifted students be supported who might want to pursue a career in computational sciences? How are synergies created between the integration of coding in the curricula and extra-curricular, voluntary activities? What are the successful models of providing teacher training?

1. Introduction

2014 was a year of momentum for coding in schools. England was one of the first countries to mandate computer programming in its primary and secondary education in state maintained schools from September onwards. The European Commission launched the CodeWeek with events all around Europe. The topic received a lot of media attention.

One year later, coding in schools continues to be an increasing world trend. In February this year, US President Obama stated that everybody should learn how to code early. This message is echoed by US-led initiatives such as Code.org and the "Hour of Code". In Australia, discussions took place on the possibility of making coding a mandatory part of the national curriculum this summer.

Coding in schools also continues to be a trend in Europe. France and Spain have just introduced coding in the curricula this school year, other countries like Finland are to follow. Poland has published a new computer science curriculum with a stronger focus on rigorous computer science including programming in July 2015 that will be formally included in the curriculum in 2016. One of the goals of the Polish curriculum is to motivate students to go "beyond the screen" and investigate how computers work and how software is designed so they can create their own solutions. Computer science lessons should prepare students for further study instead of leaving them satisfied with the knowledge and skills they have already learned.

The European Commission highlights coding as part of digital skills and one of the competences to foster employability in its draft of a joint report by the

Commission and Member States published in September 2015*. Relevant and high-skill quality skills and competences are one of the six new priorities the report proposes in the field of training and education up to 2020.

Important considerations that define the actual learning to take place are: Why teach coding? Should every student learn to code? Is the focus on teaching concrete programming skills or on wider concepts such as computational thinking? Approaches on how to introduce coding differ across Europe, as the report reveals.

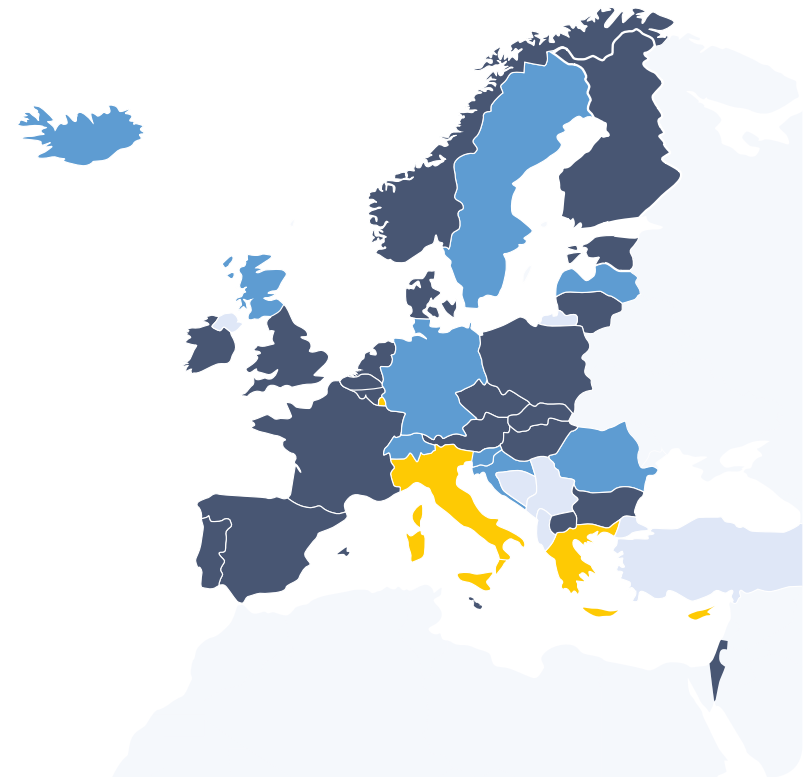
European Schoolnet re-launched the 2014 survey on coding with its Ministries of Education in June 2015 to get an updated picture on the topic covering the developments in countries and to receive information from more countries. The report focuses on the following main questions:

- What is the Ministry of Education's current thinking about this topic? Which terms are used in the national, regional or local curricula? Which are the current priorities in ICT competence development including programming and coding?
- Is computer programming or coding already part of the school curriculum and how is it integrated? What activities are required and what competences are developed? How are these assessed?
- Are there any plans to integrate computer programming and coding in school curricula in the future?
- What current or planned training provision is there to support teachers who teach computing and coding?
- Are there any school pilots or computer coding initiatives and what are the main actors involved?

Additionally, the 2015 report included the following new questions:

- Does your country have a digital skills/competences strategy for education?
- Are there evaluations of coding initiatives/pilots in your country?
- Are there any examples of good practice of coding initiatives in your country?

* http://ec.europa.eu/education/documents/et-2020-draft-joint-report-408-2015_en.pdf



21 countries participated in the survey	AUSTRIA, BELGIUM FLANDERS, BELGIUM WALLONIA, BULGARIA, CZECH REPUBLIC, DENMARK, ESTONIA, FINLAND, FRANCE, HUNGARY, IRELAND, ISRAEL, LITHUANIA, MALTA, THE NETHERLANDS, NORWAY, POLAND, PORTUGAL, SLOVAKIA, SPAIN, THE UNITED KINGDOM (ENGLAND)
No information	CROATIA, GERMANY, ICELAND, LATVIA, ROMANIA, SLOVENIA, SWEDEN, SWITZERLAND, UK (SCOTLAND)
Countries, which only participated in the 2014 report	CYPRUS, GREECE, ITALY, LUXEMBOURG

21 countries and regions gave an overview to the 2015 survey. These are Austria (AT), Belgium Flanders (BE (NL)), Belgium Wallonia (BE (FR)), Bulgaria (BG), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Hungary (HU), Ireland (IE), Israel (IL), Lithuania (LT), Malta (MT), the Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Slovakia (SK), Spain (ES) and the United Kingdom (England).*

Six new countries participated in the 2015 survey: Austria, Belgium Wallonia, Hungary, Israel, Malta and Slovakia.

“Today, computer programs are the genetic code of our world — and many educators (as well as parents, economists, and politicians willing to entangle themselves in education matters) are starting to think that students need more than a passing knowledge of computer coding. They see it as both a powerful language students can tap into that solves just about any kind of problem and an elemental structure of modern society they simply need to understand.”

■ Peter Gow, 2015

* Updated information from Cyprus, Greece, Italy, Luxembourg and Turkey, which participated in the 2014 survey, could not be obtained. Information on those countries can be found in the report from 2014.

2. Terminology

Computer programming is 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.

These instructions (source codes which are written in a programming language) are considered computer programs and help the computer to operate smoothly.

In order to write a program to instruct a computer, tablet, smart phone or any other electronic device which can be programmed, each problem needs to be clearly thought through and broken down into something called methods (occasionally referred to as functions). A typical computer program will be constructed of lots of these methods, and each will contain commands and statements to perform the operations required.

The process of programming often requires expertise in many different subjects, including knowledge of the application domain, specialised algorithms and formal logic.

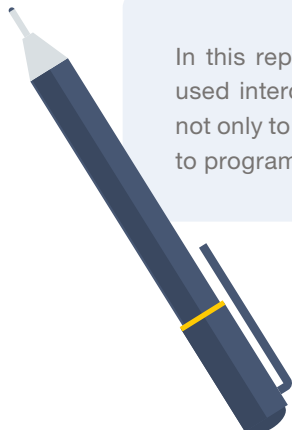
It involves activities such as:

- analysis, understanding, and generically solving such problems, resulting in an algorithm
- verification of requirements of the algorithm including its correctness
- implementation (commonly referred to as coding) of the algorithm in a target programming language.

Coding on a technical level is a type of computer programming that closely or exactly represents what happens at the lowest (machine) level. However, when most people talk about coding, they usually mean something at a higher, more human-readable level which could be anything in problem-oriented languages like Java, C++ or PHP.

Often computer programming (when referring to software) and coding are used interchangeably and refer to more or less the same activities of writing the instructions (recipe) for the computer to perform a specific task following a logic. However, based on the definitions above, coding can also be seen as a specific subtask of software computer programming which arranges the implementation of the algorithm in the target programming language.

Computational thinking is typically associated with coding and computer programming, but it is also more than that, involving “solving problems, designing systems, and understanding human behaviour,” according to Carnegie Mellon University*. Computational thinking developed as part of studying computer science can serve as a methodology for all students across disciplines for solving problems and improve understanding of the role of computing in modern society (Syslo & Kwiatkowska, 2015).



In this report the terms computer programming and coding are used interchangeably and refer to activities that enable children not only to know how to use specific programmes but to learn how to programme computers, tablets, or other electronic devices.

* <http://www.digitalpromise.org/blog/entry/a-new-model-for-coding-in-schools>

3. Integrating coding skills in the curriculum

3.1. Current situation and rationale

Among the 21 countries participating in the survey, coding is already part of the curriculum (at national, regional or local level) in 16 of them: Austria, Bulgaria, Czech Republic, Denmark, Estonia, France, Hungary, Ireland, Israel, Lithuania, Malta, Spain, Poland, Portugal, Slovakia and the UK (England).

Finland and Belgium Flanders have plans to integrate it in the curriculum. Finland has defined coding in the core curricula for 2016. In Belgium Flanders, a political and societal debate will take place in autumn 2015 about the curriculum reform in general. The issue of digital competences and coding will be addressed during this debate and outcomes of the political discussions will inform the reform. Coding will also be integrated in adult education. In September 2016, a course ‘ICT programming’ will be introduced.

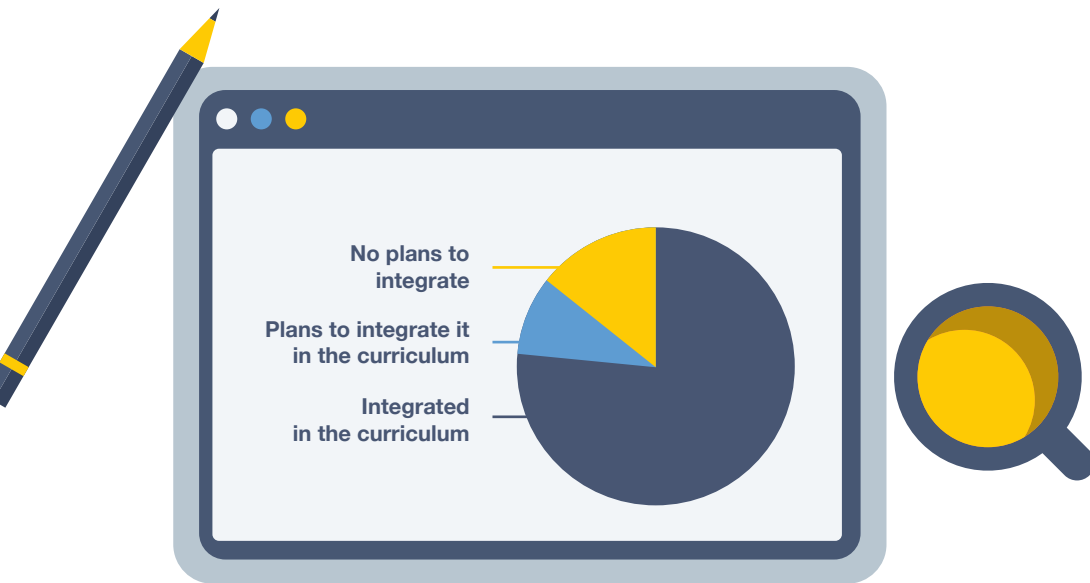
Progress in the integration of coding in the curriculum between 2014 and 2015 has been made especially by France, Spain, and Poland; the latter is currently establishing a new computer science curriculum for all school levels.

In France, the new curricula for school (primary and lower secondary education) will be published in September/October 2015 and implemented in September 2016.

In Spain, coding has been introduced in the curriculum from this school year for the whole country as an optional subject in upper secondary education. Moreover it is now integrated in three Autonomous Communities: in Navarra in primary education and in Madrid and Cataluña in lower secondary education.

Belgium Wallonia, the Netherlands and Norway stated that coding is currently not integrated in the curriculum. Norway recently decided to pilot programming as an optional subject in lower secondary schools in the school year 2016/2017. The Norwegian Directorate for Education and Training will be given the task of creating a temporary curriculum for the subject. Many schools have already started teaching programming to students as part of the optional subject “Technology in Practice” (lower secondary school), or as part of mathematics and natural science.

The Netherlands does not integrate coding in its curricula. There is a computer science subject in secondary education, but it is not a mandatory subject and schools can choose whether to teach this subject. Even if some schools choose to teach it, students have the choice to take on this subject or not. While there are no immediate plans to integrate coding as a manda-



■ AUSTRIA, BULGARIA, THE CZECH REPUBLIC, DENMARK, ESTONIA, FRANCE, HUNGARY, IRELAND, LITHUANIA, MALTA, SPAIN, POLAND, PORTUGAL, SLOVAKIA, THE UK (ENGLAND), ISRAEL

■ BELGIUM FLANDERS, FINLAND

■ BELGIUM WALLONIA, NETHERLANDS, NORWAY

tory subject, this question is still up for debate. The national institute for curriculum development (SLO) is working on developing goals and a possible curriculum on digital competences, including programming/computational thinking. In Belgium Flanders, the subject is under debate as part of a wide discussion around a curriculum review.

The survey investigated the underlying rationale for integrating ICT in the curriculum. The following table indicates the rationale adopted both by countries which have already integrated coding in the curriculum and those which still plan to do so (in green).

Table: rationale for integrating coding in the curriculum / (countries which still plan to integrate coding are highlighted)

	FOSTERING LOGICAL THINKING	FOSTERING PROBLEM SOLVING	ATTRACTING STUDENTS INTO ICT	FOSTERING CODING SKILLS	FOSTERING ICT EMPLOYABILITY	FOSTERING OTHER KEY COMPETENCES
AUSTRIA	●	●	●	●	●	●
BELGIUM (NL)			●		●	●
BULGARIA	●	●	●	●		
CZECH REPUBLIC	●	●	●	●	●	●
DENMARK	●	●				●
ESTONIA	●	●	●			●
FINLAND	●	●		●		
FRANCE			●		●	●

	FOSTERING LOGICAL THINKING	FOSTERING PROBLEM SOLVING	ATTRACTING STUDENTS INTO ICT	FOSTERING CODING SKILLS	FOSTERING ICT EMPLOYABILITY	FOSTERING OTHER KEY COMPETENCES
IRELAND	●	●	●	●		●
ISRAEL	●	●	●	●	●	●
HUNGARY	●	●				
LITHUANIA	●			●		
MALTA			●	●		
POLAND	●	●	●	●	●	●
PORTUGAL	●	●			●	●
SPAIN	●	●		●		●
SLOVAKIA	●	●				
UK (ENGLAND)	●	●	●	●	●	

Countries generally have multiple reasons for integrating coding in the curriculum. The majority of countries aim to develop students' logical thinking skills (15 countries) and problem-solving skills (14 countries), thus addressing 21st century skills. More than half of the countries, namely 11, focus on the development of key competences and coding skills. Attracting more students to study computer sciences is also a rationale for 11 countries. In particular, Slovakia is introducing the optional subject "programming and coding" in schools because of students' interest in studying computer programming at university level. The aim of fostering employability in the sector is key for only eight countries.

4. Skill priorities

4.1 Terms used for coding

There are a variety of terms used by countries to describe the integration of coding in the curriculum, such as "coding", "programming", "computing", and "computational thinking". More precisely, countries currently use the following terms when talking about the integration of coding skills in the curriculum:

- Programming (BE (FL), DK, EE, ES, FI, HU, NL, NO, PL, PT, SK) and computing (UK (England)) are the most common terms used by countries.
- Coding and computer programming are used interchangeably in Poland, England, Norway and NL.
- Some countries additionally use the terms algorithmic applications (IL), algorithmic problem solving (SK) or algorithm design and data models (HU), or algorithmic and robotics (ES).
- Ireland and France exclusively refer to coding.
- Computational thinking is referred to by Belgium Flanders, the Czech Republic, Ireland, Malta, Netherlands, and Poland.

In exploring in more detail what countries exactly mean by these terms, it appears that there are different descriptions of what is understood or covered by each of them. Some examples of what is meant exactly by the terms used in different countries is outlined in the following.

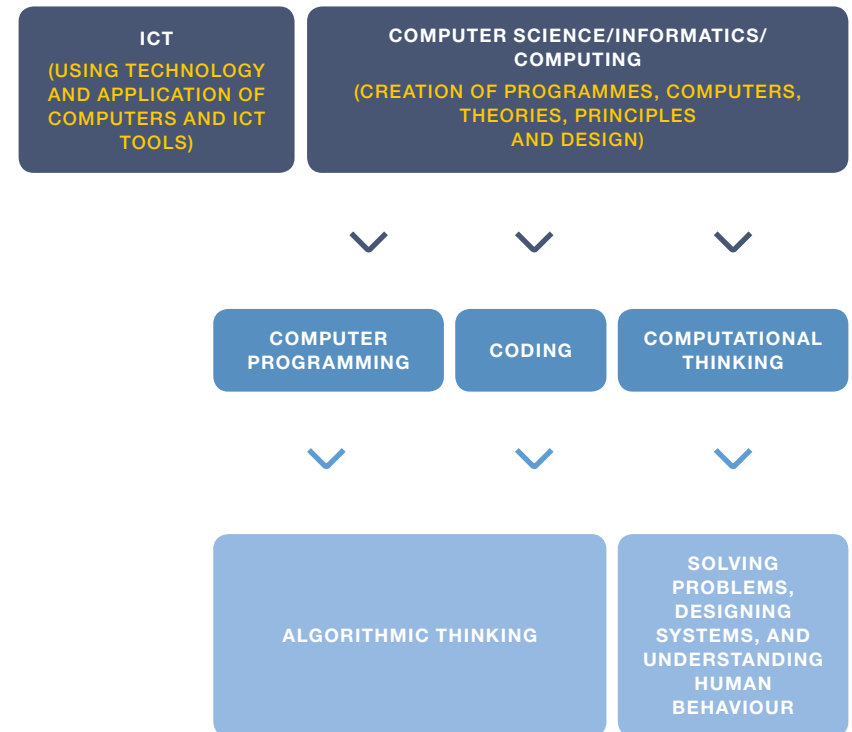
Belgium (Flanders) uses computational thinking and programming in the same sense "to be able to define a set of instructions to reach a given goal from a given starting point; to be able to write a concrete set of instructions for a computer to let the computer execute a certain task."

Poland is in the process of introducing computer science and programming to all students in K 12 and only programming not coding is in the curriculum. Programming is an integral part of computer science education, which applies algorithmic problem solving, i.e. the systematic development of a computer solution for a problem, which covers the entire process of designing and implementing the solution. On the other hand computational thinking is considered as a collection of mental tools, which is larger than programming methods and tools. The new computer science curriculum also highlights the difference between Information and communication technology which is mainly about the use of computer-related products and computer science which deals with creating “new products” related to computers (such as hardware, computer tools, programs and software, algorithms, concepts, theories). The creation of tools (e.g. programs) and information requires thinking processes about how to use abstraction and manipulate data and many other computer science and computing concepts, ideas and mental tools of computational thinking (Syslo & Kwiatkowska, 2015).*

The curriculum in the UK for computing in primary education likewise defines the core of computing as part of computer science, in which students are taught the principles of information and computation, how digital systems work and how to put this knowledge to use through programming. Building on this knowledge and understanding, students are equipped to use information technology to create programs, systems and a range of content. Computing also ensures that students become digitally literate – able to use, and express themselves and develop their ideas through, information and communication technology – at a level suitable for the future workplace and as active participants in a digital world (Berry, M. (2013)).

* See also: <http://www.digitalpromise.org/blog/entry/a-new-model-for-coding-in-schools>

The following picture illustrates the distinction between ICT and technology on the one hand, with a focus on the USE of ICT and its applications, and computer science, on the other hand, with a focus on the CREATION of programs and computer solutions, and acquiring understanding about underlying theories and principles.



DEVELOPING COMPUTATIONAL THINKING: THE CZECH DIGITAL EDUCATION STRATEGY

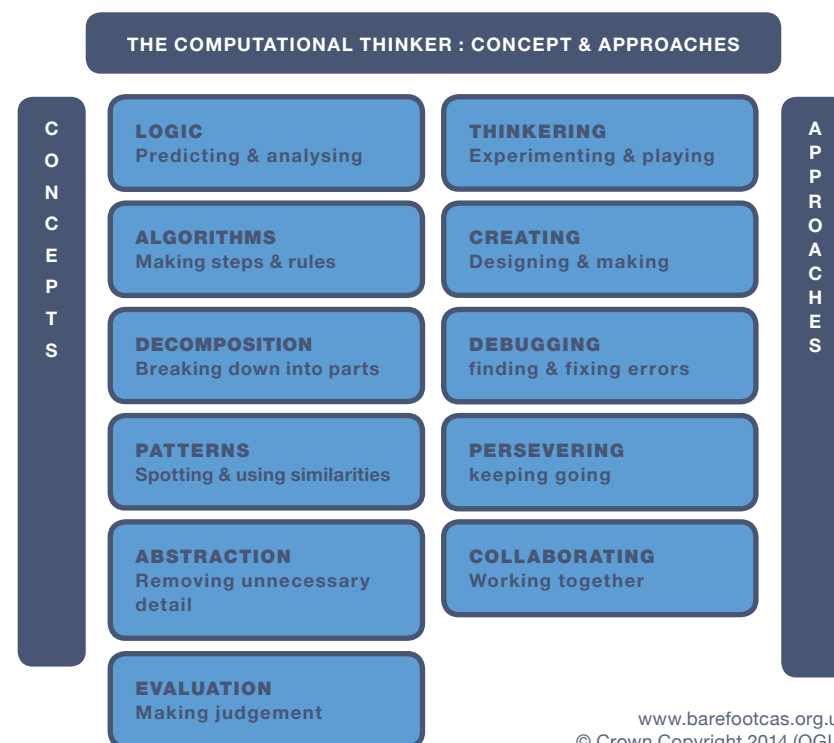
The Czech Digital Education Strategy does not refer to computer programming in particular, but defines the support of computational thinking on a more general level, since the phenomenon “computational thinking” has become more and more important in recent years. In the Strategy document, the term “Computational thinking” is described as a relatively new concept which reflects the need to understand the world around us from a new perspective, e.g. information and the ways in which digital technologies work. More specifically, Computational thinking:

1. is a form of thinking that uses computational methods to solve problems, including complex or vaguely specified problems;
2. develops the ability to analyse and synthesise, to generalise, to seek suitable problem-solving strategies and to verify them in practice;
3. enhances the ability to express one’s thoughts and processes precisely and to record them in formal descriptions that serve as a universal means of communication;
4. uses basic universal terms that extend beyond contemporary technology: algorithm, structures, representation of information, effectiveness, modelling, information systems, principles of operation of digital technology.

The inclusion of computing and the development of computational thinking in the curriculum will help to structure and formulate more advanced and more useful educational objectives. The aim of this step is not merely to nurture more IT professionals, of whom there is a constant shortage on the

labour market. Ever more professions across a range of disciplines require a grasp of computing, which is also used in dealing with everyday situations and problems. The focus is shifting from getting to know and using specific forms of technology to the basic principles of computing as a field, which encapsulates aspects of science, technology and mathematics. The development of computational thinking enables students to master skills involved in resolving a wide range of problems which arise from the very nature of effective, i.e. usually automated, information processing. Computing should therefore become a fully-fledged subject in its own right, with deeper links to other subjects.

The main concepts and approaches of computational thinking, underlining that this competence includes a wider set of mental tools, is also illustrated in the following diagram (www.barefootcas.org.uk):



* Contains public sector information licensed under the Open Government Licence v3.0
Barefoot would like to acknowledge the work of Julia Briggs and the eLIM team at Somerset County Council for their contribution to this poster

4.2 ICT skill priorities

Another important aspect before looking at curriculum integration in greater detail is to examine the importance attached to computer/programming skills in relation to the ICT skill priorities set by Ministries of Education in recent years (e.g. the development of digital competence or integrating ICT as a tool for learning). The table below shows how different countries express their ICT skill priorities:

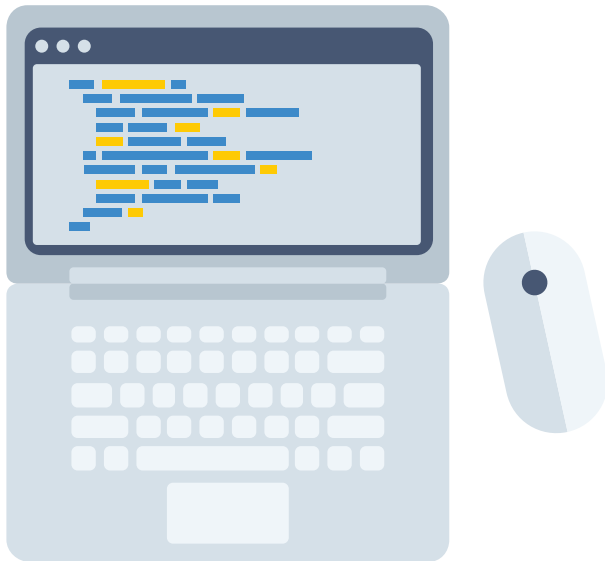


Table: ICT skill priorities (countries which still plan to integrate coding are highlighted)

	DIGITAL COMPETENCE	ICT AS A TOOL FOR LEARNING	ICT USER SKILLS	ICT TO DEVELOP KEY COMPETENCES	COMPUTING AND CODING SKILLS
AUSTRIA	●	●	●		
BELGIUM (NL)	●	●		●	
BELGIUM (FR)	●	●	●	●	
BULGARIA	●		●		●
CZECH REPUBLIC	●	●		●	●
DENMARK	●	●	●	●	
ESTONIA	●	●	●	●	●
FINLAND	●	●		●	●
FRANCE	●	●	●	●	●
IRELAND	●	●		●	●
ISRAEL	●	●	●		●
HUNGARY	●		●	●	
LITHUANIA	●	●	●	●	●
MALTA			●		
NORWAY	●	●			
NETHERLANDS					
POLAND	●	●	●	●	●
PORTUGAL	●	●		●	
SPAIN	●	●	●	●	
SLOVAKIA	●	●		●	
UK (ENGLAND)	●		●		●

As already stated in the 2014 report, most of the countries have usually adopted several priorities, in the range of 2 to 5, for developing ICT competences. Developing students' digital competence was put forward as a priority by almost all countries (19 countries). Using ICT as a tool for learning was one of the main priorities for the majority (16 countries). Developing ICT user skills and using ICT for developing key competences is also prominent (13/ 14 countries). Computing and coding is one of the main priority for ten countries. In addition to the priorities indicated by Estonia and Spain, a further priority in these two countries is to develop frameworks and self-assessment tools for teachers' digital competence. Estonia also prioritises the integration of ICT into school curricula and supports the implementation of "Bring Your Own Device".

The Netherlands does not have a clear main priority. The Onderwijs 2032 platform will come with advice for possible developments on the curriculum. Digital skills/competences will very likely be a part of that. For the Czech Republic, the future priorities set up in the national Digital strategy are presented in this table. Currently, the focus is still primarily on ICT user skills. The Digital Education Strategy of the Czech Republic formulates three priority objectives:

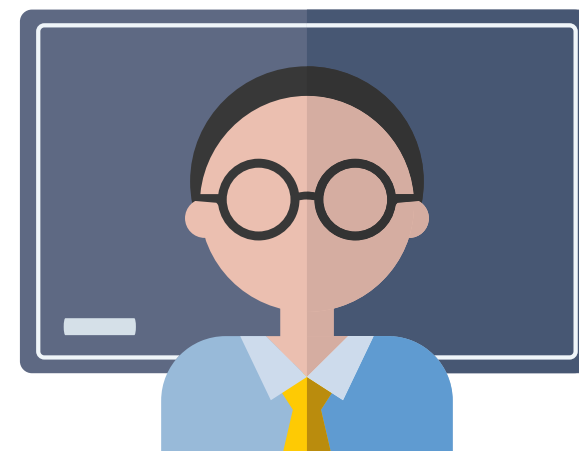
- open up education to new methods and forms of teaching using digital technologies,
- improve students' competence in working with information and digital technologies,
- develop students' computational thinking.

Malta exclusively focuses on the development of ICT user skills. 11 countries (Belgium (Wallonia), the Czech Republic, Denmark, Finland, France, Estonia, Ireland, Israel, Lithuania, Poland, Spain) address almost all or all the priorities mentioned.

In identifying current priorities with ICT competence development, countries were also asked if they have digital skills/competence strategies for education. 15 countries have such strategies in place: AT, BE (NL), BE (FR), CZ, DK, ES, FR, IL, LT, MT, NL, NO, PL, PT, UK (England). Links to the respective documents by country can be found in Annex X II: Digital Competence Plans.

* Digital Competence can be broadly defined as the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society. Digital Competence is a transversal key competence which enables acquiring other key competences (e.g. language, mathematics, learning to learn, cultural awareness (Ferrari, A. (2013)).

5. Level of curriculum integration (current and future)



5.1 Level of integration

Table: level of integration (countries which still plan to integrate coding are highlighted)

	NATIONAL	REGIONAL	SCHOOL LEVEL	STARTING YEAR
AUSTRIA	●			
BELGIUM (NL)		●		
BULGARIA	●			
CZECH REPUBLIC			●	
DENMARK	●			2014
ESTONIA	●		●	
FINLAND	●	●	●	2016
FRANCE	●			2016
HUNGARY	●			1995
IRELAND	●		●	2014
ISRAEL	●			1976
LITHUANIA	●		●	1986
MALTA	●			1997
POLAND	●			1985
PORTUGAL	●			2012
SLOVAKIA	●		●	1990
SPAIN	●	●		2015
UK (ENGLAND)	●			2014

Fifteen of the 16 countries which already integrate coding in the curriculum have done this at national level (in Ireland, Estonia, Lithuania and Slovakia additionally at local level). In the Czech Republic, currently this may be provided at school level (depending on the schools), but integration at national level is planned.

Spain integrates programming at national and regional level . (This reflects the broader situation regarding responsibilities for ICT integration in the curriculum).

Countries having plans for integration in the future, such as Finland, plans to integrate it at all three levels. Belgium (Flanders) may do this at local level, which is the level where curriculum responsibility lies.

As regards when coding was first integrated in the curriculum, Israel is outstanding with a first subject on this in 1976. The Eastern European (and former communist) countries such as Lithuania and Poland have already dealt with this as part of the informatics or computer science subjects in the mid- 80s, followed by Slovakia and Hungary in the beginning of the 90s.

Denmark, Ireland and the UK have had a long history in the integration of ICT in schools, and shifted the focus to coding and computer science in 2014. Portugal had already done so in 2012.

More detailed information on the first year of integration can be found in Annex III Curriculum Integration.

COUNTRY-SPECIFIC NOTES

In the Czech Republic, curricular documents are developed at two levels – state and school. In the system of curricular documents, the state level is represented by the National Education Programme (NEP, still in preparation) and Framework Education Programmes (FEPs). Whereas the NEP formulates the requirements for education which are applicable in initial education as a whole, the FEPs define the binding scope of education for its individual stages (preschool, elementary and secondary education). The school level is represented by School Education Programmes (SEPs), on the basis of which education is implemented in individual schools. Coding may be integrated in school curricula at the school level. Computer programming as a separate educational area is not currently part of the FEP primary education of the Czech Republic. The FEP for Secondary Education already includes the basics of computing as a field and the educational area is called Computing and Information and Communication Technologies.

5.2 Integration by level of education

The next table looks at the education levels for which coding is currently offered or compulsory (countries which still plan to integrate coding are highlighted in blue / compulsory is highlighted in red).

	PRIMARY	LOWER SECONDARY (GENERAL)	LOWER SECONDARY (VOCATIONAL)	UPPER SECONDARY (GENERAL)	UPPER SECONDARY (VOCATIONAL)	DEPENDS ON REGIONAL OR SCHOOL CURRICULA
AUSTRIA		●		●	●	●
BELGIUM (NL)	●	●	●			
BULGARIA				●	●	
CZECH REPUBLIC					●	●
DENMARK		●		●	●	
ESTONIA	●	●	●	●	●	●
FINLAND	●	●				
FRANCE	●	●		●		
HUNGARY				●	●	
IRELAND		●				●
ISRAEL	●	●	●	●	●	
LITHUANIA		●		●		
MALTA				●		
POLAND		●		●	●	●
PORTUGAL		●			●	
SLOVAKIA	●	●	●	●	●	
SPAIN	●	●		●		●●
UK (ENGLAND)	●●	●●		●●		

Coding is integrated by more than half of the countries (13) at upper secondary school level in general education. Eight of these countries also integrate it at upper secondary level in vocational education. More countries than in 2014, i.e. ten (Estonia, France, Israel, Spain, Slovakia, UK (England)) integrate or will integrate (Belgium Flanders, Finland, Poland, Portugal) coding at primary level. In the UK (England) and Slovakia it is a compulsory subject in primary education.

Estonia, Israel and Slovakia integrate coding at all levels of school education. In Slovakia, coding is integrated at all levels of school education as a compulsory element. Hence, all students learn it during their entire school education. Poland will integrate it at all levels in 2016.

In seven countries (Bulgaria, Czech Republic, Denmark, Portugal, Slovakia, Spain, UK (England)) it is compulsory for specific levels of education and mainly part of a computer course. In the UK (England), computing is compulsory in state maintained schools, while academies, free schools and independent schools can choose – although many schools will teach it. In Denmark simple programming is a compulsory part of the Physics, Chemistry and Maths curriculum.

COUNTRY-SPECIFIC NOTES

AT: Coding is integrated in some schools in the form of school trials. It depends on regional or social curricula, whether coding is compulsory or not.

CZ: Programming as a compulsory subject is taught particularly in secondary vocational schools (IT study programmes); otherwise it is an optional subject. Whether this subject is compulsory or optional depends on the SEP and the type of school. There are some secondary vocational schools (IT study programmes) where programming is covered in a number of subjects, some of which are compulsory, others optional. In other kinds of schools (mainly

grammar schools) programming is mostly offered as an optional subject.

ES: In Catalonia, teaching related to coding is offered as part of an optional subject of the last year of Compulsory Secondary Education (Lower Secondary). It is compulsory in the Autonomous Communities of Madrid and Navarra. The subject at national level and the one in Cataluña are optional. In the case of the Autonomous Community of Madrid, Primary Schools can offer a separate optional subject about coding after compulsory school time.

FR: Coding will be in the new curricula for primary education and lower secondary education in September 2015 and will be implemented from September 2016 onwards. For primary education it will be a first approach. There will be a course in the first year of upper secondary school (general education), called ICN (enseignement d'exploration d'informatique et de création numérique). Optional courses are already offered at upper secondary school level (general education) and in some technology sections.

IE: At secondary level an optional short course on coding has been introduced for the junior cycle programme (13-15 year olds). No national programme at primary level.

IL: Coding is not obligatory for all students, only for software engineering courses and other advanced tracks. Almost in every school at least one class studies computer science for their matriculation exams. Some of these schools have a track of software engineering. Four years ago computer science was taught to middle school and in elementary schools.

LT: It is planned to integrate the teaching of algorithms at primary school level.

PL: Programming will be integrated within informatics (computer science) at all school levels from 2016. Today, programming is included in the optional subject “extended informatics” in high schools and offered only by some schools. It is also taught optionally at other school levels.

PT: Some vocational and general schools with technology courses offer coding in their own curricula.

UK (England): In state maintained schools computing is compulsory but in academies, free schools and independent schools it is not – although many schools will teach it.

6. Curriculum location and integration

6.1 Curriculum location

This table looks at the part of the curriculum where computer coding is taught and whether it is stand-alone or part of another subject.

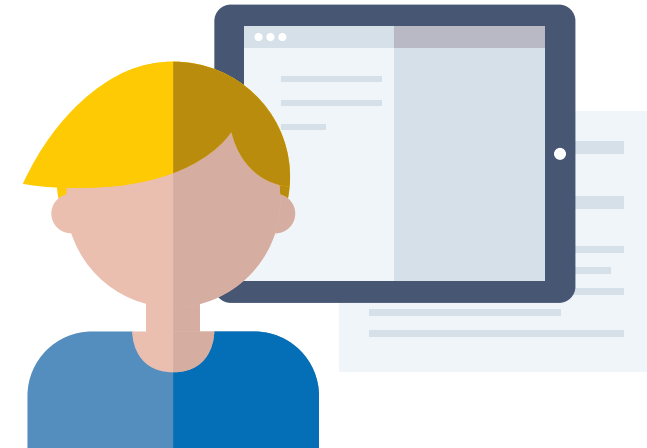


Table: curriculum location (countries which still plan to integrate coding are highlighted)

	SEPARATE SUBJECT	IN THE GENERAL ICT/ TECHNOLOGY COURSE	IN OTHER SUBJECTS AS CROSS-CURRICULAR APPROACH
AUSTRIA	Software Development	Depends on regional or school curricula	Depends on regional or school curricula
BELGIUM FLANDERS	Not decided yet	Not decided yet	Not decided yet
BULGARIA	Informatics		
CZECH REPUBLIC	Varies (e.g. Programming) Depends on regional or school curricula	Depends on regional or school curricula	Depends on regional or school curricula
DENMARK	Depends on regional or school curricula	Depends on regional or school curricula	Physics, Chemistry, Maths
ESTONIA	Depends on regional or school curricula	Depends on regional or school curricula	Maths, Technology, Informatics Depends on regional or school curricula
FINLAND			Especially in Mathematics
FRANCE		X	Mathematics, technology
HUNGARY	Informatics	X	X
IRELAND	Coding		Depends on regional or school curricula (e.g. Scratch in primary)
ISRAEL	Computer science	X	
LITHUANIA		X	
MALTA	Computer studies		
PORTUGAL		Depends on regional or school curricula	

	SEPARATE SUBJECT	IN THE GENERAL ICT/ TECHNOLOGY COURSE	IN OTHER SUBJECTS AS CROSS-CURRICULAR APPROACH
POLAND	Informatics	X	
SLOVAKIA	Programming/ Informatics Depends on regional or school curricula	X	Vocational subjects
SPAIN		Depends on regional or school curricula	Mathematics Depends on regional or school curricula
UK (ENGLAND)	Computing	Depends on regional or school curricula	Depends on regional or school curricula

More countries (12) than in 2014 have established a specific coding/computing subject in the curriculum, at national, but also at regional or school level only. Moreover, 13 countries integrate coding in a general ICT/technology course, 7 of them depending on regional or school curricula. Increasingly coding is also integrated in other subjects (mainly mathematics) as a cross-curricular approach, e.g. in Denmark, Estonia, Finland, Slovakia, Spain and France. Finland will be the first country to introduce coding in a purely cross-curricular approach.

6. 2. Examples of current curriculum integration

The following chapter gives an illustration of the current curriculum integration by country and more detailed information on the type of integration and specifying curricular objectives or competences to be taught. As is shown in this report, numerous European countries move forward with integrating coding in their curricula. The Czech Republic, Estonia, France, Malta, Lithuania and Poland have already integrated coding in their curriculum plan but are already planning changes in their provision.

In Austria

- at the technical college for ICT, coding is taught as the separate subject “software development”.
- Coding is also taught as part of school trials at lower secondary schools with focus on Informatics with Web-based coding and a second coding language.
- At lower and upper secondary schools with informatics focus coding is taught with two coding languages. For these schools, it depends on the regional or school curricula, whether coding is integrated in the general ICT/technology course.

In Belgium Flanders, digital competences and coding will be part of a wider political and social debate on the general curriculum that is taking place in autumn 2015. The planned curriculum reform will be based on the outcomes of this debate. It is not clear yet, whether coding will also be part of a general ICT course or be integrated in other subjects. Coding activities will include modifying basic settings of software, a program or an application to change a computer program and understanding the basic notions of programming and how a program is constructed.

In Bulgaria “Informatics” is a compulsory subject in grade 9. Students have 2 hours tuition per week. The course teaches:

- basic knowledge of concepts in computer science and mathematical principles
- Programming, algorithmic problem solving and representing information through abstractions (e.g. models and simulations) are part of both subjects: Informatics and ICT.

In the Czech Republic, computer programming is integrated at two levels:

- Computer programming as a separate educational area is not currently part of the Framework Educational Programmes (FEP) for primary education of the Czech Republic. Primary schools can include programming in SEP if they want – if yes, it is usually a part of computer science subject, or sometimes voluntary subject.

PLANNED CHANGES IN THE CZECH REPUBLIC

The revision of the framework education programmes is in preparation and the Digital Education Strategy until 2020 contains plans for further teacher training in this area. Introducing coding in the national curriculum is one of the objectives and priorities of the Digital Education Strategy until 2020: “Modernisation of the educational area of Information and Communication Technologies and the framework curriculum in the FEP in order to reflect current developments in digital technologies and the potential for the use of such technologies to develop digital literacy and emphasise areas which will help to develop pupils’ computational thinking and give them a grounding in computing.” It is not clear yet, how coding will be integrated in the national curriculum (as a separate subject or not), what concrete activities will be covered and whether and how much of it will be compulsory. A collaboration with other main actors is planned.

- The FEP for Secondary Education already includes the basics of computing as a field and the educational area is called Computing and Information and Communication Technologies. This means that all secondary school have to include programming into its SEP to some extent – but it is up to the school how much time the school devotes to programming. It may be only a part of broader subject, a special subject etc. In general, as a separate and compulsory subject, computer programming is primarily at secondary vocational technical schools, especially on IT study programmes, although there are some grammar schools (“gymnázium” in Czech) that include this subject in its curricula as well. It always depends on what the school decides and what is contained in its School Education Programme (SEP).

- The basics of coding or more generally computational thinking may form part of the broader subject of ICT. Some schools offer programming as an optional subject. The subject matter and names of optional subjects are the choice of the school and vary greatly.

In Denmark (Grade 7-10) coding is integrated in the binding national Common Objectives for Physics and chemistry.

- Knowledge about simple programming and transmission of data.
- programming languages and skills of programming simple digital solutions (Physics and chemistry).
- In Math to enhance systematic and abstract thinking with specific guidance.

In Grade 11-13 (Upper secondary education) coding is intergraded in the optional subject Information Technology. This course is currently an approved pilot course, which is foreseen to become an optional subject in the curriculum (Pending law [treatment](#)).

- Using programming technologies for the development of IT products and adaptation of existing IT systems (Data structures such as nested conditions; different types of loops; functions coupling different programming technologies; approaches to programming such as Step-wise Improvement, Object-oriented Programming etc.) See: <http://uvm.dk/Uddannelser/Gymnasiale-uddannelser/Fag-og-laereplaner/Forsoegsfag-i-de-gymnasiale-uddannelser/Informationsteknologi-C-og-B>

In Hungary starting from 2012 the Frame Curricula expect the use of ICT in different subjects (not coding). Though Informatics is a stand-alone subject, schools may choose to integrate it for the purposes of lessons.

- Age 13-14: 1) Algorithms 2) Logo or a similar programming language, 3) Basic commands
- Age 15-16: 1) Algorithm design and analysis, 2) Problem solving

In Ireland, no national programme at primary level. Some primary school teachers may use Scratch programming in the instruction of shape and space in mathematics. Scratch is also used in post-primary classrooms as

a gateway programming language to develop computational thinking. Other coding languages are also introduced but all is at the discretion of the teacher/school.

At secondary level an optional short course on coding has been introduced for the junior cycle programme (13-15 year olds). Problem solving and computational thinking skills are developed in this course as students build and create software projects using their own ideas and imagination. The course looks to build on any coding schools that primary students might have experienced while offering insight into possible future studies in computer science and software engineering.

In Israel the computer science subject contains:

- algorithmic thinking
- creativity
- problem solving
- project programmability chapters choice
- automatics, fundamentals of operating systems
- programming language C#, Java & assembly

In Malta, the students learn programming with Java for two years and carry out a practical final project at the end.

In Portugal, coding is taught in the subject “ICT”. At national level, some schools can offer specific courses in ICT that include coding. Students design multimedia projects (text, image, sound and video) like animations, interactive stories and simulations. The activities aim to develop students’ computational thinking, based on a problem-solving approach and the logical organisation of ideas (Curricular goals of ICT). In 2015 a pilot was launched that will introduce coding activities to students of the 3rd and 4th year in the 2015/16 school year as a special offer, outside of the curriculum.

PLANNED CHANGES IN MALTA

The new Learning Outcomes Framework (LOF) ESF 1.228 defines the subject focus of all subjects, including computing. This(ese) subject(s) will be fine-tuned or amended by subject experts on the basis of the feedback received during a public consultation process. The LOF is intended to lead to more curricular autonomy of colleges and schools, in order to better address students' learning needs. The rationale for introducing the revised version of the "computing subject" is wider than for the current integration in the curricula. Computing will be introduced as a cross-curricular subject at primary level and integrated into the ICT Compulsory Subject at secondary level. The subject will be integrated at all education levels and will be compulsory. The main goal is to develop logical problem-solving skills and introducing computational thinking at all levels.

<http://www.schoolslearningoutcomes.edu.mt/en/dashboard>

* Attracting more students to study computer sciences as part of higher education programmes, fostering employability in the ICT sector, fostering coding skills, fostering problem-solving skills, fostering logical thinking skills, fostering other key competences.

In Slovakia, algorithmic thinking/computer programming is developed in the school subject "Informatics" (primary and secondary education) or during other lessons. In some "Gymnasiums" (type of school providing advanced secondary education), programming is also a separate subject or separate thematic unit. The focus is on algorithmic problem solving and programming, algorithmic thinking, problem solving and algorithms, creation of instructions and programs. At primary level, students learn how to program and control a robot, design model toys and kits, programming steps and phases and children's programming language. At lower secondary level, teachers use educational basic graphic-oriented visual programming tools

for kids like "Karel", "Baltie" or "Imagine". Teachers also use programming of robotic construction kits. At college (secondary school) level, students learn to use CNC machine programming, the programming language PASCAL, some of the object-oriented programming languages and HyperText Markup Language (HTML).

In Spain, at national level Coding is introduced in the optional subject "Tecnologías de la Información y la Comunicación I" in upper secondary education.

- In the Autonomous Community of Madrid, contents related to Robotics and Coding have been included in the general subject "Tecnología, Programación y Robótica", which is the general Technology subject in the 3rd year of lower secondary education.
- In the Autonomous Community of Navarra, the subject Mathematics in the last two years of primary education has included contents connected to Algorithmic and Coding. They are to contribute to the digital competence of the students.

In the UK (England), computing is a distinct subject in school curricula but schools are free to teach it as an integrated subject or stand-alone. Teaching as an integrated subject is more common at primary than secondary level, where cross-curricular work is less common. Aims of computing in the English national curriculum (Department for Education, 2013):*

Students:

- can understand and apply the fundamental principles and concepts of computer science, including abstraction, logic, algorithms and data representation;
- can analyse problems in computational terms, and have repeated practical experience of writing computer programs in order to solve such problems;
- can evaluate and apply information technology, including new or unfamiliar technologies, analytically to solve problems;
- are responsible, competent, confident and creative users of information and communication technology.

* <https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study>

Case note

Poland



Poland and the new curriculum – more emphasis on rigorous computer science and personalised learning

In Poland, the new computer science curriculum replaces some activities within information technology with learning rigorous computer science, including programming. It has been accepted by the Ministry of National Education and made available for public discussion until end of October 2015. Then it will be revised according to suggestions made and is expected to be formally adopted in 2016. In preparation, teachers will take part in various in-service courses on how to develop school syllabi based on the curriculum and to develop educational materials for their instruction and for students.

The new curriculum unifies the names of all stand-alone informatics subjects as Informatics. Therefore, according to the new curriculum, Informatics is a compulsory subject in primary schools (grades 1-6 grades, 1 hour a week for 6 years), middle schools (grades 7-9, 1 hour a week for two years), and high schools (grade 10, 1 hour a week). Moreover, Informatics is also an elective subject in high schools (grades 11-12, 3 hours a week for two years) and high school students may graduate in Informatics, taking the final examination (Pl. matura) in Informatics.

The new curriculum's unified aims are as follows:

1. Understanding and analysis of problems – logical and abstract thinking, algorithmic thinking, algorithms and representation of information;

- 2. Programming and problem solving by using computers and other digital devices** – designing and programming algorithms; organising, searching and sharing information; utilising computer applications;
- 3. Using computers, digital devices, and computer networks** – principles of functioning of computers, digital devices, and computer networks; performing calculations and executing programs;
- 4. Developing social competences** – communication and cooperation, in particular in virtual environments; project-based learning; taking various roles in group projects;
- 5. Observing law and security principles and regulations** – respecting privacy of personal information, intellectual property, data security, netiquette and social norms; positive and negative impact of technology on culture, social life and security.

One novelty of the new national curriculum is that it also contains some optional attainment targets which can be freely added to a subject syllabus or assigned only to a group of students. These optional targets enable teachers to support personalised learning of gifted students as well as students with a particular interest in specific areas of computer science and its applications (such as mathematics, science, arts). Personalisation in the new curriculum is a means to encourage and motivate students to make personal choices of a range of computer science topics and areas in middle and high schools that may lead them towards a specialisation in computer science in the next steps of their education and professional career.

In conclusion, the new curriculum recognises the value of computer science as the underlying academic discipline and expects students to understand and use the basic concepts and principles of computer science, analyse and solve problems computationally, programming their solution. Nonetheless, students are still to apply information technology and to be competent, creative, and responsible users of technology in other school subjects, disciplines, and areas of computer applications.

Source: Syslo, M. & Kwiatkowska, A.B. (2015): Introducing a New Computer Science Curriculum for All School Levels in Poland, presented at ISSEP 2015 in Ljubljana, published in LNinCS, Springer Verlag, 2015.

Case note

Malta



Which programming language to teach? Considerations from curriculum integration in Malta

In Malta, a strategy group evaluated the current integration of coding in 2014. As part of this evaluation, it also discussed the use of the programming language Java in Maltese schools with relevant stakeholders. While the report finds several constraints of the programming language as it is currently integrated, it considers Java to be a strong programming language, only when coding is already taught at an early age (which is one of the recommendations of the strategy group).

The choice of programming language is an area where there are numerous trade-offs, including:

- The use of “safer” or more managed languages and environments can help scaffold students’ learning. But such languages may provide a level of abstraction that obscures an understanding of actual machine execution and makes it difficult to evaluate performance trade-offs. The decision as to whether to use a “lower-level” language to promote a particular mental model of program execution that is closer to the actual execution by the machine is often a matter of local audience needs.
- The use of a language or environment designed for introductory pedagogy can facilitate student learning, but may be of limited use. Conversely, a language or environment commonly used professionally may expose students to too much complexity too soon (Stanford (2013)).

The result of an evaluation of Java as primary programming language in the Computing SEC course in Malta is that Java is not achieving its goals of teaching students programming concepts, creative problem solving and objective thinking, all of which are a must for everyone. Java as primary programming language is challenging, as it is a very strict, case-sensitive language; it is anything but forgiving. Hence the students are more worried about construction of statements and syntax than actually understanding why they are writing that particular syntax. This can be counterproductive to the aim of getting students excited about coding.

Java also plays a role in the optional up-take female population. Albeit unfounded, it has become clear from meetings with teachers and students that the female population is ingrained with the idea that they are not able or capable of learning coding in a strict syntax manner. Obviously this is a complete fallacy as any female as much as a male can learn programming in a syntax environment; however, the problem persists.

Finally, with languages like Java, a simple task like putting a graph on screen requires several hours of explanation and tens of lines of code. Thus, the student does not experience an immediate reward for his efforts. To get the student curious and enhance the self-exploratory nature, something which has immediate cause and effect is needed. Robotics at secondary level is extremely popular since with a couple of clicks you can see a motor turning or a car moving (James Catania (2014): Computing as a Core Entitlement, Maltese Ministry of Education and Employment).

7. Assessment of coding skills

In order to get a full picture of the integration of coding in the curricula, it is also important to look at the assessment of these skills.

Almost all countries assess coding competences (Austria, Bulgaria, Denmark, France, Hungary, Ireland, Israel, Lithuania, Malta, Poland, Portugal, Slovakia, Spain). In Estonia, this depends on regional or school curricula. In most countries, the assessment forms part of the general assessment of the students, e.g. exams (Austria, Bulgaria, Slovakia), school-leaving exams (Denmark, Israel, Lithuania, Poland) or also project work (Ireland, Israel, Malta). For example, in Malta, students create a practical project over two years which is subject to a summative assessment. In Ireland, students complete a significant piece of work in the form of a final project in the final strand of the course. The project is divided into two parts. In the first part, each individual student identifies and researches on a topic/challenge in computer science. In the second part, students will work in a team. Although they are involved in a team, the student's individual role and contribution to the project will be the focus of the assessment for certification.

If coding is integrated in a cross-curricular approach in other subjects, it is assessed as part of the subject skills, e.g. in Portugal and France. In Finland, the assessment of coding skills will also be integrated in the subject-based assessment, although it is not yet clear to what extent these skills will be assessed. In the UK (England), these skills are not formally assessed and schools are free to test learning in a variety of ways. Students at key stage four (14-16) and beyond may choose to pursue formal qualifications that will be assessed, for example the new computer science GCSE. In Estonia, a level test for assessing students' digital competences is in preparation. The aim is to better understand the need or benefit regarding the integration of ICT in different subjects.

8. Evaluations of coding initiatives

Only in the Czech Republic, Denmark, Hungary, Israel, Malta and Spain, evaluations of coding initiatives/pilots are already carried out.

In Malta, a strategy group comprising teaching staff, the Ministry of Education and Employment, the University of Malta, the Malta Information & Technology Agency and industry stakeholders contributed to the outline of a practical strategy on how to introduce computing as a core entitlement for all Maltese students. One issue to tackle was that too few students chose optional STEM subjects (including Computing). The optional take-up rate for Computing is dropping at an alarming rate of around 10-45% per year depending on the college. One outcome of the consultation process was that one reason was a complete lack of exposure to such a subject in early years. Further, some students seem to have a misconception of what the subject "Computing" covers, as they are under the impression that computing is the same as ICT. Another finding was a fundamental discrepancy between what teachers are comfortable with teaching and what they are "expected" to know. Based on their findings, the strategy group formulated key recommendations, e.g.:

- Introduce Computing from Kindergarten to Form 5 (year 11).
- Change the word "Digital Literacy" to "Computing" in the NCF2012.
- Create guidelines for Kindergarten to Start Pre-Key Stage 1.
- Implement a fully cross-curricular computing subject delivery to achieve Computing outcomes jointly with core subject outcomes (Maths, Maltese, English and Science) in primary (Key Stage 1, 2 and 3).

- Assess Computing Primary through a cross-curricular lab book making up 20% of each of Maths, Maltese, English and Science marks.
- Replace ICT in Secondary with Computing Core Secondary (continuation – Key Stage 4 & 5).
- Create C3, the Computing Competency Certification (which would be recognised as an entry requirement by MCAST ICT (unlike ECDL currently)).
- Assess C3 with an automated system (like ECDL) at year 11 – compulsory for every student / Make C3 a commercial product.
- Change Computing optional in year 9 to Computer Science, making it more advanced by building on years of computing instruction and addressed for more in-depth knowledge, i.e. ICT practitioners not ICT users.
- Introduce a new position of Primary Computing Coordinators (full time post, one in every school for Computing technological and pedagogical support), but these do not affect education on general level.

In the Czech Republic, mainly universities and IT companies (e.g. CISCO, Microsoft, Intel, Google) carry out smaller evaluations.

In Spain, the University Rey Juan Carlos and the Autonomous Community of Navarra collaborate in a study to measure to what extent students are prepared to learn coding at early ages and its impact on the learning of other subjects. The results of a quantitative, quasi-experimental experiment with 42 6th grade students aged 11 or 12 showed that there is a statistically significant increase in the understanding of mathematical processes in the experimental group, which received training in Scratch (Calao, L.A., Moreno-León, J., Ester Correa, H. & Robles, G. (2015)). Moreover, the lack of tools to support educators in the assessment of student projects was identified as one of the barriers to the entry of computer programming into schools. Web applications like “Dr. Scratch”, which allows teachers and students to automatically analyse projects coded in Scratch, can support teachers in their task. Workshops with 10 to 14 year old students were run in eight schools to test the Web application. (Moreno-León, J, Robles, G & Román-González, M (2015).

9. Teacher training and initiatives

“It also has to be noted that there is a gap in the digital competences of teaching staff which needs to be addressed if the teacher is to feel comfortable in front of an audience which is increasingly technology-enabled”

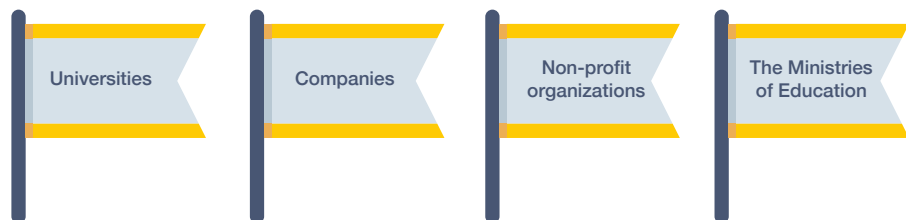
James Catania (2014): Computing as a Core Entitlement, Maltese Ministry of Education and Employment

If coding is integrated in the curriculum to ensure that students acquire the necessary skills, it needs to be complemented with teacher training and initiatives that support teaching and learning coding. Teaching a programming language can be a challenging task, especially for teachers who are not teaching ICT or computer science, and teachers who have not had prior training in this area. How are countries currently addressing this issue?

Training in this area can best be described as a mix of central support coupled with stakeholder-driven initiatives. Some official training is provided in some countries as part of in-service training and initial teacher training, but in most cases training provided by professional stakeholders prevails.

13 of the countries which integrate coding in the curriculum already offer in-service and/or pre-service training to support teachers in teaching coding at various levels (Austria, Bulgaria, France, Estonia, Hungary, Ireland, Israel, Malta, Poland, Portugal, Slovakia, Spain, UK (England)).

Training offered by :



Several Ministries of Education do not offer training directly, e.g. in the Czech Republic, France, Finland, Hungary, Lithuania and Poland. Instead, a variety of other providers offer training. In particular, universities offer training courses in many countries but also companies and non-profit organisations do so, e.g. in Belgium Wallonia, Bulgaria, Czech Republic, Estonia, Finland, Ireland, Israel and Lithuania. Training is organised at local level or regional level in France, Finland and Poland.

Some countries offer central support in this area, e.g. via the funding of teaching resources and training projects to help teachers to be ready to deliver the curriculum, e.g. in the UK, Estonia, and Ireland. Countries like Portugal support initiatives and contests at central level. Slovakia, Hungary, Malta, and Spain provide in-service training in the area of ICT, which includes training on coding for teachers in the country. Spain provides training on coding for teachers at national level and at the level of the autonomous regions, where coding is integrated. In Malta, all computing teachers were given two weeks of Java programming in-service training. Moreover, in Slovakia the Ministry of Education has a role in providing training as well as in-service training centres, schools and universities.

Teacher training is also considered to be important in the countries/regions that still plan to integrate coding in their curricula, e.g. in Belgium (Flanders). Finland does not plan to offer specific teacher training at national level, as this is rather a task for local providers. Basic teacher training is organised by the universities. Many coding initiatives already exist, with universities integrating coding in their curricula.

In Denmark, no training in this area is offered to teachers by the Ministry of Education. However, there are bottom-up initiatives like “Coding Pirates”, an association of volunteer teachers, programmers, researchers and entrepreneurs. Such bottom-up initiatives exist in many countries, which provide training and support from networks of coding enthusiasts, non-governmental organisations, private companies, teacher organisations and professional associations.

Examples of popular initiatives are coding clubs, for example in Denmark, the Netherlands and Norway but also summer schools and programming courses, often organised by universities and mainly aimed at secondary students, e.g. in the Czech Republic. Competitions are means to attract gifted students and those particularly interested in coding and to reward particular achievements. They are organised all around Europe, e.g. in Bulgaria, the Czech Republic, Estonia, Finland, France, Hungary, and Poland. Only a few countries (Austria, Estonia, Finland, Israel, Poland and Portugal) run school pilots in this area, as outlined in more detail (where available) in the country-specific section below. The Czech Republic, Spain and Portugal also offer robotics activities. Working with robotics is both engaging and rewarding for students as it gives instant results.

In addition, many countries support teachers by providing educational resources on their national or regional portals (e.g. Ireland, Belgium Flanders, Estonia, Netherlands); other countries promote specific coding websites and community platforms (e.g. Bulgaria, France, Norway, Poland).

Finally, several countries also support European-wide initiatives like the “CodeWeek” in their country, e.g. the Czech Republic, Poland, Portugal and Spain. We provide here a short overview of official training offers in each country and other training initiatives provided by stakeholders.

Austria

Universities like the University College of Education of the Diocese Linz offer training courses. School pilots are organised at the school level in secondary schools. In some cases, primary students are also introduced to easy coding e.g. with Scratch.

- campaign “Werde digital” from digital champions, digital competences (www.digikomp.at)
- The Alpen Adria Universität in Klagenfurt/Kärnten, one of the leading universities in the area of e learning and coding: (<http://www.informatik-didaktik.com/>; <http://informatikwerkstatt.jimdo.com/>)

Belgium Flanders

The Ministry of Education collaborates with the following initiatives:

- www.i22n.org : advocacy and awareness raising
- www.stem-academie.be : course, activities, coaching for schools
- www.klascement.be : educational repository with about 132 learning objects
- www.kvab.be : advice and advocacy

Belgium Wallonia

As part of the École numérique’s third call for projects, two of the 200 selected schools have developed a project involving an introduction to computer programming for children of primary education through applications like Scratch. Both projects will be carried out during the school year 2015/2016. “École numérique” is the ICT equipment plan for education in the Walloon Region in partnership with the Wallonia Brussels Federation. Moreover, external companies introduce students to programming with projects like “KODU training” (children from Brussels Region schools).

Bulgaria

The Mathematics and Informatics faculties of most universities provide pre-service and in-service teacher training.

- The Bulgarian Scratch society and Varna Free University “Chernorizets Hrabar” organise teacher training and competitions for students in primary and lower secondary school.
- The INFOS platform provides information and tasks related to the National Olympiad and tournaments in informatics.

Czech Republic

The Ministry of Education does not offer any courses directly. Teachers benefit, however, from coding courses offered by universities, businesses and non-profit organisations. Moreover, the Digital Education Strategy running until 2020 contains plans for further teacher training in this area. A variety of bottom-up activities exist, e.g.:

- Summer schools and programming courses for students, often organised by universities and mainly aimed at secondary school students, some also targeting particular groups like girls and gifted students
- Competitions, e.g.: Informatics Beaver, Baltík Creative Computing competition
- Networking teachers of ICT and computer science (NGO Union of Informaticians in Education – Jednota skolských informatiků)
- Programming courses for IT teachers organised by universities or non-profit organisations
- Robotic activities

Denmark

In Denmark, no training in this area is offered to teachers by the Ministry of Education. However, bottom-up initiatives like “[Coding pirates](#)”, an association of volunteer teachers, programmers, researchers and entrepreneurs, exist.

Estonia

The Information Technology Foundation for Education (HITSA) runs the coding programme called “ProgeTiger”. The programme’s goal is to enhance learners’ technological literacy and digital competence; its main target group is teachers in preschool, primary and vocational education. HITSA offers:

- opportunities for teachers to integrate technology into the curriculum (educational resources and training opportunities)
- financial support for schools to acquire programmable devices
- contests for student teachers
- free teaching and learning resources available on the website
- webinars and guidelines to support learning about different tools/platforms.

Besides HITSA, also universities, NGOs and companies deliver training to teachers and life-long learners. The [Look@World Foundation](#) organises extracurricular activities for children.

France

Teacher training is driven by the Ministry of Education and implemented and organised locally. The Académies (local education authorities) are in charge of teacher training. In addition, education platforms like [inria](#) and [tangara](#) and a contest “Découverte du codage des object numériques” are offered to teachers.

Finland

In Finland where the new curricula will be in use next year, teacher basic training is organised for example by the universities. It is not planned to offer specific teacher training at national level, as this is rather a task for local providers. However, the National Board of Education funds several projects where schools are developing the use of coding in learning and teaching. Moreover, there are numerous national initiatives in the area of coding in schools, run by private persons, universities, and various associations, e.g. koodikerho, koodi2016 and koodaustunti.

Hungary

In Hungary, teachers can choose from a variety of programmes from the in-service teacher training system. The most popular training courses are offered by the Association of ICT Teachers. This association and universities also offer resources for ICT teachers and coding competitions are organised for students.

Ireland

ICT in Teaching and Learning is a mandatory element of all Initial Teacher Education (ITE) programmes and optional modules on coding may be offered by some providers. There are also some ITE courses which include mandatory modules on coding in the Post-Primary ITE sector e.g. the BSC Mathematics with Education Course offered by NUI Maynooth. In the Primary ITE sector, coding is not included as a mandatory element but there are some electives offered e.g. in Mary Immaculate College the Scratch Education Elective is aimed at students interested in equipping themselves with the skills required to effectively use introductory computer programming (i.e. Scratch) to support teaching and learning across the curriculum. Summer and term time professional development courses have been designed and mediated by the Professional Development Service for Teachers in conjunction with LERO (The Irish Software Engineering Research Centre), to interested Primary and Post-Primary teachers, where the use of Scratch to develop literacy and numeracy has been explored. In addition, bottom-up initiatives help children to learn to code, e.g. digital content on the [Scoilnet](#) website and the translation of Scratch into Irish that has been provided by PDST to MIT, the developers of Scratch, so it is possible for students in Irish speaking schools to code in Irish.

Israel

New teacher training programmes will include learning on ICT. The focus of school pilots in Israel is to examine new directions in teaching computer science (cyber protection, application development, modern operating systems, parallel programming). Companies also provide training and support projects to help update curricula.

Lithuania

The Ministry of Education itself does not provide any teacher training but collaborates with educational centres, universities and students' non-formal education institutions like correspondence schools and clubs. In addition, several initiatives to support teaching and learning coding exist.

Malta

All computing teachers were given two weeks of Java programming in-service training. Moreover, the eLearning Department runs a pilot project to introduce tablets for every student in year 4 primary education level. Malta has run a school pilot last year alongside the pilot for tablet use in classrooms. In Malta teacher training is done within the confines of the unions and is mostly delivered during in-service training by fellow colleagues. Continuous support is given through peripatetic (support) teachers which are responsible for Digital Literacy in state schools.

Netherlands

An initiative for schools that want to dig deeper into the subject of programming is organised by the national organisation for primary education PO-raad, together with Kennisnet, the national institute for curriculum development (SLO) and others. These schools will create a curriculum of their own. The results of this initiative will be shared with all schools in the Netherlands. SLO is working on developing goals/a possible curriculum on digital competences, including programming/computational thinking. In general, there is a lot of development in this area and numerous other initiatives such as CoderDojo's, StichtingCodeUur, Codkinderen.nl, Codeklas.nl and MakerEd.nl.

Norway

Some schools offer programming as an after-school activity. Interesting initiatives are in particular “Lær kidsa koding” (“Teach kids to code”) and “Kodeklubben” (“Code Club”). “Teach kids to code” is a volunteer network of enthusiasts who aim to ensure that all children have the opportunity to learn programming. The network consists of schools, the government, IT companies, libraries and universities and has several international partners, such as code.org and Code Club. It provides resources for teachers who want to start teaching programming, including how coding can be included in the existing curriculum (i.e. mathematics). Kodeklubben is a Norwegian version of the British initiative, run by “Lær Kidsa koder”. It offers ready-made teaching plans which can be used by enthusiasts who want to start a local code club. The idea behind Kodeklubben is that volunteers with programming experience teach kids to code during or after school hours. Many schools have already started teaching programming to kids as part of the optional subject “Technology in Practice” (lower secondary school), or as part of mathematics, natural science, etc. Kodeklubben have an [overview of material](#) that can be used to teach and learn coding, including a list of material translated into Norwegian. Several libraries have built maker spaces and offer programming courses.

Spain

The Ministry of Education offers at national level various forms of training for teachers at all educational stages, for instance the online course “De espectador a programador” or the face-to-face course “Conecta el mundo físico y digital programando”. Moreover, the Autonomous Communities of Andalucía, Castilla-La Mancha, Cataluña, Comunidad Valenciana, Galicia, La Rioja, Madrid and Navarra offer their teachers training-related coding. In addition, several initiatives to support teaching and learning coding exist.

Slovakia

The Institute for In-Service Teachers’ education MPC provides education and training in the field of Digital Technologies and ICT. MPC provides continual education for educators and professional staff of schools for the whole country. In addition, MPC, the Ministry of Education, schools and universities offer teaching and learning resources.

Poland

In Poland, the Ministry of Education no longer organises teacher training. However, universities, non-public organisations and local training centres offer training, some of it funded by EU grants. There are initiatives run by non-governmental organisations, private companies, and private people, e.g. Baltie, The Hour of Code, The Bebras Competition, and The Masters of Coding (Samsung). Most of them are available through educational coding platforms and provide learning and teaching materials for students and teachers. Moreover, school pilots will be proposed by local governments and supported by EU grants.

Portugal

The Ministry of Education organises and promotes several initiatives either directly or through teacher training centres and other partners, such as courses on Coding in primary school (Computational Thinking, Learning Scenarios, KODU), the Scratch community, “Scratch day”, Code week, Coding and Robotics Clubs, workshops and conferences. The aim is to have teachers and students engaged in this area. In the next school year 201/2016, 1,950 primary schools will be involved with about 37,000 students in a coding pilot. The Ministry of Education has invited all Portuguese schools to participate in the project with their 3rd and 4th graders (8-10 years old).

UK (England)

In 2014-15, the Department funded projects to the value of £3.5 million to help train and support teachers to deliver the new national curriculum in computing. In 2015-16, the department is providing further funding (between £700,000 and £1.2m) to the British Computer Society to develop the “Network of Excellence” and the Master teachers’ scheme. Master teachers of computing will be trained and will then train other teachers across primary and secondary schools. This scheme will become self-supporting. The development of resources for primary teachers (Barefoot computing) is also funded. Moreover, there are a number of non-governmental organisations that run programmes designed to engage young people. Good examples of these are the Code Club, CoderDojo, Computer Clubs for Girls and the “Young Rewired State”. There are a number of projects, both funded by the Department for Education, industry and others to produce resources for teachers. An example of this is the [matched funding programme](#) which has produced a number of public/private joint funded programmes.

10. Collaboration with key stakeholders in the field

As described in the previous section, developing coding skills for teachers and students often needs to be done in partnership with other bodies and also depends on active pioneer schoolteachers. This reflects the shared interest in ensuring that skill levels in this field match the aspirations and needs of society and industry over the coming decades. 13 countries (AT, BE (NL), BG, FR, EE, ES, IL, IE, LT, PL, PT, SK, UK (England)) reported on their collaboration with a variety of key stakeholders in the field through mechanisms such as industry partnerships, sector organisations, teacher and subject associations, computer society clubs, IT/media literacy foundations and through activities to raise awareness (e.g. campaigns, competitions and media coverage). Finland also plans to collaborate with other stakeholders.

Austria: In some regions, Technical colleges are working in cooperation with industry, together with the Federal Ministry of Education and Women’s Affairs.

Belgium Flanders: Collaboration activities with the main actors in the field are already taking place, e.g. voluntary STEM academies like CoderDojo, coding clubs and technology labs, NGO’s like i22nn Technopolis, the National Science Academy and the National and Regional Chamber of Engineers, teacher training institutions and the Knowledge Centre for Media Literacy and with libraries (as part of the general Media Literacy Policy).

Bulgaria: The Ministry of Education and Science organised a National Olympiad and tournaments in informatics, in partnership with the Union of Bulgarian Mathematicians.

Czech Republic: In 2014, the Ministry of Education officially supported/endorsed the Codeweek activities in the Czech Republic.

Estonia: Cooperation between schools, universities, companies and employers' organisations is encouraged and supported.

France: Following a call for projects on entrepreneurship (investissements d'avenir), four projects focusing on coding have been selected.

Ireland: Two writers were commissioned by the National Council for Curriculum and Assessment (NCCA) to write the coding course. These writers were guided by NCCA executive officers, the NCCA's internal Board for Junior Cycle (which is made up of representative groups), some consultative focus groups, and finally by a wider public consultation process. The PDST Technology in Education has also collaborated with the Irish software engineering research centre "Iero" for the design of Scratch courses for teachers (online and face to-face courses).

Israel: High-tech companies support projects that help to update curricula.

Lithuania: The Ministry of Education collaborates with different stakeholders: teacher development seminars (educational centres, universities), students' non-formal education institutions (correspondence schools, clubs).

Poland: The Council for Informatisation of Education is an advisory board to the Ministry of Education. The Council works on various topics related to informatics and computer science education in Poland, such as educational standards, strategic documents and e-textbooks, and has recently proposed a new national curriculum for computer science education for all school levels in Poland.

Portugal: The Ministry of Education works, through partnerships, with different academic and industry stakeholders.

Spain: The Ministry of Education promoted the "CodeWeek" in Spain, along with the initiative Programamos.

UK (England): The Department of Education provides support via bundling forces with other organisations working in this area, often in partnership with industry. Professional bodies such as the British Computer Society, Computing at School and NAACE provide resources and training packages for teachers. A number of universities, e.g. Oxford University, Queen Mary's University London, Hertfordshire, Northampton, Edge Hill and Oxford Brookes Universities have also developed teaching resources and training packages for teachers.

REFERENCES

Balanskat, A. & Engelhardt, K. (2014): *Computing our Future: Computer programming and coding - Priorities, school curricula, and initiatives across Europe*. European Schoolnet http://www.eun.org/c/document_library/getfile?uuid=521cb928-6ec4-4a86-b522-9d8fd5cf60ce&groupId=43887

Berry, M (2013): *Computing in the national curriculum: A guide for primary teachers*. NAACE <http://www.computingschool.org.uk/data/uploads/CASPrimaryComputing.pdf>

Calao, L.A., Moreno-Leon, J., Ester Correa, H. & Robles, G. (2015): *Developing Mathematical Thinking with Scratch: An Experiment with 6th Grade Students*. http://jemole.me/replication/2015ectel/CodeMath_Draft.pdf

Catania, J. (2014): *Computing as a Core Entitlement*. Maltese Ministry of Education and Employment – Department of eLearning (DeL) and Department of Curriculum in the Directorate of Quality and Standards in Education (DQSE)

European Commission (2015): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. *Draft 2015 Joint Report of the Council and the Commission on the implementation of the Strategic framework for European cooperation in education and training (ET2020)*. COM(2015) 408 final

Ferrari, A. (2013): *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*, Joint Research Centre of the European Commission

Gow, P. (2015): *Teaching Computer Programming is back. Why now? A new culture of coding*.

Moreno-León, J, Robles, G & Román-González, M (2015): *Dr. Scratch: Automatic Analysis of Scratch Projects to Assess and Foster Computational Thinking*. http://www.um.es/ead/red/46/moreno_robles.pdf

Stanford (2013), *Curriculum Guidelines for Undergraduate Degree Programs in Computer Science* Computer Science Curricula The Joint Task Force on Computing Curricula, Association for Computing Machinery (ACM) IEEE Computer Society.

Syslo, M. & Kwiatkowska, A.B. (2015): *Introducing a New Computer Science Curriculum for All School Levels in Poland*, presented at ISSEP 2015 in Ljubljana, published in LNinCS, Springer Verlag, 2015.

11. Annex I Terms used for coding at national level

TERM USED	COUNTRY
Only at Technical colleges "Informationstechnologie" (HTL): Subject "Softwareentwicklung": software development, systemtechnics, networktechnics, project management etc. http://www.htl.at/fileadmin/content/Lehrplan/HTL_VO_2011/BGBl_II_Nr_300_2011_Anlage_1_5.pdf	AT
Computational thinking and programming: To be able to define a set of instructions to reach a given goal from a given starting point; to be able to write a concrete set of instructions for a computer to let the computer execute a certain task (ENG). Computatoneel denken en programmeren: een reeks instructies kunnen definiëren om vanaf eenbeginpunt een bepaald doel te bereiken, een concrete verzameling instructies voor een computer kunnen schrijven zodat de computer de taak uitvoert (NL).	BE (NL)
Informatics (ENG) – Информатика (BG)	BG
Computational thinking (ENG)	CZ
Programming (ENG) – Programmering (DK)	DK
Programming (ENG) – programmeerimine (EST) Technology education (ENG) – tehnoloogiaharidus (EST) Technology literacy (ENG) – tehnoloogiline kirjaoskus (EST) Digital competence (ENG) – digipädevus (EST)	EE
Programming, algorithmic and robotics (ENG) – Programación, algorítmica and robótica (ES) So far, coding has been integrated into other subjects, e.g. Mathematics or Technology. The curriculum refers to these contents as Programming, algorithmics and robotics.	ES
Programming (ENG) – Ohjelmointi (FI)	FI
Coding (ENG) – Codage (FR)	FR

In the Frame Curricula, subject ICT: Programming (ENG) – programozás (HU) In the National Core Curriculum: Algorithm design (ENG) – algoritmizálás (HU), data modelling (ENG) – adatmodellezés (HU)	HU
Coding (ENG)	IE
Algorithmic applications and algorithms (ENG)	IL
Programming Fundamentals, Programming (ENG) Programavimo pradmenys, Programavimas (LT)	LT
Coding = general English term Programming = commonly used for higher level syntax basic coding [Computational Thinking]	MT
Programming (ENG) – programmering (NO) Coding (ENG) – koding (NO) The terms programming and coding are used somewhat interchangeably. The terms have not yet been defined for the school curriculum, but the general meaning is the same as for the corresponding English terms.	NO
Coding (ENG) – coderen (NL) Programming (ENG) – programmeren (NL) Computational thinking as a term is used a lot as well, so far there is not a real Dutch language term for this.	NL
Programming (ENG) – programowanie (PL) (Computer) programming (ENG) – programowanie komputerów (PL) Computer programming is a part of the problem-solving process with a computer which involves: (1) analysis of a problem situation; (2) designing an algorithm and data structure; (3) checking the correctness of the algorithm; (4) implementation of the algorithm; (5) program testing and verification; (6) extensions and applications.	PL
Computing Environment Exploitation (ENG)	PT
Computer programming and coding (ENG) – počítačové programovanie a kódovanie (SK) Computer programming, object programming, coding, encryption, algorithmic thinking, algorithmic problem solving	SK

12. Annex II Digital Competence plans

AT	www.digikomp.at
BE (NL)	http://onderwijs.vlaanderen.be/onderwijspersoneel/van-basis-tot-volwassenenonderwijs/op-het-werk/lespraktijk/leermiddelen-en-projecten/ict-in-de-klas
BE (FR)	http://www.enseignement.be/passeporttic
CZ	http://www.msmt.cz/ministerstvo/strategie-digitalniho-vzdelavani-do-roku-2020
DK	http://www.emu.dk/modul/it-og-medier-vejledning
EE	https://www.hm.ee/en/estonian-lifelong-learning-strategy-2020(digital-focus)
ES	http://educalab.es/
FR	http://eduscol.education.fr/pid26435/enseigner-avec-le-numerique.html
IL	http://cms.education.gov.il/EducationCMS/UNITS/MadaTech/csit
LT	http://www.smm.lt/web/lt/lawacts/view/item.715/type.custom
MT	http://curriculum.gov.mt/en/resources/the-nct/pages/default.aspx
NL	https://www.rijksoverheid.nl/onderwerpen/onderwijs-2032/inhoud/toekomstgericht-curriculum
NO	http://www.udir.no/Stottemeny/English/Curriculum-in-English/english/Framework-for-Basic-Skills/
PT	http://www.dge.mec.pt/educacao-para-os-media
UK (ENGLAND)	https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study

13. Annex III Curriculum integration

DK	2014
ES	Coding has been introduced in the curriculum this very school year for the whole country in an optional subject in Upper Secondary Education and also in 3 Autonomous Communities, in Primary education in one case (Navarra) and in Lower Secondary Education in the other two (Madrid and Cataluña).
FR	The new curricula for school (primary education and lower secondary education) will be published in September 2015 and implemented in September 2016. The should include coding for children from their 3rd year of primary education (age 8) and students in lower secondary education
HU	1995
IE	2014
IL	1976
LT	Since 1986, Foundations of Computer Science and Computer Engineering; Since 1999, Informatics; Since 2002, Information technology
MT	Coding has been part of the curriculum (in an optional computing subject) since its inception in 1997
PL	Since the subject called informatyka was introduced to formal education – 1985
PT	September, 2012
SK	Approx. since 1990 / From the 5th grade – Lower secondary education (age 10 - 11), as a part of the subject Informatics. Subject Computer programming, Coding – as an optional subject at many Gymnasiums, or as a part of different specialised subjects at some Vocational and secondary schools. Subject called Computer Technology was compulsory in Slovakia at some school already in 1984.
UK (ENGLAND)	September 2014

14. Annex IV Links to initiatives supporting teaching and learning coding

AUSTRIA	www.digikomp.at
BELGIUM FLANDERS	<ul style="list-style-type: none"> www.i22n.org : advocacy and awareness rising www.stem-academie.be/ : course, activities, coaching for schools www.klascement.be : educational repository with about 132 learning objects www.kvab.be : advice and advocacy
BULGARIA	<ul style="list-style-type: none"> INFOS platform Telerik Kids Academy Bulgarian Scratch society
CZECH REPUBLIC	<ul style="list-style-type: none"> Codeweek.cz Summer schools and programming courses students: Codecamp.cz – focus on programming Letní Škola IT ČVUT (CTU IT Summer School) Letní Škola IT pro dívky ze SŠ (IT Summer School for Secondary School Girls) (Czechitas) Letní Škola IT pro dívky (IT Summer School for Girls) (FIT VUT in Brno) Programming courses aimed at girls – Czechitas.cz Microsoft programming academy Programming courses for gifted students Competitions, e.g.: Beaver of Informatics (Bobřík informatiky) Competition for upper secondary schools in programming (Soutěž v programování SŠ - vyšší programovací jazyky) Baltik Creative Computing competition (Soutěž tvořivé informatiky Baltik) Junior internet

- Programming courses for IT teachers organised by universities or non-profit organisations, such as:
- <http://tib.cz/tvorivyucitel/obsah.htm>
- <http://projekty.upce.cz/bravo-ii/akce/irer-seminar-programovani.html>
- Textbook “[Computing for All](#)” (Informatika pro každého)
- Robotic activities
- Robosoutěž – [FEL ČVUT](#)
- Robotický den – [MFF UK](#)
- [First Lego League](#)
- Networking teachers of ICT and computer science (NGO Union of Informaticians in Education – Jednota skolskych informatiku)

ESTONIA	<p>School-based projects and school blogs. Examples:</p> <ul style="list-style-type: none"> • Pelgulinna Gymnasium • Gustav Adlof Gymnasium • Lillekyla Gymnasium <p>Teacher networks, Facebook groups. Examples:</p> <ul style="list-style-type: none"> • Informaatikaõpetajate FB kogukond (Informatics) • M-õppe kogukond FB-s (mobile learning) • Hariduslikud mängud (educational games) • 3D printerid Eesti koolides (3D printers) • Eesti Kodu Game Lab kogukond (KODU Game lab) • Raspberry Pi Eesti (Raspberry Pi) <p>The Look@World Foundation organises extracurricular activities for children.</p>
FINLAND	<ul style="list-style-type: none"> http://www.koodikerho.fi www.koodi2016.fi www.koodaustunti.fi
FRANCE	Competitions Découverte du codage des object numériques tangara
IRELAND	Scoilnet
LITHUANIA	<ul style="list-style-type: none"> Jaunųjų programuotojų mokykla Robotikos akademija Ivairios privačios neformalaus ugdymo mokyklos

NETHERLANDS

- [CoderDojo](#)'s in a several cities.
- [Stichting CodeUur](#) gives “guest” lessons at schools.
- Several libraries or library organisations have started so called “Maker buses”, mobile fab labs which also offer programming to schools.
- [Codekinderen.nl](#): website created by Kennisnet that offers an overview of tools and guidance for schools that want to teach programming.
- [Codeklas.nl](#): book with practical examples for schools.
- [MakerEd.nl](#): platform created by Dutch Maker Education forerunners where teachers share their experiences with (amongst other things) programming in education.

Kennisnet shares information through articles, flyers, posters and booklets on this subject at: <https://www.kennisnet.nl/digitale-vaardigheden/programmeren-maken/>

NORWAY

- Kodeklubben (Code Club) resources for learning to code: <http://kodeklubben.no/>
 - List of teacher plans and teacher blogs related to teaching coding in school from “Lær Kids Koding”:
<http://www.kidsakoder.no/skole>
 - Norwegian Centre for ICT in Education offer a web portal for teachers to share teaching plans and experiences with coding:
<https://iktipraksis.iktsenteret.no/tema/koding-i-skolen>
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POLAND

- Baltie environment used in some schools;
 - The Hour of Code (<http://godzinakodowania.pl/>)
 - The Bebras Competition (in November each year)
 - The Masters of Coding (Samsung) in K-9
 - Olympiads in Informatics for middle and high schools;
 - Several local and regional competitions on programming in various environments (Logo, Python, Scratch, Pascal,...)
 - European Coding Week
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PORTUGAL

- Several initiatives and contests, especially in the robotics area:
 - [Scratch community](#)
 - <http://www.roboparty.org/>
 - <http://robotica2015.utad.pt/pt-pt/>
 - Participation in the last World Championship of Robotics in China with four teams, with excellent results:
<http://www.robocup2015.org/>
-

SPAIN

Examples of other initiatives to support teaching and learning coding are:

- [Programamos](#): non-formal training
 - [Community Código21](#)
 - [Initiative CodeMadrid](#)
 - [Programme mSchools](#)
-

UK (ENGLAND)

- [Code Club](#)
- [CoderDojo](#)
- [Computer Clubs for Girls](#)
- [Young Rewired State](#)

15. Annex V Country codes

AT	Austria
BE (FR)	Belgium Wallonia
BE (NL)	Belgium Flanders
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
HU	Hungary
IE	Ireland
IL	Israel
LT	Lithuania
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
SK	Slovakia
UK (ENGLAND)	United Kingdom (England)

16. Acknowledgements

European Schoolnet would like to thank all Ministries of Education, organisations nominated to act on their behalf and experts that provided information for this report.

COUNTRY	ORGANISATION
AUSTRIA	Federal Ministry of Education and Women's Affairs
BELGIUM FLANDERS	Flemish Ministry of Education & Training
BELGIUM WALLONIA	Ministère de la Fédération Wallonie-Bruxelles/Service général du Pilotage du Système éducatif/Direction Enseignement.be
BULGARIA	Ministry of Education
CZECH REPUBLIC	Dům zahraniční spolupráce (Centre for International Cooperation in Education, DZS)
DENMARK	National Agency for IT and Learning, Ministry of Education
FINLAND	Finnish National Board of Education
FRANCE	Ministry of education, higher education and research
HUNGARY	Educatio Public Services Non-profit LLC
ESTONIA	Information Technology Foundation for Education (HITSA)
IRELAND	Department of Education and Skills
ISRAEL	Ministry of Education
LITHUANIA	Education Development Centre

MALTA	Ministry of Education and Employment, Malta Information Technology Agency
NETHERLANDS	Kennisnet Foundation
NORWAY	Norwegian Centre for ICT in Education
POLAND	Ministry of National Education
PORTUGAL	Directorate-General for Education
SLOVAKIA	Institute for In-Service Teachers' Education and Training – Metodicko-pedagogické centrum (MPC)
SPAIN	Ministry of Education, Culture and Sport
UK (ENGLAND)	Department for Education

Notes

Computing our future

Computer programming and coding

Priorities, school curricula and initiatives
across Europe

www.europeanschoolnet.org

<http://eskills4jobs.ec.europa.eu>

www.allyouneediscode.eu

