

Strategies to include computational thinking in school curricula in Norway and Sweden

European Schoolnet's 2018 Study Visit



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Introduction



Teaching Computer Science in schools is not a new trend; in particular many Eastern European countries have a long standing tradition in teaching the subject. However, in the last five years, the integration of programming in curricula across Europe has considerably taken up speed¹; and programming is increasingly recognized as one of the new skills needed for students to succeed in our digital society.

As of 2015², “Computational Thinking” (CT) emerged as a term used by policy makers in different countries. Generally, the term marks a new focus on learning programming as a new thinking skill that develops crucial 21st century skills such as logical thinking, problem-solving skills, creativity and collaborative and social skills. However, others prefer to use related terms such as “algorithmic thinking” or “programming”, taking a broad perspective on its definition. In this report, we will refer to “CT/programming”. A remarkable hype around the topic has recently been created by large grassroots initiatives such as EU Code week³, supported by the European Commission and industry partners. Furthermore,

1 According to our research, at least 20 countries have done so, namely: AT, BG, CZ, CH, DK, EE, ES, FI, FR, HU, HR, IT, IE, LT, MT, PL, PT, SK, UK (England), UK (Scotland). Also see: A. Balanskat, K. Engelhardt & A. Ferrari (2017). [European Schoolnet perspective. The integration of Computational Thinking \(CT\) across school curricula in Europe](#)

2 e.g. Belgium Flanders, Czech Republic, Ireland, Malta, Netherlands, Poland)Also see: A. Balanskat, K. Engelhardt (2015). [Computing our Future. Computer programming and coding. Priorities, school curricula and initiative across Europe. European Schoolnet](#)

3 <https://codeweek.eu/>

CT/programming is already part of many curricula across Europe. However, five years down the road, several open questions still remain e.g.: Should CT/programming best be integrated as a subject in its own right, as part of Computer Science lessons, or across some (or all) subjects? How can policy makers support schools and teachers in teaching CT/programming in a way that fosters 21st century thinking skills?

Following a strong interest in the topic expressed by Ministries of Education, European Schoolnet organised a first study visit on 31st of May and 1st of June 2018 in Oslo (Norway) and Stockholm (Sweden), with the support of the two hosting organisations; the Norwegian Directorate for Education and Training and the Swedish National Agency, Skolverket. **The focus of this first peer learning visit was to learn from the two country examples about the purpose of teaching CT/programming, strategies to implement it and how to assess it.** The visit was organized in these countries because as of August 2018 in Sweden, and in 2020 in Norway, CT/programming becomes a compulsory part of the national curriculum. In total, 25 people participated, including a mix of policy makers, researchers and teachers from 14 countries. Participants visited the Hundsund Ungdomsskole⁴ in Oslo, Norway, and Årstaskolan school⁵ in Stockholm, Sweden as well as the respective hosting organisations.

This report aims to share observations, reflections and lessons learned from the visit. Taking the two schools we visited as inspirational examples, this report reflects on the ways CT/programming is practiced in each school, taking a close look at its position in the curriculum, the skills and training required for teachers involved, as well as general supporting conditions such as shared leadership in schools.

4 Hundsund School website: <http://hugs.no/>

5 Årstaskolan website: <https://arstaskolan.stockholm.se/>

1. Curriculum development in Norway and Sweden

In both countries, quite a few schools are already teaching Computational Thinking (CT)/programming⁶. However, with the implementation of Sweden's new curriculum in August 2018 for all schools⁷ and Norway's new curriculum in 2020, CT/programming will become a compulsory component for all students in both countries.

1.1. New curriculum in Norway

Norway is currently preparing its new curriculum for 2020 concerning all subjects. Its main purpose is **to enable children and young people to meet and find solutions to the challenges of today and tomorrow**. All subjects in primary and secondary school and the compulsory subjects in upper secondary education shall be reviewed and updated. In this new curriculum, a framework for all subjects outlines 5 basic skills: oral skills, reading, writing, digital skills and numeracy. The BetaLab⁸ team in The Norwegian Directorate for Education and Training, was strongly influenced by the English curriculum, (introduced in 2014), when defining the curriculum for Programming/Computational Thinking

6 Bocconi, S., Chiocciariello, A. and Earp, J. (2018). [The Nordic approach to introducing Computational Thinking and programming in compulsory education](#). Report prepared for the Nordic@BETT2018 Steering Group.

7 In Sweden, schools were free to already implement the new curriculum since August 2017. However, as of 2018 it will be mandatory for all schools.

8 BetaLab is the Directorate's lab for experimenting with technology and innovative pedagogical practices.

as an optional subject. However, the position of Programming/Computational Thinking within the revised curriculum has not yet been established.



FOCUS OF THE NEW CURRICULUM IN NORWAY

The new Norwegian curriculum will put a stronger emphasis on understanding, critical thinking, relevance and the concept of deep learning. For deep learning to take place, the curriculum needs to provide sufficient time, as “students gradually and over time develop their understanding of concepts and contexts within a subject”.

The process of preparing the curriculum also includes some novelties. A new element in this process is to first define the core elements that students should learn for each subject. Such core elements consist of general provisions for subjects and for practice in schools (e.g. values, understanding of competence, principles for learning etc.). Only as a second step then is the actual content of the curriculum developed. This new approach aims to ensure a better progression within and more coherence between subjects. Moreover, this time more stakeholders are involved in the process and schools will have more time to prepare for the new curriculum. Another novelty is that more thinking has been put into how to better present the curriculum’s intentions to teachers, for them to more closely follow the curriculum in their own teaching. To that end, the curriculum documents themselves will be directly linked to the accompanying guiding documents in an interactive digital format. This format will allow teachers to browse through the curriculum documents via a simple search using keywords.

1.2. New curriculum in Sweden

While schools have been free to implement the new curriculum since 2017, as of August 2018 the new Swedish curriculum has become mandatory for all schools. As part of the new curriculum, a new requirement for teachers is to organize and carry their work out in ways that enable students to make use of digital tools to enhance their knowledge and development. Sweden is also preparing a new national strategy and action plan for the digitalisation of the

school system. There has been no national strategy in place for the last 15 years. In 2016, a proposal for such a strategy was put forward and decided by the government in 2017. The vision for 2022 is that all children will develop adequate digital skills.



FOCUS OF THE NEW CURRICULUM IN SWEDEN

The new curriculum stipulates 4 main goals for students' digital competence:

- to understand the digital transformation of society and how it affects us
- to be able to use digital tools and media
- to be critical and develop a responsible approach to digital technology
- to learn to put one's own creative ideas into action and learn how to solve problems.

2. Definition of Computational Thinking/programming

During the discussions, it became apparent that CT was understood in different ways by study visit participants. Making these different definitions of CT⁹ explicit was a prerequisite to discuss its practical implementation in the classroom in a meaningful way.

On a European level, such an exchange helps to develop a shared understanding of the term but also to make a clearer distinction between CT and related concepts such as active learning, critical thinking, creative thinking etc. In a national or regional context, a common working definition of CT helps to establish a shared understanding of the term among all stakeholders (students, head teachers, parents, NGO's, industry etc.), as a pre- condition for successful implementation of CT in the classroom.


In Norway, the term CT was first mentioned in policy documents in preparation of school pilots on programming which started in 2016 and still run until 2019 (described in more detail in the next section). This first mention necessitated the definition of the term in the national context, which puts a specific emphasis on CT as a problem solving skill. During the study visit, the Norwegian Directorate for Education and Training illustrated their approach with a picture of the TV

9 Bocconi, S., Chiocciariello, A., Dettori, G., Ferrari, A., Engelhardt, K. (2016). [Developing computational thinking in compulsory education - Implications for policy and practice](#); EUR 28295 EN; doi:10.2791/79215

series star MacGyver who could be described as a good example of someone who successfully solves real-world problems using the tools he has available.

The new Swedish curriculum refers to the term “programming” and does not use the term CT, taking a **broad view on the definition of programming, with a focus on understanding digital changes**. For instance, students should know enough about the use of programming e.g. to be able to discuss possible implications of allowing the use of autonomous cars.

According to Christian Magnusson, Director of Education, Skolverket,



“programming should be seen in a broader perspective that also includes creativity, control and regulation, simulation and democratic dimensions. Programming includes coding, which has great similarities with general problem solving.”

3. The position of Computational Thinking in the curriculum

3.1. Integrating Computational Thinking as part of a taught subject or transversally across the curriculum

Whether to integrate CT/programming in the curriculum as part of a specific subject, transversally across subjects or to combine both approaches, was a key question for study visit participants. This decision depends on the aim of implementing CT/programming in the curriculum, according to Kristine Sevik, Norwegian Directorate for Education and Training. For instance, the main goal of the subject “Programming” is to teach programming, while in the subject “Norwegian” the goal is to learn Norwegian where CT becomes a tool to achieve this goal.


In the new Swedish curriculum, programming is integrated mainly in three subjects: Technology, Mathematics and Social Sciences. The actual position of CT/programming in the new Norwegian curriculum is still being discussed. However, it is likely to be integrated in Mathematics but possibly also in other subjects. One consideration is that an integration of CT/programming in all subjects could result in a more inclusive approach that is attractive for boys and girls alike.

During the visit at the Hundsund ungdomsskole school in Oslo, study visit participants had the opportunity to observe a Music lesson where the students used the app [garageband](#) to create their own music. This lesson observation inspired participants to discuss the potential of teaching CT in creative arts subjects.

What became apparent from the discussions is that policy makers in many countries need to take into account practical constraints in their decision of where to locate CT/programming in the curriculum. For instance, introducing a new subject or even content is a big challenge in many countries, since it usually means that something else needs to be removed from the already crowded curriculum. In the light of these practical considerations, implementing CT/programming transversally across subjects can be an attractive option.

In the new Swedish curriculum, the democratic dimension of programming is mainly discussed in **Social Sciences**.

In the **subject “Technology”**, students learn, amongst other things, how to control objects by means of programming (years 1-3), including students’ own constructions (years 4-6), in which they also apply control and regulations (years 7-9).



“The idea is to show students that computers are fairly stupid. You have to tell them exactly what to do”

says Christian Magnusson, Director of Education at the Swedish National Agency for Education.

In the **subject “Mathematics”**, students first learn, amongst other things, how step-by-step instructions can be constructed, described and followed as a basis for programming (years 1-3). This can be taught as an unplugged activity or with technology. In years 4-6, students learn how algorithms can be created and used in programming as well as how programming is used in visual programming environments. Finally, in years 7-9, students learn to program in different programming environments, learning how algorithms can be created, tested and improved when programming for mathematical problem-solving.

3.2. Fostering an inclusive approach

In Norway, Programming as an optional subject in lower secondary schools is currently being piloted (2016 - 2019) and an evaluation will be ready in 2019. 144 official pilot schools were selected, including Hundsund

ungdomsskole school. The government has already decided to offer the course as a permanent elective subject as of 2019. The curriculum for this elective course refers to computational thinking skills (“algoritmsk tankegang”) as a method for problem solving in programming¹⁰. The Norwegian Directorate for Education and Training asks the schools to teach core concepts of programming such as algorithms. However, it does not prescribe a specific programming language. When asked for advice, the BetaLab team at the Directorate usually suggests schools to use Python and schools with a specific interest in developing apps to use Javascript.

At the Hundsund ungdomsskole school in Oslo, as in schools across the country, this new elective subject is competing with other attractive options such as Theatre and Drama, Sports and Environment studies. In fact, 55% of students nationwide take one of these 3 electives. Competing with such popular subjects, only 3% of students choose programming as an elective¹¹ and 83% of these students are boys, many of who



are already interested in STEM subjects¹². Hence, offering CT/programming as an elective course might possibly even widen the gap between those that are already interested in technology and those that are not. Anecdotal evidence however suggests that it is possible to encourage more girls to join elective programming courses. For instance, study visit participants heard about one teacher at a different Norwegian school who intentionally approached a few popular and influential girls in his class and challenged their beliefs about programming. Once these girls were on board, they helped him to promote the course and as a result many girls joined it. Another interesting approach,

10 <https://www.itd.cnr.it/doc/CompuThinkNordic.pdf>

11 <https://www.udir.no/tall-og-forskning/statistikk/statistikk-grunnskole/valg-fag-pa-ungdomstrinnet/>
accessed 07 September 2018

12 <https://www.udir.no/tall-og-forskning/statistikk/statistikk-grunnskole/valg-fag-pa-ungdomstrinnet/>
accessed 07 September 2018

presented by the Norwegian Directorate for Education and Training, was to offer a course on how to make e-textiles. Such courses have up until now in Norway mainly attracted girls. However, it is subject to discussion whether open-ended tasks for both boys and girls are an even more interesting alternative to designing course offers targeting boys or girls only.

4. Teacher training

The introduction of CT and programming in the curriculum in Norway and Sweden calls for major teacher training initiatives targeting in-service teachers as well as future teachers, as most did not learn how to teach CT/programming as part of their initial training. It also calls for teachers to have an open mindset and be willing to learn and move outside their comfort zone to tackle new challenges.

Teachers in both countries have a degree of freedom to decide about the actual implementation of CT/programming in their own classroom. As Kristine Sevik from the Norwegian Directorate for Education and Training explains:

“Never tell a teacher what to do but give them guidance... Teachers do not like the idea that some students may be better at programming than they are. However, they can use these students as a resource. The teacher will still be the most important person for students’ learning.”

In Norway, with the revision of the core curriculum, teachers are faced with the challenge of implementing the required twofold changes:

1. To develop students’ understanding of concepts within their subject (deep learning), the development of reflection and critical thinking skills and a larger focus on technological applications, programming and algorithmic thinking. It is, however, not yet clear in which subjects this will be required.

2. Teachers need to acquire programming skills for teaching the optional programming subject in lower secondary schools.

The next section looks at training offers currently available to address this need.

4.1. Training opportunities in initial teacher training - an example from Norway

“Initial teacher training education in Norway is really changing. The professional framework for digital competence has a crucial role to play within teacher education. There is no future for Computational Thinking in school education, if we do not have a broader framework as well”. Morten Sjøby, Norwegian Directorate for Education and Training.

The Oslo Metropolitan University is one of the training providers that already offers training for future teachers specialised in design, arts and crafts. However, as pointed out by Kristine Sevik,

“For the new curriculum to succeed, other training providers need to follow. Otherwise, we will have a lag of 5 years with implementing the curriculum.”

As a specialised teacher in design, arts and crafts, teachers teach children, young people and adults how to develop their creativity and aesthetic sense. The technology and design subject in schools is a multidisciplinary subject, closely connected to science but needs to incorporate more design, arts and crafts as pointed out by Peter Haakonsen from the OsloMet - Oslo Metropolitan University.

In the design subject at the teacher training institution, student teachers can formulate ideas, drawings and products they invent and make an artefact that fulfills functional and aesthetic qualities. The “bright ideas” assignment involves 2nd year teacher students in the teacher training programme at OsloMet. During the assignment, teacher students are requested to create smart textiles with

led or reflective fabric. Finally, they exhibit their projects in a 3-day intensive workshop held in a Makerspace. OsloMet University collaborates with the Norwegian Museum of Science and Technology on a “be a maker teacher education programme” offering a joint ECTS course. Questions dealt with in the 3-day workshop are directly related to curriculum integration, and include amongst others, how can a makerspace support teachers’ efforts to introduce peer collaboration and problem based learning?

4.2. MOOCs - a scalable solution for in service teacher training in Sweden and Norway

One might ask how long does it take to learn programming? The BetaLab team in the Norwegian Directorate of Education and Training in Norway knows, since they have tried it themselves. Having a realistic idea of how long it takes to acquire some basic programming skills can be useful when planning training.

To support the elective pilot course on programming, the Directorate has developed and is running a MOOC targeting teachers. The MOOC comprises a core course and 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 teachers to use while teaching the elective course.

The MOOC consists of six modules:

- Introduction to “programming as an 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

Reference: The Nordic Approach to introducing computational thinking and programming in compulsory education¹³.

¹³ https://www.researchgate.net/publication/322993437_THE_NORDIC_APPROACH_TO_INTRODUCING_COMPUTATIONAL_THINKING_AND_PROGRAMMING_IN_COMPULSORY_EDUCATION accessed Jul 05 2018.

In Sweden, Skolverket, the Swedish National Agency for Education, created an online course to support the introduction of programming in the revised curriculum. The goals of the course, are to give an overview about programming and how it affects society, the way it is linked to the curriculum with examples of integration, and lastly, to reduce teachers anxiety about teaching programming. The course can be completed individually or collaboratively, as the practical programming part is practiced in groups. It is important to note that the course can also be used for teachers in Adult Education or Initial Teacher Training, however the latter is under the responsibility of universities.

Another course created by the Swedish National Agency of Education in cooperation and collaboration with universities and university colleges is “Basic knowledge about programming 7,5 ECTS” for teachers in lower or upper secondary schools and teachers in adult education. The course’s goal is for participants to successfully learn how to program.

The course content was designed in collaboration with universities to ensure that the same core content is taught across the 18 universities, while allowing universities some flexibility regarding certain elements of the course. The courses also includes didactic elements, so teachers will be able to not only practice programming but also teach elements of the subject to their own students. The course provides the fundamentals of programming, including mathematical problem solving using programming (for Mathematics teachers) and technical solutions using electronic equipment (for both Mathematics and Technology teachers), and how they can be programmed (for Technology teachers).

300 teachers participated in the course in 2017. As of September 2018, the course is open to only Mathematics and Technology teachers, as training them is the agency’s priority. 3000 teachers are foreseen to participate in the course in the 2018-2019 school year.

As previously explained, the integration of programming in Mathematics, Technology and Social Sciences is compulsory for Swedish schools from August 2018 onwards. The staff at Årstaskolan school proactively took up the challenge. Coding is already integrated by some teachers in the school in order to be prepared for the 2018-2019 school year. According to Skolverket, eight out of ten teachers in Sweden have no training or background in coding or

programming, but in Årstaskolan, there is an open mindset towards the subject. The ICT coordinator Mikael (Micke) Kring in Årstaskolan highlighted that around 150 hours are needed to train the school teachers and the training should take place at the school, with teachers passing on their knowledge to other teachers.

The integration of CT/programming is seen as a possibility to try new methods and ideas by the teachers of the school. The school - in particular the ICT coordinator, has created a MOOC on programming and computational thinking (MOOC-kurser.arstaskolen.se), which is open, public and available to all teachers in Sweden. This allows teachers to learn at their own pace and combine the course content with open labs, where teachers can do hands-on exercises.

4.3. Inspirational conferences to support positive attitudes towards CT

Another interesting model to train teachers in Sweden in how to teach programming in Mathematics and Technology is using **inspirational conferences**, two of which were held in autumn 2017 and 2018. The main idea of the conferences is to establish a positive attitude towards CT/programming via hands on activities in workshops inspired by the Sinus project in Germany¹⁴. The conferences (23 in total) have been held all over Sweden from the North to the South and cover upper and lower secondary school level teachers. The course modules are located on the web based learning platform (laerportalen) to develop **strategies to support continuing work with programming in the classroom over time**. An essential innovative element are the steps to be followed based on a tutoring model, classroom practice and collegial reflection. The steps are as follows: Step A: individual preparation, Step B: collegial discussion with a Mathematics tutor, Step C: try out a lesson in the classroom, Step D: collegial reflection with Mathematics tutor. This type of teacher training is promising as it allows deep learning and long term successful integration of programming by linking individual reflection with peer support and classroom practice.

14 SINUS project <http://sinus.uni-bayreuth.de/2956/>

5. School leadership

5.1. Why is leadership important?

There are various reasons why Hundsund and Årstaskolan schools successfully implemented CT/programming in different subjects. We found that in both schools teachers had the opportunity to follow training sessions and learn how to integrate CT/programming in their teaching practices. They were provided with time and adequate support to do so, as the school leadership recognised the importance of developing their skills and investing in training. Furthermore, in both schools the implementation of CT/programming was directly linked to the school vision, which was clearly defined and shared among the school community. This might have been facilitated by the way leadership was practiced, engaging formal and non-formal leaders in implementing change in the school.

Research shows that leadership plays a key role in enabling schools to implement change in learning and teaching in a successful way. Leadership is a social process of influence, mobilizing others' efforts to reach specific objectives serving a vision¹⁵. It is about learning together, constructing meaning and knowledge collectively and collaboratively¹⁶. In this sense, a coherent and well-constructed school leadership will allow teachers, school administration staff, directors and heads of departments to generate ideas together, reflect and make sense of their work in light of shared beliefs. This in turn will help them to define concrete actions and goals that grow from their common understanding (ibid.).

In Hundsund school, Norway, this was reflected in the school vision presented by the students when study visit participants arrived at the school. The vision "Creating the future" was embedded in the way the lessons in the school

15 Leithwood K, Jantzi, D & Steinbach R (1999). *Changing Leadership for Changing Times*, Philadelphia: Open University Press.

16 Harris, A. (2003). Teacher leadership as distributed leadership: heresy, fantasy or possibility?. *School leadership & management*, 23(3), 313-324.

operate; students working collaboratively is part of the school curriculum goals, acknowledging that this is a central skill students will be required to master in their future careers. Furthermore, the teacher in the Social Sciences class, observed by some study visit participants, explained that teachers at the school encourage students to be creative, focusing on the “how and why” rather than the “what”. In the various classes participants to the study visit observed students working in groups, engaging in self and peer assessment, taking the time to discuss and reflect while using digital tools such as e- portfolios, schemes, googledraw, and more.

5.2. From a school vision to an action plan

As a new field, requiring the development of skills and competencies of teachers and students, integrating CT/programming in curricula depends not only on the development of teachers’ expertise, but also on their willingness and engagement to experiment and learn. This was echoed in the visit to Årstaskolan School in Sweden, where Mikael (Micke) Kring, the ICT coordinator and a group of Mathematics and Science teachers work collaboratively, experimenting with new tools and methods to integrate CT/programming in their own classes and in the whole school. This group of teachers, in collaboration with the ICT coordinator, translates the school vision into action by “actively developing the use of IT in education and promoting innovation while focusing on inclusion and integration of all learners in the school”.

The team constructed a 10-year plan to integrate CT/programming throughout students’ school career. The program, a simple Excel spreadsheet, provides examples of progressively developing activities, in terms of complexity and skills, starting from the first grade until grade ten. The plan specifies not only the skills and competences students develop through the various activities, but also the competencies and tools teachers need to master in order to implement each step of the plan. Hence, the plan provides a clear learning path for teachers. Teachers of students in upper grades are requested to adjust to this plan starting from 2018/2019 school year. This is a challenging task for teacher and students, requiring teachers’ flexibility and adaptability to the new standards, together with assistance and training by the ICT coordinator.

This plan can serve as an interesting example of exercising shared leadership, as it was designed by a group of teachers. The plan is an outcome of a consultation and collaboration process with other teachers in the school. Similar plans or documents exist in other schools; nevertheless, many of them have not been implemented or were unsuccessfully implemented. Research shows that distributed/shared leadership practices and teacher collaboration can support an effective and lasting school level change¹⁷.

There is no prescribed method or handbook to follow for schools looking to implement change, and shared/distributed leadership is not the only leadership practice that can favour the introduction of change in schools. Nevertheless it is worth underlining that during this study visit elements of shared leadership were recognized in both schools.

5.3. Conditions for implementing change and Computational Thinking

In both countries, local authorities are responsible for providing schools with sufficient learning materials including ICT infrastructure and access to digital learning resources according to the school's needs and requests. Schools are responsible for deciding which ICT tools and resources they wish to use in order to implement the curricula they draft. In Hundsund school, Norway, the school leadership decided to introduce digital skills in the curricula by using google applications for learning. In Årstaskolan school in Sweden, the school principal decided to allocate funds and hire an ICT coordinator to help teachers to introduce ICT in their lessons. The ICT coordinator is there to advice teachers and help them to implement their ideas by using ICT tools, assist them in finding solutions and training possibilities when needed. Teachers shared their positive feedback with the study visit group, indicating that having such support has made a big difference to their teaching. In both countries, digital skills are part of the basic skills in the new curriculum (together with literacy, numeracy etc.); However, in both schools, the syllabuses, subject plans and curriculum implementation plans remain in the hands of teachers, who work collaboratively to draft the curriculum in line with the school vision. In such conditions, the

17 Harris, A., & DeFlaminis, J. (2016). Distributed leadership in practice: Evidence, misconceptions and possibilities. *Management in Education*, 30(4), 141-146.


accountability, responsibility and independence of teachers and school leaders increases.

However, decentralization of the education system is not a precondition to successful teacher collaboration or the creation of a common school vision. Neither is it a prerequisite to successfully implementing CT/programming in the class. In all school realities, school leadership plays a crucial role in engaging the whole school community to bring forward and implement change. In both Hundsund and Årtaskolan schools, there was a clear vision, designed and implemented by the school teachers themselves, together with the school principal who serves as an empowering leader that supports and engages other leaders in the school, such as the IT group.

5.4. Shared/distributed leadership- benefits and risks

Shared/distributed leadership practices can assist a successful implementation of changes and innovations in school, but also entail a risk. Some leaders are not always willing to give away power and instead of designing a vision and action plan collaboratively with teachers, may revert to another version of delegation and management, where teachers are not motivated nor empowered or encouraged to engage in bringing forth changes in the school.

As we saw in both schools, some conditions can favour shared leadership practices or teacher leadership practices. These conditions include first and foremost the support of official school leaders to rethink the traditional top-down school structure, allowing more fluidity and interaction between formal and non-formal leaders. Secondly, as collaboration and learning take time, we cannot expect teachers to add more tasks on top of their regular and already busy work schedules. Thus, a designated place and time is a crucial element. As teachers explained in both Hundsund and Årtaskolan schools, they are encouraged and expected to collaborate and design lessons together, and when possible even implement them together. Lastly, and maybe most importantly, the process of creating a safe collaborative atmosphere where teachers can develop their skills, test and grow together is essential. As one of the teachers in Årtaskolan commented:



“In this school we (the teachers) are learners; we try and fail, try and fail, until we succeed”.

This attitude manifests itself in the ways teachers experiment new methods and ideas. The school established arenas that provide teachers with the place and time to collaborate and learn, create new meanings and translate the school vision into action. These arenas provide opportunities for other teachers outside of the school to develop their skills, as the school has created an online course on coding and programming, open to all teachers in the country and beyond. This process of collaboration, democratization and sharing, reflects also in the online (and offline) spaces students operate in: e- library, YouTube channel, TED like talks, moviemakers platforms, and more. These online and offline arenas serve as collaboration spaces, where students upload their authentic work, videos, poems, novels and drawings, discuss ideas, experiment and work collaboratively, as do their teachers.

6. Case example: Use of Beebots in Mathematics and Science lessons, Årstaskolan, Sweden

One of the interesting examples of implementation of CT/programming observed during the study visit was in Årstaskolan, Stockholm, with 7-year old, first graders. A group of participants had the opportunity to participate in a Mathematics lesson using Beebots.

The Teacher explained that she had a training with the ICT coordinator on how to use Beebots, as this tool, and in general coding, was completely new to her. The Beebots are used once a month with a group of students (10 at a time), providing students with the possibility to code and work collaboratively.

During the lesson, students were asked several times to write a code, using each time a different number of commands (starting with 10 at the beginning of the lesson and ending with 16 at the end of the lesson). Each time, students were working in pairs, writing their code on a piece of paper and testing it with the Beebot. After each peer work, the group gathered and others needed to identify the loop in each sequence. This activity was practiced several times, each time with more complicated commands. Furthermore, in every round, each pupil was assigned to a different peer, resulting in opportunities to learn and help each other. At the end of the lesson, students were asked to write a code individually, and this code was given to the teacher as a hand-in assignment.

Students were very engaged and independent in this activity, lasting an entire lesson. They were working in various parts of the classroom, using different spaces; lying on the floor, and sitting on a chair, while the teacher was moving around them, assisting students that needed help. Students told study visit participants at the end of the lesson that they very much enjoyed this activity. When asked where else can they see loops other than with Beebots, students showed deep understanding of the nature of this kind of activity, by commenting that they can see them also outside of school in street signs or in a department store for example.



Finally, the teacher explained that CT/programming in lower grades is not only practiced with Beebots. When introducing coding they discuss various patterns, using their body, maps, papers and other non-ICT based tools. The teacher explained that this is the base for further activities on CT/programming, as from grade three onwards, Python and other programming languages are introduced in class.

Conclusions



The study visit provided a wealth of conclusions, but also raised new questions and considerations emerging from the school visits, the insights provided by the two hosting organisations, (the Norwegian Directorate for Education and Training and the Swedish National Agency), as well as from the discussions among study visit participants.

While the “not one size fits all” approach is relevant here, as school education systems across Europe differ considerably; there are a number of considerations that are useful to take into account for any policy maker who aims to integrate CT/programming in national or regional school curricula. Below, six such considerations are listed, on the basis of what has been learned from this study visit:

- 1. Specifying the relation of CT/programming to other digital competences and overall curriculum objectives can ensure the overall coherence of the curriculum.** Both Sweden and Norway revised their curricula widely or even entirely, in order to ensure that it prepares their students for the future. To that end, CT/programming is integrated in the curriculum, also taking into account its relation to other digital skills and the general vision of the overall curriculum.
- 2. Where to position CT/programming in the curriculum depends both on the specific reasons for its integration as well as practical considerations.** Policy makers in Norway and Sweden generally favour

the integration of CT/programming across several subjects. Sweden's approach to integrate CT/programming in Technology, Mathematics and Social Sciences is interesting as it allows different aspects to be covered, e.g. the understanding of how the machine works in the subject 'Technology', and general considerations on the societal impact of technology in the subject 'Social Sciences'.

3. CT/programming needs to be integrated in the curriculum in a way that does not actually widen the gap between those students who are already interested in technology and those who are not.

One consideration in that regard is to design tasks that are also, or even in particular, interesting for girls, and to put a special effort in recruiting those students that are not yet interested in technology, or do not think that they are capable to engage in programming courses. Another option is to make it compulsory for every student to learn some basics about CT/programming.

4. Special attention should be given to training and supporting teachers with this new challenge.

With the new curricula in Sweden and Norway making CT/programming a compulsory element for all students, many teachers are faced with a new challenge their initial teacher training did not prepare them for. Hence, a special focus on training and supporting teachers is necessary. To cope with the high number of teachers that require training, Sweden for instance offers a mix of training options offered by different providers (the National Agency, schools themselves, universities and other providers), also including large-scale solutions such as MOOCs. One interesting model to support teachers' positive attitude towards CT/programming are inspirational conferences, as tested in Sweden. Another approach, appreciated by teachers is support and training provided directly at school, for instance by an ICT pedagogical adviser, as is the case in Årstadskolan in Stockholm. Such local approaches also lend themselves to foster teachers' positive attitudes towards teaching CT/programming and to encourage them to "try and fail", and draw on each others' peer support. Finally, it can also be beneficial to prioritize training for those teachers that need to integrate CT/programming in their teaching first. For instance, the course "Basic knowledge about programming" offered by 18 Swedish universities is

currently open to Mathematics and Technology teachers only, as these teachers need to acquire the new skills most urgently.

5. Providing schools with the possibility and certain freedom to invest in training, resources and guidance for teachers can facilitate the process of introducing change in schools.

This was the case in the two schools visited, as such possibilities encouraged ownership and engaged teachers in implementing the necessary changes. A clear strategy and vision aimed at innovation and change was noted by study visit participants as playing an important role: “It is important to foster computational thinking by using specific methods for every stage and age of a child. Developing a whole school approach and having a shared vision and understanding in the school seem to be very important. We will have to integrate the question of CT into the discussion about school development”, Christian Lamy from the Ministry of Education in Luxembourg commented. The engagement of teaching staff, school leadership, training institutions and policy makers is paramount to ensure that CT/programming becomes an integral part of the curriculum implemented through various lessons and contexts. Agreeing and clarifying basic concepts and the goals of teaching CT/programming in schools with relevant stakeholders might be an important step for any country when starting to plan, review or introduce CT in schools.

6. Lastly, it will be important to continue the exchange of experiences and lessons learned both at national and international levels.

This can be done in part on the basis of new findings from academic research and policy evaluation, such as the evaluation of the Norwegian pilot on programming as an optional subject in lower secondary schools, due to be ready in 2019. Such an exchange can help to provide clearer answers to key questions such as how to define CT/programming, how to design the learning of CT/programming in order for it to impact on students’ development of 21st century skills, and how to assess CT/programming. For instance, one of the study visit participants, Jesus Moreno-Leon from the National Institute for Educational Technologies and Teacher Training (INTEF), recently published an interesting paper “On Computational Thinking as a Universal Skill: A review of the latest

research on this ability”¹⁸ which discusses the definition of Computational Thinking. Remco Pipers from Kennisnet, another study visit participant, summarized his lessons learned from the visit in his article “Digital Literacy in Sweden: This is what the Netherlands can learn from the Swedes”¹⁹ (in Dutch). Finally, the recent OECD publication “Teachers as Designers of Learning Environments”²⁰ also defines key components of CT (logical reasoning, decomposition, algorithms, abstraction, and patterns) and discusses how CT relates to other innovative pedagogies.

18 Moreno-León, J., Román-González, M., & Robles, G. (2018, April). On computational thinking as a universal skill: A review of the latest research on this ability. In Global Engineering Education Conference (EDUCON), 2018 IEEE (pp. 1684-1689). IEEE.

19 access online: <https://www.kennisnet.nl/fileadmin/kennisnet/digitale-geletterdheid/Documenten/Kennisnet-digitale-geletterdheid-in-zweden.pdf>

20 Paniagua, A. and D. Istace (2018), Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies, Educational Research and Innovation, OECD Publishing, Paris, <https://doi.org/10.1787/9789264085374-en>.

ANNEX 1:

List of study visit participants

COUNTRY	FIRST NAME	LAST NAME	ORGANISATION
AUSTRIA	Harry	Axmann	<i>eEducation, network for primary schools in Vienna</i>
AUSTRIA	Klemens	Frick	<i>Digital Education, Pädagogische Hochschule Wien</i>
BELGIUM	Anja	Balanskat	<i>European Schoolnet</i>
BELGIUM	Katja	Engelhardt	<i>European Schoolnet</i>
BELGIUM	Tommaso	Dalla Vecchia	<i>European Schoolnet</i>
BELGIUM	Alexandra	Licht	<i>European Schoolnet</i>
IRELAND	Tony	Weir	<i>Department of Education and Skills</i>
IRELAND	Anthony	Kilcoyne	<i>PDST Technology in Education, Teacher Education</i>
ITALY	Margherita	Di Stasio	<i>National Institute for Documentation, Innovation and Educational Research (INDIRE)</i>
ITALY	Giovanni	Nulli	<i>National Institute for Documentation, Innovation and Educational Research, (INDIRE)</i>
LUXEMBOURG	Christian	Lamy	<i>SCRIPT Department of Coordination of Educational and Technological Research and Innovations Ministry of Education, Children and Youth</i>
LUXEMBOURG	Luc	Weis	<i>SCRIPT Department of Coordination of Educational and Technological Research and Innovations Ministry of Education, Children and Youth</i>

MALTA	Keith	Aquilina	<i>Directorate for Digital Literacy & Transversal Skills</i>
NETHERLANDS	Remco	Pijpers	<i>Digital Literacy, Kennisnet</i>
NORWAY	Vibeke	Guttormsgaard	<i>Norwegian Directorate for Education and Training</i>
NORWAY	Kristine	Sevik	<i>Norwegian Directorate for Education and Training</i>
NORWAY	Morten	Søby	<i>Norwegian Directorate for Education and Training</i>
POLAND	Małgorzata	Szybalska	<i>Innovation and Technology unit Ministry of National Education</i>
POLAND	Anna	Chrościcka	<i>Innovation and Technology unit Ministry of National Education</i>
POLAND	Tomasz	Kulasa	<i>Innovation and Technology unit Ministry of National Education</i>
PORTUGAL	Maria João	Horta	<i>Teacher Education, Directorate-General for Education (DGE)</i>
SWEDEN	Peter	Karlberg	<i>Skolverket, Swedish National Agency</i>
SLOVAKIA	Slavomír	Kachman	<i>Regional Education Division, Ministry of Education, Science, Research and Sport</i>
SPAIN	Mirian Olga	Cecilia Martínez	<i>National eTwinning Support Service School, National Institute of Educational Technologies and Teacher Training (INTEF)</i>
SPAIN	Jesús	Moreno León	<i>Department of Innovation and Development, National Institute of Educational Technologies and Teacher Training (INTEF)</i>
SWITZERLAND	Angela	Fuchs	<i>Swiss conference of Cantonal Ministers of Education</i>

ANNEX 2:

Study visit programme

31 MAY 2018, 8:30 - 19:15, OSLO, NORWAY

LEARNING FROM A PRACTICE EXAMPLE

8:30	Transport to the school
9:00 - 11:30	Visit to Hundsund ungdomsskole including a lesson observation & discussion with teachers & students
11:30	Transport back to The Norwegian Directorate for Education and Training
12:00 - 12:30	Welcome (Trond Ingebretsen, The Norwegian Directorate for Education and Training) Exchange on school visit: Lessons learned

12:30 - 13:15 *Lunch*

IMPLEMENTING CT IN NORWAY

13:15 - 14:15	Implementing CT in the curriculum in Norway, presentations following discussion and Q&A <i>Perspectives from policy makers, research and teachers</i> Renewal of subjects and competences - new curriculum 2020 (Tone Børresen Mittet, The Norwegian Directorate for Education and Training) Computational thinking and coding into the subjects (Kristine Sevik, The Directorate)
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14:15 - 14:30 *Coffee Break*

14:30 - 16:00	<p>Implementing CT in the curriculum in Norway e.g. teacher training and student assessment.</p> <p><i>Perspectives from policy makers, research and teachers:</i></p> <ul style="list-style-type: none"> • Computational Thinking from the perspective of initial teacher training institution: Need for competence (TBA, University College of Southeast Norway) • Future Classroom Lab project in Norway» med Jørund Skaug (The Directorate) • Computational Thinking and Makerspaces - how are they connected? (Vibeke Guttormsgaard and Kristine Sevik, the Directorate) • Computational Thinking and Makerspace integrated in the teaching and learning at a Norwegian Upper Secondary School (Ellen Flø, teacher at Mailand Upper Secondary School)
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16:00 - 16:15 *Short break*

IMPLEMENTING CT IN OTHER COUNTRIES ACROSS EUROPE

16:15 - 17:30 Tour de table, presentations from other countries and discussion on the Code week

17:30 - 19:15 *Reception*

21:35-22:30 Flight to Stockholm

1ST JUNE 2018, 8:15 - 17:00, STOCKHOLM, SWEDEN

LEARNING FROM A PRACTICE EXAMPLE

8:15	Transport to the school
08:45 - 11:30	Visit to Årstaskolan school including a lesson observation & discussion with teachers & students
11:30 - 12:00	Transport back to the Skolverket
12:00 - 12:30	Exchange on school visit: Lessons learned
12:30 - 13:45	<i>Lunch</i>

IMPLEMENTING CT IN SWEDEN

- 14:00 - 15:45 Implementing CT in the curriculum in Sweden:
Perspectives from policy makers, research and teachers:
- Christian Magnusson, director of education and expert on curriculum.
 - Jessika Paulsson, director and expert in School development department
 - Lotta Ramqvist Idebring, director of education
 - Mats Hansson, director of education

15:45 - 16:00 *Coffee break*

16:00 - 17:00 Comparing the approaches in Norway & Sweden, Group work/ discussion on lessons learned & recommendations

Strategies to include computational thinking in school curricula in Norway and Sweden

European Schoolnet's 2018 Study Visit

www.europeanschoolnet.org

