THE NORDIC APPROACH TO INTRODUCING COMPUTATIONAL THINKING AND PROGRAMMING IN COMPULSORY EDUCATION

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Transforming education in Europe

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FOREWORD

> ***Computational methods and models give us the courage to solve problems and design systems that no one of us would be capable of tackling alone. Computational thinking confronts the riddle of machine intelligence: What can humans do better than computers? and What can computers do better than humans? Most fundamentally it addresses the question: What is computable? Today, we know only parts of the answers to such questions.***
>
> *[Jeannette M. Wing][1]*

In a complex, fast-changing and increasingly digital world, it is – more than ever – crucial that all young people leave school with appropriate knowledge, skills and attitudes, able to adapt rapidly to new and unexpected occupations and skills needs. As the OECD[2] observes, a stronger emphasis than in the past has therefore to be placed in promoting foundation skills, digital literacies, higher order thinking competencies as well as social and emotional skills.

In the last five years, coding (or programming) has emerged as one of these new skills. The decision of England to mandate computing in schools from September 2014 created a momentum leading to curriculum reforms in other countries focusing on computer science concepts, programming skills and 'computational thinking'. This decision arose from a perception that the subject Information and Communication Technology in the English National Curriculum overemphasized functional skills in using computers, did not prepare young people for careers using ICT or reflect how 'software code and algorithms have been put to work in disparate social, political, cultural and economic contexts, across governmental, civil society and industrial sectors, and in scientific, social science and humanities disciplines'[3].

From the beginning, European Schoolnet has been monitoring initiatives in order to provide ministries and practitioners with up-to-date information about this rapidly evolving area.

Currently more than 20 European countries integrate programming or computational thinking in their curricula[4].

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[1] Wing, J., 'Computational Thinking', Communications of the ACM, March 2006/Vol. 49, No. 3 https://www.cs.cmu.edu/~15110-s13/Wing06-ct.pdf

[2] OECD, Skills for a digital world, 2016 http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS(2015)10/FINAL&docLanguage=En

[3] Williamson, B., Political computational thinking: policy networks, digital governance and 'learning to code', Critical Policy Studies Vol. 10, Iss. 1, 2016. http://www.tandfonline.com/doi/full/10.1080/19460171.2015.1052003

[4] Balanskat, A., Engelhardt, K., Ferrari, A., 'The integration of Computational Thinking (CT) across school curricula in Europe', European Schoolnet Perspective, issue no. 2, April 2017

Among over 100 examples in The Open Book of Educational Innovation[5] are several describing computational thinking initiatives: Scratch in France, primary school coding in Portugal, Italy and Belgium, and coding and creativity in Spain. They involve active collaboration between different age groups and aim to develop transversal skills across a wide range of subjects.

Computational thinking has emerged as a new concept to help prepare children for future challenges in an increasingly digital society. However, its impact on children's learning and skills is not yet clear.

As a recent European Schoolnet paper notes:

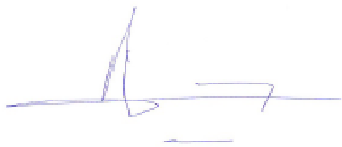
> ***Rigorous research on specific aspects such as assessment methods and transfer of knowledge will be key to the successful implementation of computational thinking in formal education. As more tangible results on implementation and pedagogical choices become available in many countries, the exchange of experience and lessons learned at both European and international levels will become crucial.***

This report is an inspiring contribution to our collective understanding of computational thinking, providing a wealth of detail on its place in Nordic curricula as well as on its essential accompaniment: well-prepared teachers, pedagogically competent in both algorithmic thinking and programming.

I commend the report to policy-makers, researchers, industry partners and practitioners.

Marc Durando

European Schoolnet



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http://www.eun.org/documents/411753/665824/Perspective2_april2017_onepage_def.pdf/70b9a30e-73aa-4573-bb38-6dd0c2d15995

[5] Licht, A.H, Tasiopoulou, E., Wastiau, P. (2017). Open Book of Educational Innovation. European Schoolnet, Brussels. http://www.eun.org/news/detail?articleId=855836

PREFACE

The European Commission presented on 17 January 2018 a new "Digital Education Action Plan" for Europe {COM (2018) 22 final} to help people, educational institutions and education systems better adapt to life and work in an age of rapid digital change. The Action Plan sets out three priorities: making better use of digital technology for teaching and learning; developing relevant digital competences and skills for the digital transformation; improving education through better data analysis and foresight. The support for relevant digital competences needed for life and work form part of priority area 2. This contains an action on bringing coding classes to all schools in Europe, including by increasing schools' participation in the EU Code Week.

Coding, and more broadly, computational thinking (CT) has indeed been on the agenda for several years now in Europe (e.g. Digital Agenda, New Skills Agenda, E&T2020). This was also demonstrated in our 2016 report "Developing Computational Thinking in Compulsory Education – Implications for Policy and Practice", a study designed and funded by the JRC and carried out by the Italian National Research Council, Institute for Educational Technology (CNR-ITD) in conjunction with European Schoolnet. The report provided a comprehensive overview of the most significant Computational Thinking (CT) developments undertaken in compulsory education across Europe, including implications for policy and practice.

We are pleased to see a contextualised update of this report for the Nordic countries and to observe that CT still remains high on the educational agenda. It is an important goal in itself to develop CT competences, but as illustrated also in this Nordic report, programming and/or CT should be part of a more comprehensive 21st century skills approach also labelled as digital competence. This is consistent with the approach proposed in the European Digital Competence framework for citizens (DigComp) developed by the JRC, where programming is one of the 21 competences of DigComp encompassing also information and data literacy, communication and collaboration, digital content creation, safety and problem solving.

In addition, capacity-building for the digital transformation of education and learning, and for the changing requirements for skills and competences should also look at educators' digital competence as well as the digital capacity of educational organisations. JRC has developed competence frameworks for all these (DigComp, DigCompEdu, DigCompOrg) and others (DigCompConsumers, EntreComp, OpenEdu) with the aim to provide a common language and understanding at European and MS level to tackle challenges related to digital age learning[6].

Yves Punie

Deputy Head of Unit

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European Commission

[6] More information on all our studies can be found on the JRC Science hub: https://ec.europa.eu/jrc/en/research-topic/learning-and-skills

ACKNOWLEDGMENTS

The authors of this report would like to thank all the experts from the Ministries of Education who participated in the survey for their valuable support and for the additional information they provided on policies and documents relevant to this short study (see Annex 1).

Our special thanks go also to the experts and stakeholders who provided valuable insights on current developments in CT in primary and secondary education in Nordic countries, highlighting the major implications for policy and implementation. The list of experts interviewed is included in Annex 2.

We would also like to acknowledge and thank Ann-Thérèse Arstorp, Norwegian Directorate for Education and Training (Norway) and Tobias Heiberg, of the University College Capital (Denmark), for providing valuable and detailed input.

INTRODUCTION

The New Media Consortium Report *Technology Outlook for Nordic Schools* explains that "educational technologies are not yet fully exploited in the Nordic region to impart real-world skills that reflect the needs of the workforce. Triggering large-scale, sustainable changes necessitates collaborative, focused actions that engage policymakers, local communities, school leaders, educators, and learners." [1, p.8].

Accordingly, Nordic countries have a need for a strategic policy framework that provides a vision, a rationale, and clear goals for ICT in education. If ICT use is to generate the expected benefits for school communities and society at large, national ICT policies will need to be positioned and aligned with other strategic and operational measures. Key to this effort is ensuring that centrally defined educational goals can and will be adapted to the particular needs of regions and the schools that serve them.

A vital component in bringing about this change is building consensus among all the stakeholders involved, as they are more likely to implement that change effectively if they have a clear sense of its rationale and potential usefulness. Leadership at all levels in the use of educational technology requires road-mapping to guide decision-making and action plans. To be truly useful, these roadmaps need to blend contextual understanding of real-world technologies with a firm grounding in the pedagogical frameworks that guide their application.

In recent times, Computational Thinking (CT) and programming have become central to the debate on exploiting the full potential of ICT for education. Indeed, these skills are now considered by many as being as fundamental as numeracy and literacy.

In 2016, the Joint Research Centre of the European Commission (JRC – Unit B.4) published the report *Developing Computational Thinking in Compulsory Education – Implications for Policy and Practice* [2]. This discusses the main results from the CompuThink study conducted for the EC JRC – Unit B.4 by the Italian National Research Council, Institute for Educational Technology (CNR-ITD) in conjunction with European Schoolnet. The report provides a comprehensive overview of the most significant Computational Thinking (CT) developments undertaken in compulsory education across Europe, including implications for policy and practice. Nineteen Ministries of Education (MoEs) - or organisations nominated to act on their behalf - contributed to the 2016 report. One of its chief findings is that the introduction of computational thinking and programming is a key priority for compulsory education in several countries, including England, France, Finland, Ireland, Malta and Poland [2].

Building upon results and experiences collected in the CompuThink study, CNR-ITD and European Schoolnet have prepared this short report about the introduction of computational thinking in compulsory education in Denmark, Finland, Norway and Sweden. Promoted and funded by the Nordic@BETT2018 Steering Group, the report provides an overview of the current status of CT and Programming in the four countries' curricula and national plans. It also discusses ongoing CT development in the Nordic countries. The report was developed as part of preparations for and contributions to Nordic@BETT2018, a Nordic-themed event at BETT 2018 in London. It presents key findings and emerging trends, with ideas for policy actions.

Approach

To provide an up-to-date overview of the position computational thinking and programming occupy in the school curricula of Nordic countries, a short survey was prepared. This was designed to:

- identify how Nordic countries[7] are currently integrating (or planning to integrate) CT and Programming in their curricula and national plans;
- collect additional information on implementation plans (i.e. programmes of study) and/or significant supporting measures like teacher training and assessment;
- identify relevant initiatives/projects supporting the introduction of CT and Programming in compulsory education.

The survey was carried out in November-December 2017 and was based on an updated version of the questionnaire for MoEs used in the 2016 CompuThink study. The data collected were subsequently analysed and discussed during semi-structured interviews with an expert from each of the four countries to clarify key aspects and collect further information. These efforts were complemented by desk research into the available evidence from Nordic countries. When analysing the survey results and reviewing collected documents for this report, we focused on the following aspects:

- terminology used;
- the role of CT and Programming in the compulsory level curriculum;
- integration approach;
- in-service teacher training.

This short study focuses particularly on curriculum guidelines and initiatives implemented as part of the Nordic countries' single structure education. Single structure education comprises primary and lower secondary education for children (i.e. International Standard Classification of Education, ISCED, Levels 1 and 2). Education is provided from the beginning to the end of compulsory schooling, with no transition between primary and lower secondary education, and with general education provided in common for all pupils [3, p.5]. Each of the four MoEs provides a national core curriculum that serves as a guide for the formulation of curricula at local level. This provided a reasonably uniform basis for comparing the approaches promoted in Nordic countries (information about the single structure education in the four countries is included in Annex 4).

[7] The Nordic Region consists of Denmark, Norway, Sweden, Finland and Iceland, as well as the Fareo Islands, Greenland and Åland. This report is about Denmark, Finland, Norway and Sweden (members of Nordic@BETT steering group).

KEY FINDINGS AND IDEAS FOR POLICY ACTION

Understanding of Computational Thinking and Programming

Nordic countries include CT and Programming as part of an evolving definition of digital competence. Although the term "computational thinking" is not explicitly used in policy documents, some key elements are included. There is an ongoing debate in all Nordic countries about the understanding of CT and Programming, pointing in two main directions:

- A broad understanding that frames CT as something more than programming, encompassing key 21st century skills like problem solving, logical thinking and creativity;
- A more technology-oriented understanding of CT and Programming, advocating the acquisition of competencies learners require to boost their employability in the ICT sector and their capacity to address societal challenges.

The variety of terminology used in the four countries reflects multi-faceted policy discussion and actions being undertaken in this area at different levels. This denotes a certain complexity that may hinder efforts to reach a shared understanding, and could thus affect implementation plans.

These considerations highlight the need to shift towards clear, shared definitions to ensure effective communications on CT, as well as collaboration among all key educational players (practitioners, academia, stakeholders).

IDEAS FOR POLICY ACTION

Foster collaboration among all key educational players (practitioners, academia, stakeholders) to compile a shared terminology that supports the process of curriculum integration.

Implementation of Computational Thinking and Programming in curricula

Three different approaches are open for integrating CT and Programming in the curriculum: a cross-curriculum strategy, accommodation in subject(s) already being taught, establishment of a new, purposely-designed subject.

In the Nordic countries, all three options are being pursued, even though at different stages of development.

Finland and Sweden have adopted a blend of cross-curriculum and single subject integration, where the strongest subject link - in terms of coverage and learning outcomes - appears to be with mathematics. Danish and Norwegian pilot initiatives at lower secondary level position CT within an elective subject that has strong links to computer science, leveraging synergic links with learning contents for developing CT skills.

The choice between these different strategies at national level is conditioned by the country's political mandate for CT-oriented reform and by the organizational constraints governing how curriculum changes are implemented and rolled out within the specific education system.

Obviously, irrespective of the strategy adopted, accommodating new topics in the curriculum poses a number of difficulties *per se*, not least that it implies taking hours away from other activities.

Establishment of an elective course on CT and Programming as part of an integration strategy softens organisational disruption but may also result in limited local uptake and actual student participation. This may undermine efforts to promote CT and Programming for all and could perpetuate existing inequalities.

Another major consideration impacting on the strategy to be adopted for compulsory education is the progressive subject area specialization that occurs in the transition from primary to lower secondary school.

IDEAS FOR POLICY ACTION

- Careful consideration should be dedicated to how transversal implementation of CT and Programming is to be actuated in practice, namely how it links up with the different subject areas and how it may impact on students' achievement.
- Where CT and Programming is embedded within a single discipline, attention should focus in particular on ensuring that knowledge and skills are developed in a way that promotes their transfer to other domains and contexts.
- Establishing CT and Programming as an elective subject should be considered a transitory step leading to a more comprehensive policy action whereby CT and Programming become a mandatory part of the curriculum.
- Specific actions for inclusive education (i.e. without regard to background, race or gender) should be undertaken as part of efforts to promote CT for all.
- Irrespective of which strategies are followed for curriculum integration, it is crucial to clearly formulate and assign responsibility to teachers in charge of integrating CT and Programming.

Actuation, assessment, and continuous professional development

In Nordic countries, adoption of CT and Programming in the curriculum is grounded on the assumption that this provides an ideal foundation for bolstering problem solving and logical skills, and digital competence. Clearly, this is unlikely to happen without proper guidance and support, paving the way for the actuation of suitable classroom activities.

IDEAS FOR POLICY ACTION

- Consider commissioning further studies/research to investigate the type of skills students acquire when following CT and Programming syllabuses, and which pedagogical approaches are most effective for acquisition of these skills.
- Consider sourcing and comparing case studies that report concrete implementation (pedagogy, tools, assessment).

Having appropriate assessment strategies and procedures in place is critical not just for gauging outcomes and effectiveness, but also to ensure that the whole educational community attributes real value to CT and Programming activities.

IDEAS FOR POLICY ACTION

Define specific criteria for teachers' assessment of their students' CT and Programming skills for all related goals included in the curriculum, both subject related and cross-curricula.

The introduction of CT and Programming in the curriculum calls for major in-service teacher training initiatives to up-scale competences. In all four countries, MOOCs are used to provide a scalable solution. While it is too early to report on the efficacy of approaches adopted for teacher training, inputs from the interview with the Finnish expert point to the following:

- The decision to adopt visual programming environments for primary school teachers is leading to successful appropriation of programming.
- Social media play a key role in disseminating good practices among teachers.
- The commitment of schools and local education authorities is important in creating the conditions (e.g. leave time, substitutions) for securing teachers' participation in training initiatives.

IDEAS FOR POLICY ACTION

- Prioritize peer exchange and community building, so as to promote the sharing of good practice among teachers.
- Promote specific initiatives for school leaders so they understand the importance of including CT and Programming in compulsory education and hence facilitate and promote its implementation.
- Ensure measures are in place at school level to support teachers' participation in in-service training courses (e.g. provision of replacement teachers).

To conclude, we wish to direct attention to aspects that we believe ought to be taken into account for introducing CT and programming.

On the question of where to make room for CT and Programming in the curriculum, we feel these are best placed (when conditions allow) within a purposely-designed subject that is respectful of CT's epistemological roots and that grants time for learners to acquire related skills through relevant practice.

At the same time, the introduction of CT and Programing should also encompass measures that ensure these skills are explicitly intertwined with the widely-advocated transfer of problem solving and logical thinking abilities to other domains.

Evidence shows that the transfer of programming skills is more likely to happen when (i) transfer is addressed in the upskilling of all teachers involved and (ii) forms an integral part of the pedagogical approach adopted in the classroom. Here, the connection between mathematics and CT is a common starting point, in Nordic countries as elsewhere, but this connection needs to be broadened to other domains in which CT and Programming can bring added value.

KEY TERMS AND CONCEPTS RELATED TO COMPUTATIONAL THINKING AND PROGRAMMING

In recent years, computational thinking and related concepts like programming and algorithmic thinking have been advocated by educational stakeholders as abilities for all that are as fundamental as numeracy and literacy.

A number of educational initiatives promoting CT concepts and programming have been carried out at European level (e.g. EUCode week) but also on a national scale, including in Nordic countries (e.g. introducing programming into the statutory curriculum).

In general terms, computational thinking is regarded as a thought process entailed in designing solutions that can be executed by a computer, a human, or a combination of both [4; 5]. In spite of the wide variety of definitions in use [6], it is possible to identify a set of constituent core concepts recursively positioned under the CT umbrella, namely *abstraction*, *algorithmic thinking*, *automation*, *decomposition* and *generalization*. These in turn are related to a set of attitudes and skills (or practices), including *creating computational artifacts*, *testing* and *debugging*, *collaboration* and *creativity*, and the ability to *deal with open-ended problems* [2].

This understanding frames CT as a foundational competency for being an informed citizen capable of coping with societal challenges. CT also bears potential as a means for creative problem solving and for innovating in a range of other disciplines, and thus has a crucial role to play in compulsory education [7].

Although the term "computational thinking" is not explicitly used in policy documents in Nordic countries, related key concepts and skills are often included. It is worth noting that the main understanding of CT in Nordic countries revolves around two focus points: *solving problems* and *digital competence* (i.e. creating digital solutions and being a critical user).

Figure 1 depicts the set of CT-related terms considered in this report to capture major trends in Nordic countries.

The terms derive from MoE responses to the survey question: "*Which term do you use in your own national language to refer to CT?*", as well as from interviews with experts.

There is no single Danish word covering CT, and Denmark's MoE does not have a general term or any policy document referring to Computational Thinking. The term "*teknologiforståelse*" (EN: understanding of technology) is used in primary and lower secondary education, and "*Informatik*" is used for computing, which is mainly studied at upper secondary level. The terms *21st century skills* and *digital literacy* are more widely used in Denmark.

FIGURE 1. CT-RELATED TERMS USED IN NORDIC COUNTRIES' EDUCATION POLICY DOCUMENTS.

In Norway, algoritmisk tankegan (EN: *algorithmic thinking*) emerges as the most widely used umbrella term that includes common CT features.

In Finland, *algoritminen ajattelu* (EN: algorithmic thinking) is used synonymously with *ohjelmoinnillinen ajattelu* (EN: computational thinking). Both are defined as a "*process that generalizes a solution to open-ended problems*." However, in the new national core curriculum *algorithmic thinking* is closely related to *programming,* and is only used in the parts that deal with programming. The term *coding* is not mentioned in the Finnish national core curriculum.

The concept of CT is part of education in Sweden, but the terms used in MoE policy documents to refer to it are *algorithmic thinking* and *programming*. The national curriculum, updated in March 2017, places greater stress on digital competence and includes programming in its definition.

The variety of terminology used reflects the richness of policy discussion and actions in this area. However, it might also pose obstacles to a shared understanding, and this could affect implementation plans.

For example:

- in Norway, Denmark and Sweden the term programming is very broad in scope, including key concepts of CT (modelling, abstraction, debugging), as well as of digital citizenship; in Sweden it encompasses creative solutions, governance and regulation, simulation, and the democratic dimension;
- even though algorithmic thinking plays a key role in Finland, it is not mentioned among the seven transversal competences. Instead, it is introduced at subject matter level, mainly in mathematics;
- in Sweden, the connection between programming and digital competence is explicitly made in the definition of digital competence. In a commentary [8][8] to the revised curriculum [9] from Skolverket, the National Agency for Education, it is clarified that the focus is not on coding skills, but on programming as a pedagogical tool and problem-solving process.

These considerations highlight the need to shift towards clear, shared definitions to ensure effective communications on CT, as well as collaboration among all key educational players (practitioners, academia, stakeholders).

Acknowledging the complexity inherent in this domain, as reflected in the variety of terms used in Nordic countries, this report will refer to "Computational Thinking and Programming" (henceforth CT and Programming).

Computational Thinking and Programming as part of the digital competence

The variety of terminology used not only reflects the value attributed to different aspects of CT and Programming at compulsory education level, it also demonstrates the strong relationship that CT and Programming has in Nordic countries with the development of 21st century skills and digital competence[9].

A common trend emerging from analysis of policy documents and interviews with experts is that Nordic countries have included CT and Programming as part of a broad and evolving definition of digital competence, one that embraces key 21st century skills like *problem solving*, *logical thinking* and *creativity*. This triangulates with socio-technical influences encouraging the use of technology (programming) as a means for creating, seen as a new language to be developed and acquired by all students.

When considering computational thinking in relation to digital competence [2, p. 15], two particularly significant aspects emerge for compulsory education:

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[8] The commentary by Skolverket entitled "Få syn på digitaliseringen på grundskolenivå" (2017, pag. 9) provides supplementary material for teachers and educational stakeholders, offering background understanding on the role of digitalization in the curriculum.

[9] In this report, "digital competence" - when related to CT and Programming - includes other terminologies in place in Nordic countries such as digital skills, digital literacy and ICT competence.

- CT is a thought process, thus independent of technology;
- CT is a specific type of problem solving that entails special ways of analysing problems which can be solved computationally and of developing solutions to them.

Hence, CT involves a set of skills that can transfer across disciplinary domains. Furthermore, CT is not only a way to acquire problem-solving skills but also a support for expressing oneself with digital media. This means that CT capacities are applicable in design and social cooperation.

Different authors suggest a variety of skills related to CT acquisition, such as: problem solving, examining data patterns and questioning evidence; collecting, analysing and representing data, decomposing problems, using algorithms and procedures, making simulations; using computer models to simulate scenarios; dealing with open-ended problems and persisting in challenging cases; and reasoning about abstract objects.

These connections also emerge from the different definitions and understandings of digital competence in Nordic countries.

The new Finnish core curriculum places an emphasis on transversal competencies in the instruction of subjects. These include *thinking and learning-to-learn*, *cultural competence, interaction and self-expression*, and *multiliteracy* (i.e. the ability to produce and interpret a variety of different texts). Two of the seven transversal competences (to be addressed in each subject), namely n. 4 *Multiliteracy* and n. 5 *ICT competence*, respectively deal with digital literacy and skills [10, sect. 3.3]. Pupils develop their ICT competence in four main areas:

1) understanding the principle behind using ICT and its operating principles, and developing practical ICT competence in producing one's own work;
2) using ICT responsibly, safely and ergonomically;
3) using ICT in information management and in exploratory and creative work;
4) gathering experience in using ICT for interaction and networking.

Since transversal competences focus on general principles, the relationship between competence and CT varies according to school level and subject area.

> ***The pupils gain and share experiences of working with digital media and age-appropriate programming tasks*** *[10, sect.13.2]*

In Sweden, Skolverket acknowledges that the meaning of digital competence changes over time due to changes in society, technology and available services. Skolverket's definition is based on the EU key competences [11] and those outlined by Digitaliseringskommissionen [12].

In the Swedish curriculum, digital competence is transversal across all subjects and includes four aspects:

1) understanding how digitalization affects individuals and society
2) understanding and knowing **how to use digital tools and media**
3) **critical** and responsible usage of digital tools and resources
4) being able to **solve problems** and implement ideas in practice.

In contrast with Finland, the Swedish curriculum's definition of digital competences explicitly mentions programming (included under Point 2).

> ***The curricula contain programming as part of the digital competence that students should be given the opportunity to develop. Programming includes writing code, which has great similarities with general problem solving. This includes problem formulation, choosing solutions, testing and rethinking, and documenting. [...] However, programming should be seen in a broader perspective, which also includes creative creation, governance and regulation, simulation and democratic dimensions. This further perspective of programming is an important starting point in teaching, and programming thus includes all aspects of digital competence*** [8].

In Denmark, digital competence forms part of the common objectives underpinning all subjects. ICT and media competences include communicating through the media by finding and sharing information digitally, creating content, and participating in social processes via ICT and media. Student competences are summarized in four student roles [13]:

1) The student as a **critical investigator**
2) The student as an **analysing recipient**
3) The student as a **creative producer**
4) The student as a **responsible participant**

> ***The cross curricular theme "IT and media" in grades K0-K9 is integrated in all subjects. It includes some elements of Computational Thinking such as problem solving and logical thinking.*** [Source: Danish MoE survey]**.**

In Norway, digital competence is a transversal competence fundamental for learning in all subjects [14]. The description of "digital skills" is currently being updated as part of the current revision of the K–12 curriculum. The responsible government-appointed committee describes digital competence as an integral part of different disciplines in school and education [15]. It establishes which types of digital tools are relevant and how pupils should use those tools as part of their subject competence.

Digital competence is also considered to be a cross-curricular competence, i.e. the capacity to apply a range of tools and skills related to safety and security, to think critically, and to communicate and collaborate.

> ***The Norwegian Centre for ICT in Education sees Computational Thinking as distinct from general digital literacy in that CT focuses more on the problem-solving process and methods for creating solutions. While general digital literacy tends to focus on being a competent and safe user of digital tools and resources, CT is more about understanding what lies 'behind the curtain' and about how those tools actually work. In this way, users become able to design and develop their own digital tools and solutions*** [Source: Norwegian Centre for ICT in Education survey].

The relevance of the policy debate on CT and digital competence is underlined by the contribution from the Finnish [16] and the Danish [17] MoEs to the EC consultation for revision of the 2006 Recommendation on Key Competences for Lifelong Learning. Here, the two MoEs explicitly called for the inclusion of Computational Thinking in the definition of digital competence:

> ***There are some issues missing that are of crucial importance to understanding the challenges of this competence, such as [...] computational thinking*** [16].

> ***We find that the Key Competences Framework 2006 could be more ambitious with regard to digital competences. The Danish Government sees computational thinking as a key digital competence today*** [17].

How CT and Programming are positioned within digital competence emerges from the contents of curricula, as discussed in the following section.

POSITIONING COMPUTATIONAL THINKING AND PROGRAMMING IN THE CURRICULUM

Policy initiatives to include Computational Thinking and Programming in compulsory education curricula are being undertaken in the four countries. In this section, we provide an overview of the current situation in each one, drawing on information derived from a survey of MoEs, a round of interviews with experts, and desk research.

Stages of implementation

The introduction of CT and Programming is as a key priority in Nordic countries. As it entails the complex process of formulating and rolling out curriculum change, it is no surprise that the four countries are at different stages of development, from exploring (DK), to planning (NO), to implementing the changes (FI, SE).

In Finland and Sweden, where the decision-making process is already completed and a renewed curriculum is in place, CT and Programming is included as part of digital competence as well as part of the goals for specific subject matters (i.e. Maths&Craft in Finland; Maths&Technology in Sweden).

Revision of the Finnish core curriculum to include algorithmic thinking and programming was completed in 2014, with implementation starting from 2016. A two-year implementation period is foreseen, giving municipalities the possibility to prepare for the transition and develop local curricula[10]. To accompany this process, digital learning materials have been developed and training provided throughout Finland for different target groups, namely principals, teachers and local education authorities. Once local curricula were developed and put in place, questionnaires were sent to all education providers as part of a general monitoring process. Currently, an analysis of curricula in 200 schools/municipalities (about 25% of the total) is being carried out to determine how the national core curriculum has been interpreted and operationalised. A round of school visits will follow.

In September 2015, the Swedish government gave Skolverket the task of presenting a national ICT strategy for the Swedish school system. As part of this work, Skolverket was to update the curriculum for primary and secondary education. The government explicitly mandated that the curriculum should 1) strengthen students' digital competence and 2) introduce programming at compulsory school level. In March 2017, the Swedish government issued the revised curriculum [9], with a definition of digital competence that features programming. The new curriculum will be mandatory from Autumn 2018, but is to be piloted by schools and teachers on a voluntary basis starting earlier in the year [18]. In October 2017, the government issued the national ICT strategy [19] for the Swedish school system.

Norway and Denmark are at a different stage of development: while Norway has already decided to renew the curriculum, Denmark is in an exploratory phase.

[10] In Finland, school curricula are formulated at local level as interpretations/adaptations of the national core curriculum.

Although still in the initial stages, both countries are piloting elective subjects specifically focusing on CT and Programming.

In Norway, a revision of the national curriculum is currently underway, with the purpose of meeting the challenges posed by wide-ranging and rapid changes in society. The Ministry of Education has published a digitalisation strategy for primary, secondary and vocational education for 2017-2021[20]. This states that CT and Programming should be integrated into the curriculum, but to what degree and in what subjects is yet to be decided. The Norwegian Directorate for Education and Training has started the process of revising the entire curriculum for primary and secondary education and for training. The government has implemented a pilot project offering programming as an elective subject in lower secondary school, and this will become a permanent elective subject from 2019. Trials in programming and modelling in upper secondary school will also commence in 2019. The revised curriculum will come into force in 2020 [21].

The Danish Ministry of Education is currently looking at measures to strengthen CT and Programming in relation to "teknologiforståelse" (understanding technology) in primary and lower secondary school. The final roadmap for introducing these changes is due to be released later in 2018. In December 2016, the Danish Growth Council published a report with recommendations for the government that included five "Here & Now Recommendations" [22]. One of these is that CT should become a mandatory component in education at all levels. The Ministry has recently nominated a new advisory group to produce a long-term action plan for technology in education; the group includes representatives from industry and research with strong competences in technology development, big data and learning. In summer 2017, an optional (pilot) subject called "technology understanding" (including CT and Programming) was launched in lower secondary schools for the following three years.

Rationale

A number of policy documents issued in Nordic countries address the rationale for including CT and Programming in compulsory education. The main focus is placed on CT as a means for developing learners' problem-solving abilities (Table 1). Programming is considered an ideal way of developing computational thinking, which learners can then apply more broadly.

Introducing CT and Programming is also seen as a way of bridging the gap between curricula and the current needs of learners and society in general. This is part of a more general trend towards strengthening the digital competence of students, seen as critical users and creators of digital products. Both roles are considered important for students to participate fully in the digital world.

Both industry and NGOs are contributing to the debate on curriculum reform, which is increasingly part of the broader discussion on societal challenges. Industry stresses the need for learners to acquire the competences required by the job market, while NGOs are promoting initiatives that bring coding to primary schools.

Furthermore, Computational Thinking and Programming are also considered as an innovation that should contribute to maths and science learning by boosting the motivation of disaffected learners. Indeed, students who have little interest in mathematics or other STEM subjects may well see programming as an appealing activity presenting a tangible need to apply mathematics understanding [23].

TABLE 1 RATIONALE FOR INTEGRATING CT IN THE CURRICULUM, AS EMERGING FROM THE SURVEY OF MOES.

	Finland	Sweden	Denmark	Norway
Fostering employability in the ICT sector	■	■		
Fostering coding and programming skills	■	■		
Fostering problem-solving skills	■	■	■	■
Fostering logical thinking skills	■	■	■	■
Fostering other key competences	■	■		■
Strengthen pupils' motivation to study mathematics	■			
Developing digital citizenship		■	■	
Understanding society and the role of technology in society		■	■	■

Integration approach

In the following, we look at how CT and Programming are introduced in Nordic countries' curricula for compulsory education. In particular, for each country, we examine at *what level* they are introduced (ISCED 1 primary, ISCED 2 lower secondary) and in *what way* (transversally, within an existing subject, as a new subject). Finally, we discuss and compare key CT and Programming contents present in the curriculum.

While Finland and Sweden have included CT and Programming both as transversal competences and within existing subject matter, Norway and Denmark are piloting CT and Programming as a new (elective) subject (Table 2).

TABLE 2. TRANSVERSAL COMPETENCES AND SUBJECTS INTEGRATING CT AND PROGRAMMING IN NORDIC COUNTRIES' CURRICULA.

Finland		Sweden		Denmark		Norway	
ISCED 1	ISCED 2	ISCED 1	ISCED 2	ISCED 1	ISCED 2	ISCED 1	ISCED 2
Trans-versal ICT	Trans-versal ICT	Transversal Dig. Comp.	Transversal Dig. Comp.	Transversal IT&Media	Transversal IT&Media		
Maths	Maths	Maths	Maths		Physics & Chemistry		
Crafts	Crafts	Technology	Technology		*Technology understand-ing (Pilot)*		*Program-ming (PILOT)*
		Social Science	Social Science				

In Finland and Sweden, CT and Programming are introduced both in ISCED 1 and ISCED 2. Since CT and Programming form part of revised definitions of digital competence, all subjects are involved (i.e. a transversal competence).

CT and Programming are also placed within existing subject matters in which specific objectives and sometimes assessment criteria are defined (Maths & Crafts in Finland; Maths, Technology and Social Sciences in Sweden).

In the Danish curriculum, the "IT and media" transversal subject is foreseen for ISCED 1 and ISCED 2. This transversal theme includes digital literacy but also problem solving and logical thinking skills, thus entailing some elements of CT. Moreover, in ISCED 2, some elements of programming are also integrated in physics and chemistry. Since summer 2017, an optional (pilot) subject dealing with CT and Programming called "Technology Understanding" is offered to students in lower secondary schools (ISCED 2). The Danish MoE, in cooperation with the Danish IT industry, the Coding Pirates NGO and six municipalities are working together to introduce CT into primary schools within the project Coding Class.

As of 2016, 144 lower secondary schools in Norway have been engaged in the piloting of programming as an optional subject. The curriculum for the "Elective Programming" subject refers to computational thinking skills ("algoritmisk tankegang") as a method for problem solving in programming. The pilot will run for three years and an evaluation will be ready in 2019. However, the government has already decided to offer programming as a permanent elective subject from 2019 [21].

Coding Class (Denmark)

Coding Class is a project in which the Danish IT Industry Association, six municipalities, the Ministry of Education, and the non-governmental organisation Coding Pirates work together to introduce computational thinking into primary schools and teacher university colleges in Denmark. The goal of Coding Class is first and foremost to get children to turn on IT so they get a better understanding of the world that surrounds them, now and in the future. Coding Class also seeks to put IT education on the agenda of politicians so it becomes a regular part of the primary school curriculum.

The project provides classes with a Coding class instructor who, in the first year, teaches children computational thinking in close collaboration with the teacher. The aim is to enable schools and municipalities to carry out the classes themselves as of year two. Coding Class runs over a year: 6th grade students are introduced to both algebraic and abstract thinking, logical structure and problem solving, as well as programming.

Source: https://itb.dk/articles/fremtidens-kompetencer/coding-class

Key Computational Thinking and Programming contents in compulsory school curricula

In order to understand the extent of the changes introduced in curricula, we briefly discuss how CT and Programming are positioned with respect to subjects across the four countries (Table 3).

In Finland and Sweden, students are introduced to CT in ISCED 1 via programming, which involves the construction of simple programs using visual environments (in maths). In Technology / Craft, programming is mainly used to control physical objects like robots. In ISCED 2, the focus is on algorithmic thinking and problem solving (in maths), and constructing and programming physical objects in Technology / Crafts.

It is worth noting that at ISCED 2 level, both curricula require a shift from visual to text-based languages. This is driven both by the increased level of complexity in the subjects studied, and by the objective to develop students' digital skills for future employment.

In the Swedish curriculum, the relationship between programming and digital citizenship falls under social studies, particularly in ISCED 2.

TABLE 3. CT AND PROGRAMMING CONTENTS COVERED IN THE FINNISH AND SWEDISH CURRICULA (ISCED 1 AND 2).

ISCED	**Finland**		**Sweden**	
ISCED 1	**Maths**	**- Step-by-step** instructions **- Simple programs** in a **visual** programming environment	**Maths**	**- Step-wise** instructions - Creation and use of **algorithms** in **visual** programming environments
	Crafts	- Programming **robots** and **automation**	**Technology**	- Controlling **self-made constructions** or other artifacts through programming
	ICT Transversal	**- Age-appropriate programming** tasks - How **human decisions** affect how tech works	**Social Studies**	- **Acting responsibly** with digital and other media - Improved possibilities for **communication** and **e-commerce**
ISCED 2	**Maths**	**Algorithmic thinking** and **problem solving** in mathematics and programming	**Maths**	- Creation and use of **algorithms** in programming - Programming in **different programming environments** (visual and text-based).
	Crafts	**Programming** applied to the design and production of **physical objects**	**Technology**	- **Controlling and regulating one's own constructions** using programming
	ICT Transversal	Programming in **different subjects**	**Social Studies**	- **Evaluation** of news - Portrayal of individuals and groups (e.g. gender and ethnicity) - How **information in digital media is controlled** (hidden programming) - **Opportunities** and **risks** of the Internet and digital communication

In Denmark and Norway, the syllabuses for the ISCED 2 level pilots in CT and Programming focus on the areas of *design* and *implementation*.

In Denmark, the elective subject "Technology Understanding" positions students as creative and innovative producers, fostering their ability to design and implement digital products. Students are also required to consider the social importance of digital products. The subject is explicitly connected with mathematics, natural sciences, humanities and the arts.

In Norway, the pilot subject "Elective Programming" emphasizes the development of algorithmic thinking skills. It chiefly addresses the steps involved in solving problems by programming. The modelling of phenomena in maths and the natural sciences is a central part of this. Students are expected to develop their own programs using different programming languages. The main focus here is on tackling the complexity entailed in solving a problem, and the appropriate choice of programming language [24].

Table 4 presents key CT and Programming concepts in elective subject pilots being run in Denmark and Norway (ISCED 2).

TABLE 4. CT AND PROGRAMMING CONCEPTS IN NORWAY AND DENMARK PILOTS

Denmark Elective "Technology Understanding" (ISCED 2)		**Norway Elective Programming (ISCED 2)**	
Design	- Idea and specification - Realization - Social significance	**Modelling**	- Types of problems suitable for solution using a computer - Breaking down problems into sub-problems - Designing solutions - Modelling of mathematical and natural sciences phenomena - How computers and programs are designed and function - Different programming languages - Principles behind good programming practices
Programming	- Patterns - Algorithms - Data and program structure - Coding (modifying and constructing a simple program) - Programming languages - Testing and error correction - Programming applied to the production of physical objects	**Coding**	- Basic principles of programming such as loops, tests, variables - Control or simulation of physical objects - Troubleshooting - Generalization and reuse of solutions - Using multiple programming environments (visual and text-based) - Assessment and analysis of one's own code and that of others.

Role of CT and Programming at upper secondary level

The Nordic countries have a long tradition in teaching programming and computer science at upper secondary level. Although this study is dedicated to CT and Programming in compulsory schooling, the survey of MoEs also collected upper secondary data in order to complete the picture. Here is an overview.

Finland. Upper secondary school level (general education): the NCC course "The Algorithms of Mathematics" gives students a deeper understanding of computational thinking. A feature in the new 2016 NCC, Interdisciplinary Studies, makes provision for regional curricula and studies to further enhance students' programming skills. Upper secondary school level (vocational education): Computational thinking and Programming are integrated in some diploma programs.

Denmark. Grades K10-K12: Currently, programming is integrated in the subject Informatik (computer science). The future Informatik course comprises two levels (C and B) common to all secondary education streams (general upper secondary, technical, commercial), with seven generic learning goals. Both curricula may unfold differently in different streams. Informatik is a mandatory subject in the commercial stream.

Norway. In 2017, the Norwegian Directorate for Education launched a pilot for a new subject in upper secondary schools called "Programming and Modelling X". The syllabus for this subject includes computational thinking (algoritmisk tankegang). Programming and Modelling X should provide an introduction to algorithmic thinking and enable students to break down natural and social problems into partial problems. The course will provide an introduction to numerical methods, and compare numerical and analytical methods in mathematics. An important aspect of the subject is to foster exploration within the fields of science. The subject will provide the basis for applying creativity, critical thinking and methodology in different subjects. It will also support further studies and careers within science subjects.

Sweden. In upper secondary school computing courses are elective for all students [25].

IN-SERVICE TEACHER TRAINING IN COMPUTATIONAL THINKING AND PROGRAMMING

With the introduction of Computational Thinking and Programming in curriculum guidelines (Finland and Sweden) and in pilot projects (Denmark and Norway), a number of in-service teacher training initiatives are in place[11]. While many are being financed by MoEs and carried out by universities, industry and NGO-backed initiatives also play a key role.

From the analysis of teacher training courses mentioned in the survey and the interviews in the four countries, two main areas emerge:

- Algorithmic thinking and programming of computers (e.g. apps, simulations, video games) and physical objects (e.g. robots, embedded systems).
- Programming in visual and text-based environments.

These two dimensions clearly reflect and map against the main topics and subjects covered in school curricula (e.g. in Finland and Sweden CT and Programming is placed within Maths and Crafts/Technology respectively, focusing on virtual and physical domains). Even though in the school curricula there is a strong relation with digital competence, teacher training courses in the four countries mainly focus on CT and Programming.

Table 5 summarises the main contents and tools used within in-service training courses in Nordic countries. This picture emerged from the survey and the experts' interviews, and is discussed below.

Finland has three major training initiatives, two (Koodiaapinen MOOC and the Innokas Network) financed by the MoE, and another (Suomen Kood-Koulu) that is commercial. The Koodiaapinen MOOC [26; 27] provides teacher training on algorithmic thinking and programming at all levels of the Finnish compulsory curriculum. The activities are run by the IT Trainers Association, the Innokas network, the Department of Computer Science at Helsinki University, and the Information Technology Institute at Aalto University. The Innokas Network [28; 29] comprises 400 schools and promotes robotics and programming. Coordination of the network is the responsibility of the Department of Teacher Education at Helsinki University and the City of Espoo.

Skolverket is promoting a number of initiatives in Sweden, including a web course on basic programming knowledge, conferences and webinars. Universities offer basic programming courses for lower and upper secondary maths teachers. Vinnova, Sweden's innovation agency, has funded several projects on digital competence and programming in schools, e.g. *Computational Thinking for All*, aimed at all 50 compulsory schools in the city of Linköping [30]. Vinnova also funded the Trippel Helix

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[11] In-service teacher training is not compulsory in Nordic countries. Contents and courses are usually designed and implemented by universities and commercial companies. In recent years, training in ICT has been a major focus.

Project[12], aimed at getting school, industry and academia to formulate a common and achievable action plan.

TABLE 5. KEY TOPICS COVERED IN IN-SERVICE TRAINING COURSES

	Denmark	Finland	Norway	Sweden
Algorithmic thinking and programming of computers	Developing video games and apps (loops, conditionals, variables, events) [Primary teachers]	CT and basic programming (commands, loops, conditionals) [Primary teachers] Algorithms, abstraction, logic, loops, recursion, lists [Lower Sec. teachers]	Algorithms, loops, conditionals, variables and functions Debugging Developing simple simulations [Lower Sec. teachers]	Step by step, patterns, decomposition, abstraction, algorithms; testing and troubleshooting; communication and collaboration [Primary and Lower Sec. teachers]
Algorithmic thinking and programming of physical objects (kits)		Lego Mindstorms Arduino Robbo	Lego Mindstorms Arduino, Drones Micro:bit	Micro:bit
Programming in textual environments		Python Racket	Python Java Script	Python Swift Playground
Programming in visual environments	Scratch App Inventor	ScratchJr Scratch	Scratch Code Studio Micro:bit	ScratchJr Scratch

Skolverket is promoting a number of initiatives in Sweden, including a web course on basic programming knowledge, conferences and webinars. Universities offer basic programming courses for lower and upper secondary maths teachers. Vinnova, Sweden's innovation agency, has funded several projects on digital competence and programming in schools, e.g. *Computational Thinking for All*, aimed at all 50 compulsory schools in the city of Linköping [30]. Vinnova also funded the Trippel Helix Project[13], aimed at getting school, industry and academia to formulate a common and achievable action plan.

In Norway, *The Professional Digital Competence Framework for Teachers* document includes "algorithmic thinking" in the knowledge and skills expected of teachers [31,p.5]. In conjunction with the new elective course pilot on programming, the Norwegian Centre for ICT in Education provides a MOOC for teacher training on the elective course and basic programming[14]. Interestingly, one of the MOOC's modules

12 http://www.trippelhelix.se
13 http://www.trippelhelix.se
14 http://kurs.iktsenteret.no

features a suggestion to assess student achievement in the elective programming course via a project-based approach using an evaluation rubric.

Several Norwegian universities offer courses for in-service teachers on introducing programming at school[15]. The NGO Laer Kidsa Koding[16] provides support for teachers, including guides for different programming languages[17] and workshops[18].

In Denmark, few institutions for teacher education have included courses addressing CT and Programming. University colleges offer pilot courses for in-service teachers' in teknologiforståelse (teachers professional digital competence including programming and coding) as part of a larger project initiated by the Ministry of Education. During the course, teachers are presented with a variety of technologies and then choose to focus on a few specific examples. Based on this, they develop a lesson plan that they then execute over the course of three weeks at school. Throughout the course activities, university college staff facilitate and actively support participants. The initiative seeks to focus on and adjust to teachers' specific knowledge, needs and practice.
Another initiative, Coding Class[19] is offered in an increasing number of municipalities as a kind of in-service training of teachers in primary school (K6).

Table 6 provides an overview of the initiatives presented above.

TABLE 6. TEACHER TRAINING INITIATIVES ON CT AND PROGRAMMING MENTIONED IN THE SURVEY AND IN INTERVIEWS IN THE NORDIC COUNTRIES

PROVIDERS	DENMARK	NORWAY	FINLAND	SWEDEN	*TARGET*
Educational Agencies	National Agency for IT and Learning Local Government Denmark University Colleges		INNOKAS Network Kopiannen MOOC	Skolvertket initiatives Computational Thinking for All (Vinnova)	***Primary teachers***
		Senter for IKT i Utdanningen	Kopiannen MOOC INNOKAS Network	Skolverket initiatives Universities	***Lower secondary***
NGOs and commercial	Coding Class	Laer Kidsa Koding	Lear kodi-koolu		***Primary teachers***

In Sweden and Finland, where changes to the curriculum to include CT and Programming are already in place, existing training offers cover both primary and lower secondary teachers.

[15] E.g. http://www.hioa.no/eng/Studies/TKD/Evu/Programming-for-Teachers
[16] http://kidsakoder.no/skole)
[17] http://oppgaver.kidsakoder.no
[18] http://kidsakoder.no/konferanser
[19] https://itb.dk/articles/fremtidens-kompetencer/coding-class

In Norway, a specific teacher training initiative has been developed in conjunction with the pilot initiative for lower secondary (ISCED 2).

It is worth mentioning that there are several NGO initiatives at primary level.

The introduction of CT and Programming in the curriculum calls for major in-service teacher training initiatives to up-scale teachers' competences. In all four countries, MOOCs are used to provide a scalable solution.

While it is too early to report on the efficacy of approaches adopted for teacher training, inputs from the interview with the Finnish expert point to the following shortcomings and possibilities:

- The commitment of schools and local education authorities is important in creating the conditions (e.g. leave time, substitutions) for securing teachers' participation in training initiatives.
- The decision to adopt visual programming environments for primary school teachers is leading to successful appropriation of programming.
- Social media play a key role in disseminating good practices among teachers.

Koodiaapinen MOOC (Finland)

Course Structure

The course has four parallel tracks dedicated to teachers of different age groups and subject areas. Each track is composed of 5 - 8 units and is headed by a teacher from that specific grade level. This person is in charge of producing the course materials, together with short introductory and feedback videos, and helps participants during the MOOC. Moreover, each track addresses key age-appropriate activities for students in relation to the national core curriculum. Each session features an introduction to programming concepts, practical exercises, and a reflection on the role of coding in teaching. The weekly working time is about 30 minutes to 2 hours.

Course contents

- Computational thinking and basic programming concepts (such as commands, loops, and conditional statements).
- Hands-on experience with programming tools considered suitable for pupils (grades 1-2 ScratchJr; grades 3-6 Scratch; grades 7-9 Racket or Python).
- How computational thinking can be presented to students in a meaningful way so that the learning objectives of the curriculum are met.
- How the teacher's role and classroom practices are changing.
- How coding could be used in all school activities, like sports, music, art, cooking, and crafts, as well as academic subjects and STEM (science, technology, engineering, and mathematics).

Course participants

In the first edition, 511 of the 1500 teachers who enrolled in the course completed it; in the last two editions, 1300 out of the 3600 enrolled teachers completed the course. These figures indicate a high retention rate compared to other types of MOOC courses.

Source: http://koodiaapinen.fi/mooc/

Programming MOOC (Norway)

To support the elective pilot course on programming, the Norwegian Centre for ICT in Education has developed and run a MOOC for participating teachers. This comprises a core course, plus five short courses on specific programming languages: Scratch, Code Studio, Python, JavaScript and Micro:bit. The main course provides an introduction to programming and suggested resources for teaching the elective course.

Course contents

The course consists of six modules:
- Introduction to "the programming elective course"
- Organization and student assessment in the programming elective course
- Theoretical content on the subject
- Block-based programming
- Text-based programming
- Programming of physical objects

Source: https://kurs.iktsenteret.no/courses

Innokas Network (Finland)

Innokas is a national network to promote robotics, coding and the use of ICT in education. Funded by the Finnish National Agency for Education, the network is coordinated by the Department of Teacher Education at the University of Helsinki and by the City of Espoo.

This Finnish network is designed to fuel educational reform for the learning of 21st century competences. The key question driving the Network is how to foster and support the learning of 21st century competence in practice.

The Innokas approach is a combination of the cross-disciplinary Finnish traditions in crafts, arts, science, technology, engineering, and mathematics (STEAM), and other school subjects including methods of digital fabrication, coding and robotics, hands-on learning and technology. The Innokas approach is closely related to the "maker culture".

Students are guided and encouraged to use creative planning processes, thinking skills, and engage in teamwork and in projects that cross the traditional boundaries between school subjects. A key guiding principle in the model is the comprehensive and versatile use of digital technology, both in learning and teaching and in schools' daily operational processes.

The Network has an intensive work programme, including professional training courses for teachers, nationwide coding and robotics roadshows, and national-level Innovation Education events.

Source: http://www.innokas.fi

On programming – web course (Sweden)

To support the introduction of programming in the revised curriculum, Skolverket has developed an online course to provide all staff within the school system with a basic knowledge of programming and increased awareness of programming's impact on society, both historically and today. In addition, the effort aims at giving everyone who works in Swedish school an understanding of programming in the curriculum.

The course consists of eight modules:
1. Programming in society, historically and today
2. Try programming
3. Curriculum
4. Words and concepts
5. Programming in school
6. Try on
7. Programming in the future
8. How do I go on?

The course is estimated to take approximately 16 hours.

Source: http://www.skolverket.se/omprogrammering

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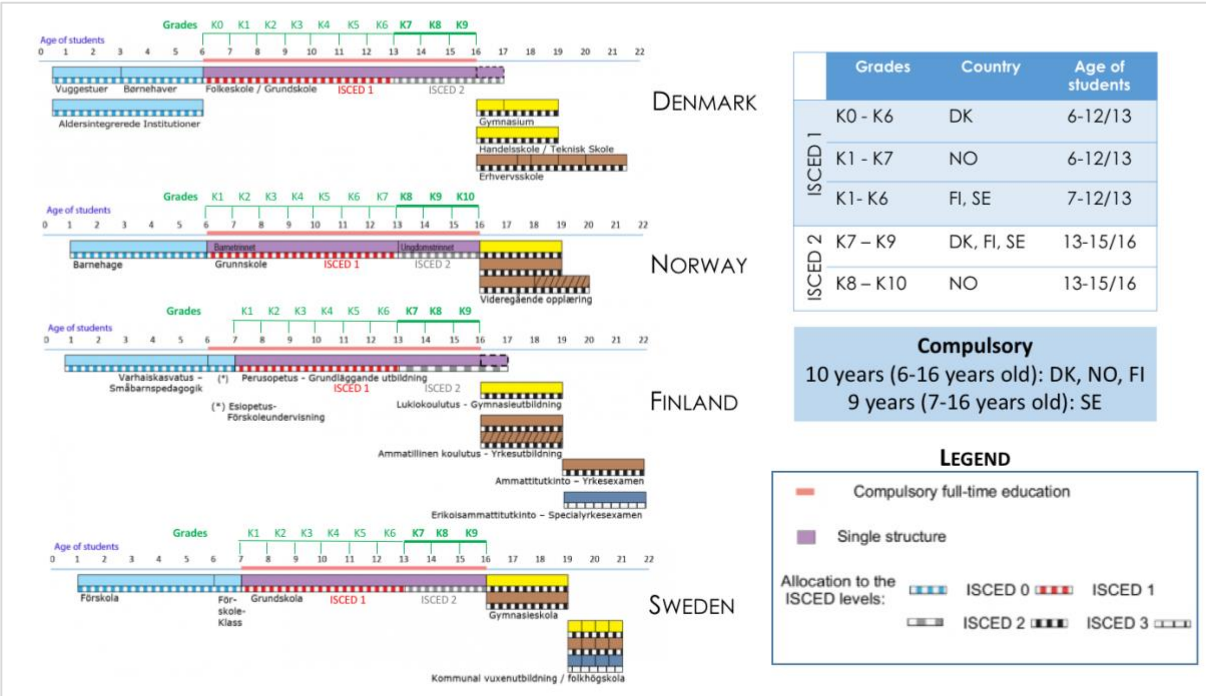
ANNEX 4. SINGLE STRUCTURE EDUCATION IN NORDIC COUNTRIES

The following schema, adapted from Eurydice Country descriptions[20], depicts similarities among the single structure education in the four countries (DK, NO, FI, SE) and guided the analysis of data collected in this study.

All four countries have adopted a single structure education for compulsory education. A common structure underlies the four systems, although there are differences in when primary school starts. For instance, compulsory education in Finland starts at the age of six although this year is still part of ISCED 0 (i.e. not included in the single structure system). By the time of preparing this short report, Sweden has also announced that, starting from autumn 2018, last year of pre-school will also become obligatory[21].

Main commonalities and differences, including how grades are labelled in the four countries, are detailed below.



[20] https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Countries

[21] The Danish parliament announced the decision of introducing pre-school class as mandatory from the autumn 2018 https://www.skolverket.se/laroplaner-amnen-och-kurser/forskoleklass/forskoleklassen-1.202791

Abstract

This report discusses the introduction of Computational Thinking (CT) in compulsory education in Denmark, Finland, Norway and Sweden. Promoted and funded by the Nordic@BETT2018 Steering Group, the report provides an overview of the current status of CT and Programming in the four countries' curricula and national plans. It also discusses ongoing CT development and emerging trends, with ideas for policy actions.

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