Attracting people to ICT: innovative learning and teaching

Computer Science Education Consultations – Conclusions and Recommendations

European Commission

Grand Coalition for Digital Jobs

European Schoolnet

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for Digital Jobs

About the Grand Coalition for Digital Jobs

The European Commission is leading a multi-stakeholder partnership to tackle the lack of digital skills in Europe and the thousands of unfilled ICT-related vacancies across all industry sectors.

The Secretariat of the Grand Coalition has been established to support the initiatives of the European Commission's Grand Coalition for Digital Jobs.

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Statement of Originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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1 Introduction to the deliverable and scope

The Grand Coalition for Digital Jobs has the ambition to cope with the negative effects on today digital economy and society, of the lack of skilled professionals for the ICT sector as well as the decreasing interest among youth for ICT studies and careers.

While mitigation actions, as e.g. training, re-training and mobility programmes, can be certainly successful in producing short and mid-term effects, longer term and structural changes are considered crucial to solve the problem at its roots. The Secretariat of the Grand Coalition has been therefore focusing on awareness raising actions aimed to change young people perception of the ICT sector, and worked towards the endorsement of structural changes in the Education sector aimed at equipping pupils with stronger digital competences.

On the latter, a stronger emphasis on computer science education, especially when integrated in the curriculum with innovative approaches, was regarded as a crucial element for both educating on digital competences and engaging youth to ICT studies and careers.

1.1 Description of the report

This short summary of conclusions and recommendations was produced as a part of a more comprehensive report within the activities of DIGITALJOBS Work Package 6: *Attracting people to ICT: innovative learning and teaching,* led by EUN. The ultimate aim of this report was not only to take stock of the situation of computer science education in the different countries, but also to consider and assess different approaches adopted by Ministries of Education and other stakeholders in order to foster teaching and learning of digital competences.

The report and its conclusions were produced on the basis of various types of actions. In particular, since May 2014, three dedicated regional workshops have been organised, two questionnaires on computing in the curriculum have been distributed to Ministries of Education, ad hoc desk research has been carried out, high level policy consultations involving education policy makers and ICT sector major companies' representatives have been integrated in major events, and finally a European closing workshop took place in Brussels on the 27th of January 2016.

1.2 Methodology

Given the diverse nature of the sources and stakeholders consulted, the approach used to prepare the report and its conclusions has followed different leads and approaches, including face-to-face roundtables, distribution of questionnaires and surveys, desk research and informal consultations. The process has also been constantly adapted in reason of the findings of the consultation iterations, leading to focus on specific aspects of computer science education as for instance computing and coding.

In order to gain a better understanding of the situation regarding computer science education across Europe, three regional face-to-face workshops were organised bringing together formal education, training providers, industry and other stakeholders' representatives. The roundtables were also expected to help identify and exchange best practice in teaching and learning ICT.

Ad hoc consultations have been carried out in 2014 and 2015 with the aim to investigate at country level how computer science, computing and coding are already, or plan to be, integrated in the formal education curriculum both at primary or at secondary school level. These questionnaires, addressed to all the Ministries of Education member of EUN served as a basis for the publication of two reports:

- 2014 - Computing our future: Computer programming and coding. Priorities, school curricula and initiatives across Europe
- 2015 - Computing our future: Computer programming and coding. Priorities, school curricula and initiatives across Europe

The results of the questionnaires provided not only a good insight on the integration of computing by the formal education sector, but also a better understanding of how initiatives undertaken by the civil society and the industry are supporting the spreading of digital competences and coding across all age groups.

Results from the policy workshops organised annually in conjunction with EMINENT - the Experts Meeting in Education Networking event organised by EUN - provided also useful information for the purpose of this report. During these sessions, experts in education, Ministries representatives and industry stakeholders, had the chance to discuss latest trends in education with a specific focus on digital competences and computing.

When necessary, desk research and bilateral consultations were also carried out with the aim of collecting more details on specific initiatives and programmes.

1.3 Definitions

Computer science as a discipline can be defined as the science that deals with the theory and methods of processing information in computers, the design of hardware and software and the use of computers.

In a narrower sense, it is generally intended as the study of **computing**, **programming** and **computation** in correspondence with computer systems. This field of study utilises theories on how computer works to design, test and analyse concepts.

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.

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.

2 Final Workshop on Computer Science Education

The main findings and outputs of the above mentioned consultations and research works were presented during a Final Workshop on Computer Science Education (27 January, 2016), in order to achieve a deeper understanding of what reforms, solutions and initiatives are being adopted in Europe to improve and further disseminate Computer Science education at both primary and secondary school levels. The ultimate aim of the event was to discuss together with key stakeholders the findings collected so far and reflect on where to focus our actions in order to make sure our commitment reaches the best outcome and impact.

The starting point for the dialogue were the key findings extrapolated from previous consultations on computer science education, which can be summarised as follow:

The government perspective

- ➔ It is a priority to equip students with ICT skills & competences
- ➔ There is an interest to innovate and transform teaching practices
- ➔ There have been investments in ICT equipment for schools

However

- There are several other priorities on the Ministries' agenda to be considered
- There is a need for evidence based studies in order to justify and support curriculum reforms
- Teachers need to be (re)trained to keep up with the change in curriculum / pedagogical approaches

The civil society perspective

- ➔ Civil society has been more and more active in the promotion of ICT skills and especially programming and coding skills
- ➔ Computer science education is considered a means to foster not only young people employability but also entrepreneurship and active digital citizenship

However

- There is a lack of coordination among the initiatives and a high degree of overlapping / duplication at local, regional and European level
- The majority of these initiatives are run by volunteers and there is a lack of sustainable funding
- The attention for coding and computer science has raised exponentially in the last years giving a lot of traction to civil society initiatives, a decrease of the public opinion attention towards the topic may lead to a decline of the support such activities receive

The industry perspective

- ➔ Industry created a variety of highly innovative and engaging digital tools for educating to coding, programming, game and app design, and other digital skills
- ➔ The main motivating factor for industry is to contribute to the upskill of future ICT professionals and to an increase interest in ICT careers among youngster.
- ➔ Having a more digital savvy society could also boost economy and create new business opportunities, keeping European digital economy vibrant and thriving

However

- Companies need clear recognition of their efforts and would like their investments to generate the desired impact on society. In order to get this recognition, companies often partner up with public authorities and civil society organisations
- It is sometime difficult to join forces with other companies which may be direct competitors, even if we can notice several programmes where natural competitors are working together to achieve a better impact with their initiatives

3 Conclusions & Recommendations

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 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 a digital society. Teaching and learning how to code, in formal and non-formal education settings, can play a significant role in this process.

Based on the consultations carried out within and beyond the DIGITALJOBS project, we can state that computer science education, and especially computing and coding, is currently high in the agenda not only of policy makers in the education sector, but also of industry key players, civil society organisations and training providers.

The rationale for integrating computing 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 to respond to the lack of IT-skilled labour force in Europe.

Referring specifically to the integration of computing in the formal education national curricula, we can highlight the following main findings and conclusions:

- ➔ Among policy makers, the **development of students' digital competence** as well as the **use of ICT as a tool for learning** is high on the agenda. Developing ICT user skills and using ICT for developing key competences is also highly regarded.
- ➔ A higher profile for **coding in the curriculum**. A number of countries already 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.
- ➔ Integrating coding in the curriculum is seen as an effective way to **foster 21st century skills**. The majority of countries consulted aim to develop students' **logical thinking** skills and **problem-solving** skills, thus addressing 21st century skills. Attracting more students to computer science related studies and foster their employability is also considered a rationale.
- ➔ Computing and coding is **mainly integrated at secondary** level, **but also increasingly in primary education**. Coding is integrated or will be integrated by about half of the countries consulted at upper secondary school level in general education. In comparison with the data collected in 2014, more countries, namely Estonia, France, Israel, Spain, Slovakia, UK (England) integrate or will integrate (Belgium Flanders, Finland, Poland, Portugal) coding at primary level.
- ➔ In about one third of countries consulted **coding is already compulsory**, but at different levels of education. E.g. in Bulgaria, Czech Republic, Denmark, Portugal, Slovakia, Spain, UK 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.
- ➔ **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.
- ➔ **Assessment of coding skills** is mostly part of students' general assessment. Most countries consulted (e.g. Austria, Bulgaria, Czech Republic, 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 approach, coding is assessed as part of the subject skills (Portugal, France or Finland in the future).

- ➔ There is a variety of **support for teachers (formal and informal)** provided 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** (e.g. Austria, Belgium Flanders, Bulgaria, France, Estonia, Israel, Ireland, Lithuania, Poland, Portugal, Slovakia, Spain, UK have ongoing collaborations 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.
- ➔ Evaluation of coding initiatives is still rare among countries, which is reflected by a lack of evidence-based studies on these approaches. Only a **few countries are currently running pilot exercises** to assess whether the introduction of computing in the formal curriculum is actually achieving the expected impact.

Even though computer science will be high on the education sector agenda, and coding will remain most likely an important component of the subject, there are several questions that need to be tackled from a pedagogical perspective, i.e.:

- ➔ 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 computer science?
- ➔ How to refine assessment, in particular where computing 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 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.

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 computing, 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, thus promoting interconnections between public, private and civil society actors (e.g. CoderDojo);
- ➔ Supporting teachers and students in computing and coding based activities, as part of both formal and informal education. This could result in more training opportunities as well as in exchange frameworks where practices, resources and learning materials could be co-developed, validated and shared;
- ➔ Offering a dialogue platform on computer science education to policy makers (on the basis e.g. of the European Coding Initiative) and developing a major awareness programme on computing (on the basis e.g. of the Europe Code Week);
- ➔ Supporting the gathering of evidence in this area by monitoring and analysing research studies and evaluations in the field, encouraging pilot testing of educational approached and teaching and learning practices.
- ➔ Endorsing the integration of computer science in the school already from primary education level. Stressing at the same time the importance to consider the cross-curricular approach to

coding as a powerful mean to both train and interest pupils in computer science and technology related topics and careers.

➔ Encouraging a European exchange between countries that already integrated or reformed computer science in the curriculum 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 on how computing should be thought.

All these proposed actions should ultimately aim to support the momentum gained by computing and coding in the last years, making sure that all the stakeholders involved in the process are equipped with the best resources, networks and contexts to operate a radical and long lasting change in the way young people are provided with computer science related competences. Thus introducing widely in the curriculum computer science as a subject that enable a person to become an active and responsible digital citizen and a creator of technology, rather than merely a user or consumer of digital software and devices.

About the European Schoolnet

European Schoolnet (EUN) is the network of 30 European Ministries of Education, based in Brussels. As a not-for-profit organisation, European Schoolnet aims to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners.

For further information about European Schoolnet please visit our website: http://www.eun.org/

European Schoolnet is member of the Secretariat of the Grand Coalition for Digital Jobs.

About the Secretariat of the Grand Coalition

The Secretariat of the Grand Coalition has been established to support the initiatives of the European Commission's Grand Coalition for Digital Jobs. Specific initiatives of the Secretariat of the Grand Coalition include:

- Establishment of Student Placement Programmes (SPPs) across Europe to create temporary job placements
- Promotion of valuable industry and stakeholder-led initiatives to improve the level of e-skills in the labour force, specifically ICT practitioners
- Identification of concrete, short-term solutions to increase the mobility of skilled EU workers across Member States to address the shortage of ICT practitioners
- Dissemination of the activities of the Grand Coalition through a dedicated awareness raising campaign
- Creation of a toolkit to support the establishment of National and Local Coalitions to facilitate action towards enhanced digital skills at national, regional or local level

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