A solution to what? Aims and means of implementing informatics-related subjects in Denmark, Sweden, and England

Abstract
Based on policy borrowing (Cowen, 2009; Steiner-Khamsi, 2016), this paper studies the political rationales of curriculum revisions with regard to informatics in Danish, Swedish, and English compulsory school. The paper also studies how these rationales are converted into concrete curriculum revisions and implementation strategies in the three countries. Empirically, the paper is based on policy documents, research papers, and reports from the three nations and interviews with 10 experts who were part of, or knowledgeable about, the implementation processes in the respective countries. The study finds that, in spite of all three countries targeting the internationally agreed-upon challenge of preparing students to participate in a digitised society, the national policy aims vary substantially. In Denmark, the curriculum revisions aimed to educate critical, democratic citizens. Revisions in England were related to a strong push from the IT industry and an aim to reclaim the historical role of being tech pioneers, and Sweden was oriented towards creating equal digital competencies across demographic and socioeconomic factors. In spite of such relatively clear-cut political rationales, the paper also finds that the initiatives launched to meet the rationales are highly nationally situated, and, to some extent, contingent. In that respect, the paper argues that the policy revisions in all three countries rather are products of what was possible or mere chance than of painstaking planning.

Keywords: curriculum policy, computational thinking, comparative educational research

En løsning på hvad? Mål og midler i implementeringen af informatik-relaterede fag i Danmark, Sverige og England

Sammendrag
Baseret på ”policy borrowing” (Cowen, 2009; Steiner-Khamsi, 2016) studerer denne artikel de politiske rationaler bag læseplansrevisioner med hensyn til informatik i danske, svenske og engelske grundskoler. Artiklen undersøger også, hvordan disse rationaler omsættes til konkrete læseplansrevisioner og implementeringsstrategier i de tre lande. Empirisk er artikel baseret på politiske dokumenter, forskningslitteratur og rapporter fra de tre lande samt interviews med 10 eksperter, som var en del af eller vidende om implementeringsprocesserne i de respektive lande. Undersøgelsen viser, at på trods af at alle tre lande sigter mod den internationalt anerkendte udfordring relateret
til at forberede elever til deltagelse i et digitaliseret samfund, varierer de nationale politiske mål betydeligt. I Danmark havde læseplansrevisionerne til formål at uddanne kritiske, demokratiske borgere. Revisioner i England var relateret til et stærkt pres fra IT-industrien og et mål om at genvinde den historiske rolle som tech-pioner, og Sverige var orienteret mod at skabe lige digitale kompetencer på tværs af demografiske og socioøkonomiske faktorer. På trods af disse relativt klare politiske rationaler finder artiklen også, at de konkrete ændringer, der er iværksat for at indfri rationalerne, er et produkt af specifikke nationale forhold og til en vis grad kontingente processer. I den henseende argumenterer artiklen for, at de politiske revisioner i alle tre lande snarere er produkter af, hvad der var muligt eller blot tilfældigheder, end af omhyggelig planlægning.

Nøgleord: curriculum policy, computational thinking, komparativ uddannelsesforskning

Introduction

In most European countries, informatics-related topics in various forms have been or are soon to be implemented in compulsory school curricula (students aged 6–16), and there seems to be an international consensus that the omnipresence of digital technology requires a reconsideration of what is taught in compulsory education. In Europe alone, a recent report showed that 22 countries have implemented computational thinking in the compulsory school curriculum (Bocconi et al., 2022). With this international consensus in mind, it is remarkable how different the approaches adopted by various European countries to address this need are (Balanskat & Engelhardt, 2014; Bocconi et al., 2016, 2018, 2022). These differences both relate to the content of curriculum revisions and the formats of these revisions (e.g., whether informatics is implemented as a subject in its own right or integrated in existing subjects). Previous studies that have outlined this topic (e.g., Bocconi et al., 2016, 2018) have described these divergences and brought important insights into the conversation about these variances in relation to definitions of computational thinking (CT), and the implementation of the initiatives across Europe. However, less attention seems to have been devoted to studying the potential reasons for these vast differences.

Based on policy borrowing (Cowen, 2009; Steiner-Khamsi, 2016), this paper investigates the political rationales of curriculum revisions with regard to informatics in Denmark, Sweden, and England. It also examines how these aims are converted into concrete curriculum revisions and implementation strategies in the three countries. The empirical foundation consists of policy documents, research papers, and reports from the three nations, together with interviews with individuals who were part of, or knowledgeable about, the implementation processes in the respective countries. A central advantage of comparative research is that it

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1 Compulsory school refers to mandatory schooling for students aged 6–16.
exhibits possibilities and alternatives that may have a supportive role to play in
the development of future initiatives (Steiner-Khamsi, 2016). From this perspec-
tive, Denmark, Sweden, and England are particularly relevant units of analysis for
comparison, since they have adopted highly different approaches to address informatics in their compulsory school curricula. This paper contributes by providing insights into the relationship between the means and aims of implementation that are at play in these nations. Such insights foreground that informatics in education is indeed a means of improving the system; furthermore, discussions of this matter go beyond how informatics can be implemented and what needs to be done for this to happen, instead addressing why it is so imperative by illustrating three concrete, diverse examples. To achieve this, I address the following research question:

What is the declared rationale for implementing informatics-related topics in Denmark, Sweden, and England, and how is that rationale acted upon in concrete curriculum policy changes?

I begin the paper by reviewing existing research on informatics subjects in Euro-
pean schools and situate its contribution in relation to this body of knowledge.

Related work

As the attention given to CT and programming in education has grown, we have also seen an increasing number of comparative studies. The European Schoolnet has initiated two studies into the differences in how Nordic and European countries have implemented these changes in their curricula (Bocconi et al., 2016, 2018, 2022). These studies primarily described the variations between nations with regard to what content they have each integrated, at what grade levels, to what extent and how in- and pre-service training of teachers is being conducted, and what teaching materials are available (Bocconi et al., 2016, 2018). Other studies have focused on how international interest in learning coding and digital competency (DC) is interpreted and acted upon in different ways in various countries (Olofsson et al., 2021; Williamson et al., 2019). A study by Olofsson et al. (2021) investigated K–12-based measures in relation to DC policy in Denmark, Finland, Norway, and Sweden. In spite of the common conception that these countries share Nordic values (Blossing et al., 2014), Olofsson et al. (2021) argued that DC is not a fixed concept “that trickles down into national policy without [a] change of meaning” (p. 10). Rather, DC is translated within the countries’ national beliefs and needs, leading to different policies with divergent approaches to the subject. Meanwhile, Williamson et al. (2019) comparatively investigated educational policies relating to programming in England, Sweden, and Australia. That work studied the processes and lobbying that have primarily been engaged in by industry and have led to policy development; it found that
educational policies on computing are the unpredictable results of “strategic campaigning alliances, public initiatives, funding arrangements and more long-term partnerships” (Williamson et al., 2019, p. 720). While Olofsson et al.’s (2021) research focused broadly on DC, Williamson et al. (2019) focused more narrowly on the learning-to-code agenda. My study adopts a focus on policy initiatives that address informatics-related topics. Moreover, the aforementioned studies primarily considered either the implementation or the history of educational policies, while my work makes a wider contribution by studying both the declared rationale for such policies, how this is converted into a concrete curriculum and policy revisions, and the effects of this on the existing system. Below, I describe the analytical tool used to achieve the above goals of this research.

Theoretical approach: Policy borrowing

This paper studies how the international interest in informatics subjects in compulsory school is interpreted and converted into concrete policies in Denmark, Sweden, and England. To this end, I draw on Phillips and Ochs’ (2003) framework of policy borrowing, which was developed in comparative educational research to study instances where one nation develops curriculum revisions based on inspiration from outside that country (Cowen, 2009; Steiner-Khamsi, 2016). Policy borrowing studies often investigate when, where, and why a specific country seeks to adopt trends in educational policies in other contexts, and how what is borrowed is adapted to the home country. Phillips and Ochs (2003) defined policy borrowing as consisting of four stages, which I describe below.

Cross-national attraction

Cross-national attraction includes impulses and externalising potential. Impulses are the preconditions for policy borrowing and can arise from internal dissatisfaction, results of external evaluation through influential research, or economic change (Phillips & Ochs, 2003). Analysing the impulses in the three countries includes identifying the declared reasons for revising the curriculum. Meanwhile, externalising potential is the search for appropriate models to address the impulse and can consist of a guiding philosophy, strategies, structures, processes, or techniques. Therefore, I investigated what models, resources, or other inspirations there were for the curriculum revisions in the three countries.

Decision

The second stage in policy borrowing is the decision stage, which relates to how decisions are made and by what descriptor they can be characterised. Phillips and Ochs (2003) distinguished the different decision descriptors: theoretical, phoney, realistic or practical, and a quick fix. Theoretical decisions are overarching ideas
that will inform future initiatives. Phoney decisions refer to choices that have an instant appeal to the public yet are unlikely to be implemented in the country concerned. Realistic or practical decisions are based on initiatives that have proven effective elsewhere without being dependent on specific contextual factors, yet they are not possible to introduce in other contexts. Finally, quick-fix decisions happen when policy decisions are implemented without having the essential infrastructure needed for the success of an envisioned change. By analysing the three countries’ decision stages, I determined the process of decision-making and the descriptor.

Implementation
The implementation stage concerns how models externalised from the outside are adapted when subjected to the borrower’s system (Phillips & Ochs, 2003). Adaptations can take the form of amending the aims, formats, or content of sources that are identified as having externalisation potential. My analysis of this stage will concern itself with the way external inspirations are adapted to the national context of their implementation and the reasons or rationales for these adaptations.

Internalisation
The final stage of policy borrowing is internalisation, which relates to how a policy becomes part of, and the implications it has for, the system in the borrowing country. This stage is about the impact on the existing system, absorption of external features, synthesis, and evaluation. Impact on the existing system addresses the motives and objectives of policy-makers that are in conjunction with the existing system. Meanwhile, the absorption of external features is linked to which outside attributes are internalised and how they are adapted from their original formats to fit the objectives of the policy change and the existing system. Synthesis relates to how and to what extent educational policy becomes part of the overall strategy, and evaluation includes appraisals of the effects of the policy change.

Method and data
This paper draws on documents that describe the situation and policy process in the three countries. I also interviewed experts who were involved in or were knowledgeable about the decisions and approaches of implementing the curriculum revisions. The respondents included researchers, teachers, and consultants, but not politicians, and were therefore not entirely representative of all stakeholders. The informants were chosen by the following criteria: they possessed knowledge of the development of the curriculum revisions in the concerned countries, from having either studied or directly participated in the curriculum revision process. I predominantly collected the documents by screening them
through available documents on the websites of the education ministries of the three countries, which were supplemented by Google queries. In the Google queries, I searched for words specific to the curricula revisions in the three countries concerned (e.g., computing curriculum in England). Following a snowball sampling (Given, 2008), I identified relevant documents by looking at the references of the ones I already had found and, in turn, their references, if they were relevant. The relevance criteria were that the documents contained information about the curriculum revisions in relation to the four stages of policy borrowing described above. The included documents were published in the period 2008–2021. For all three countries, I included documents released prior to the curriculum revisions (typically white papers stating the need for revisions), documents released when revisions were settled and announced (typically official curricula and implementation strategies), and documents released after the actual implementation (typically evaluations or research studies). These documents were as follows:

- Policy documents (such as white papers) describing the background for integrating informatics-related subjects and content areas in the curricula in the countries concerned
- Reports from industry and non-profit organisations
- Official curricula
- Official documents describing the approaches and strategies used to implement the new curricula
- Research literature that investigated or evaluated implementation processes

Regarding the interviews, I interviewed 10 respondents (four from Denmark, three from Sweden, and three from England). These dialogues were conducted after I had collected the documents and served to provide additional data to conduct the policy borrowing analysis. In that respect, this study could be classified as mixed methods research in that the research design included several data genres (Brewer & Hunter, 2006). The interviews were semi-structured, followed an outline based on the four stages of the policy borrowing framework, and were conducted online. The interviews with the English and Swedish respondents were conducted in English to avoid misunderstandings due to language. The interviews were each 45–60 minutes long and were conducted in May–June 2021. I translated to English the Danish respondents’ comments included in this paper. Tables 1 and 2 illustrate the data sources in the study.

Table 1. Overview of the number of documents and respondents for each country.

<table>
<thead>
<tr>
<th>Denmark</th>
<th>Sweden</th>
<th>England</th>
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<tbody>
<tr>
<td>Documents</td>
<td>Respondents</td>
<td>Documents</td>
</tr>
<tr>
<td>18</td>
<td>4</td>
<td>12</td>
</tr>
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Table 2. Overview of respondents included in the study.

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Country</th>
<th>Role</th>
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<tbody>
<tr>
<td>1</td>
<td>Denmark</td>
<td>Researcher and member of the expert writing group for the technology comprehension subject.</td>
</tr>
<tr>
<td>2</td>
<td>Denmark</td>
<td>Consultant at a centre for teaching materials, member of the expert writing group for the technology comprehension subject, and involved in developing teaching materials.</td>
</tr>
<tr>
<td>3</td>
<td>Denmark</td>
<td>Researcher who acted as a consultant in developing the technology comprehension curriculum and including curriculum materials.</td>
</tr>
<tr>
<td>4</td>
<td>Denmark</td>
<td>Researcher specialised in computer science education. Took part in developing initiatives in teacher training education.</td>
</tr>
<tr>
<td>5</td>
<td>Sweden</td>
<td>Researcher with expertise in computer science education in Sweden.</td>
</tr>
<tr>
<td>6</td>
<td>Sweden</td>
<td>Researcher with expertise in training teachers in programming.</td>
</tr>
<tr>
<td>7</td>
<td>Sweden</td>
<td>Researcher in computer science education who acted as a consultant in the development of the Swedish curriculum revision.</td>
</tr>
<tr>
<td>8</td>
<td>England</td>
<td>Researcher with expertise in the implementation of the computing curriculum.</td>
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<tr>
<td>9</td>
<td>England</td>
<td>Researcher with expertise in the computing curriculum and its implementation.</td>
</tr>
<tr>
<td>10</td>
<td>England</td>
<td>Researcher who took part in developing the curriculum in England.</td>
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The processing and analysis of both interviews and documents were theory-driven and informed by the four stages of policy borrowing as follows: I began processing the documents by screening them for relevance in relation to the four stages described above. Second, I inserted snippets from the documents into a Word document with four sections devoted to each of the policy borrowing stages. Based on these categorised snippets, I identified one or more central analytical narratives for each stage. After completing this analysis, I processed the interviews, which were transcribed as close to the spoken word as possible immediately after conducting them. In a similar manner to the document analysis, I coded the respondents’ replies according to the policy borrowing stage in which they fitted and considered whether they supported, nuanced, or contradicted an existing analytical narrative developed from the document analysis. In cases where the respondents reinforced or made existing narratives more nuanced, I added quotes and scrutinised them to provide an account that was as rich as possible in the particular situation. There were no instances in which the respondents’ revelations contradicted the examinations of the documents. This implies that the interview excerpts functioned as a nuance to the archetypical aspects of policy, as it was described in the documents included in the analysis. Below, I present the results of these analyses.
Denmark: Technology comprehension to develop critical democratic citizens

Cross-national attraction

Denmark has not yet made a final decision to revise the curriculum to include informatics-related topics. However, in 2018, the Ministry of Education launched an ambitious pilot project in which 46 schools implemented a new subject called technology comprehension (TC) (Regeringen, 2018). The purpose of this project was to gain and systematically collect experiences relating to the implementation of this subject to inform a curriculum revision on a national scale in the near future. In my analysis of Denmark, I draw on this initiative. In policy documents and expert interviews, a central aspect of the impulse in the Danish initiative is the need to educate compulsory school students to be able to critically relate to and shape technology (Undervisningsministeriet (UVM hereafter), 2018a). During the interviews, the respondents emphasised that the TC curriculum primarily intends to educate students critically and democratically engage them in digitised work. Programming was highlighted as one among several other means of achieving this goal:

Technology comprehension does not aim for students to merely learn to program. Programming is a tool, a part of reaching a more general goal, namely to critically relate to and co-construct digital solutions to societal challenges. (Respondent 1)

Respondent 2 stated, “The nature of TC is way broader than programming. We must know more. Actually, it’s only thought of as a technique that is part of a much broader aim.”

In a similar vein, policy documents stressed that a national curriculum revision was needed to ensure that Danish compulsory schooling would continue to live up to the legal purpose of its declaration (UVM, 2018b). Sections 2 and 3 in §1 of the purpose for Danish compulsory schooling, as declared in (UVM, 2018b), specify that Danish schools “must prepare students for participation, co-responsibility, rights, and duties in a society with freedom and democracy” and that they should create opportunities for students to build “confidence in one’s own possibilities and background for taking a stand and acting” (UVM, 2021a). Due to the rapid digitisation of society, the reasoning was that living up to the purpose declaration would require a focus on teaching students the mechanisms of digital technology (UVM, 2018b, 2021b).

Regarding externalising potential, Danish policy documents do not refer explicitly to inspirational sources. Nevertheless, Respondent 1 mentioned that Danish-based TC drew on inspiration from the US:
The CS4ALL project and England were some of the places that were referred to. You could also say that we are standing on the shoulders of some of the movements we have seen in the US with Resnick and those who have a participatory orientation. (Respondent 1)

More importantly, the Ministry of Education also found inspiration for TC in the concept of computational empowerment (CE) (Iversen et al., 2018), which emerged as a result of a Danish research project (Hjort et al., 2015). Computational empowerment can be described as a re-articulation of ideas of participant design, such as empowerment, democracy, and emancipation (see Simonsen & Robertson, 2012) in the context of education (Smith et al., 2015, 2016). It emphasises processes in which children develop the skills and insights needed to engage critically and constructively with the ways in which digital technology affects their lives (Iversen et al., 2018). In that respect, the externalising potential was partly identified in the approaches and results from national research projects.

**Decision: From ideas to curriculum**
The Danish approach sought to gain initial experience with two different models for implementing TC in order to systematically research the effects of these approaches and ultimately inform a future, national-scale curriculum revision (see below). In that respect, we can label the Danish decision what Phillips and Ochs (2003) refer to as theoretical in the sense that it seeks to inform future changes. The content of the decision included launching a pilot project, during which 46 schools were meant to gain experience with two strategies for implementing TC in compulsory schools. The two strategies were 1) TC as a subject, and 2) TC as an integrated part of existing subjects, such as Danish, mathematics, social sciences, science, physics/chemistry, craft and design, and the arts (UVM, 2018b).

A Danish private consulting company evaluated these strategies midway through and after the project. Both implementation strategies took the outset in a TC curriculum, which was developed at the beginning of the pilot project. Moreover, the decision specified that both implementation strategies should address the same curriculum components, and that the curriculum for TC as a subject in its own right should be developed first. Afterwards, the individual components of this curriculum were distributed among the subjects in which it was to be integrated. Besides these new curricula, which were made publicly available on the pilot project’s website, the pilot project also developed a number of ready-made resources to support teachers in either teaching the new subject or integrating the new TC elements into existing subjects in their teaching.4

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3 The CS4All is a public-private partnership launched in 2015 in New York City, aimed at providing computer science education to students in elementary, middle, and high schools in New York City. [https://sites.google.com/strongschools.nyc/cs4all/home](https://sites.google.com/strongschools.nyc/cs4all/home)

4 [https://tekforsøget.dk/forlob/](https://tekforsøget.dk/forlob/)
Implementation
The implementation stage in the policy borrowing framework corresponds with how sources of inspiration are being adapted to the national context of application and references the reasons given for adaptations. An important step in acting on the impulse and exploiting the externalising potential was converting these into a curriculum that accommodated the general structure of any other subject in the Danish compulsory school curriculum. This curriculum describes each of the subjects that are to be taught in grades 1–9 (ages 6–15) and includes an identity specification for the overall purpose of the subject, related competency goals, and skills and knowledge areas linked to the competency areas.5 In addition, each subject has a reading plan and a teaching guide. Part of internalising TC at Denmark’s compulsory school level was to develop these documents. This was done by an advisory expert writing group appointed by the Minister of Education (UVM, 2021b). It consisted of 15 individuals and included researchers in computer science education and computer science, teachers and consultants from teacher education institutions, educational consultants from municipalities, teachers from compulsory schools, and consultants from the Ministry of Education (UVM, n.d.). The duties of the writing group were described in a mandate (UVM, 2021b) and involved two main tasks: 1) to describe the content and the competency goals for the new subject, and 2) to advise the Ministry of Education in the design and implementation of the pilot project.

The mandate specified a number of areas that the Ministry of Education was encouraged to include in the new curriculum, such as CT, iterative design processes, and complex problems (UVM, n.d.); it also allowed the group to develop additional areas of content for the curriculum. The work of the expert writing group resulted in a syllabus consisting of four competency areas, which are shown in Table 3.

Table 3. The new competency areas and their definitions (UVM, n.d., my translation).

<table>
<thead>
<tr>
<th>Competency area</th>
<th>Definition</th>
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<tr>
<td>Digital empowerment</td>
<td>Critical and constructive exploration and analysis of how technology is imbued with values and intentions, and how it shapes our lives.</td>
</tr>
<tr>
<td>Digital design and digital design processes</td>
<td>The ability to face problems within a complex problem area and, through iterative processes, generate new ideas that can be transformed into form and content in interactive prototypes.</td>
</tr>
<tr>
<td>Computational thinking</td>
<td>The ability to translate a complex problem into a possible digital solution, and the abstraction of phenomena and relationship in the world and the computer’s ability to process this information.</td>
</tr>
<tr>
<td>Technological agency</td>
<td>The ability to understand and use digital technology as material for developing digital artefacts.</td>
</tr>
</tbody>
</table>

The purpose of TC was phrased as follows: “students shall develop competencies and obtain skills and knowledge so that they constructively and critically can participate in the development of digital artefacts and understand their import-

5 https://www.uvm.dk/folkeskolen/fag-timetal-og-overgange/faelles-maal/om-faelles-maal
Thus, the emphasis on democratic values and building a critical mindset remained key in this purpose.

**Internalisation**

As described, the pilot project was meant to generate experience with the two different strategies for implementing TC: as a subject and as topics integrated into existing subjects. In both strategies, the TC curriculum did not replace an existing subject or parts of an existing subject. Instead, it was added as an additional subject or part of the subject to cover. As described, the integration of TC into existing subjects was based on the curriculum for TC as a subject in its own right. This process was seen as problematic by several Danish respondents. For example, Respondent 3 described the process of distributing the TC components in the following way:

> We [representatives from the different subjects] basically sat there with a bunch of goals from the curriculum, which we had to play bingo with to agree which subject takes the different curriculum components. I am definitely not sure that it would have ended up the way it did if we as mathematics educators had had the opportunity to integrate what we found meaningful. (Respondent 3)

As evident from the quote, the “bingo” approach involved contingency aspects. This was the case in that the practical concerns of distributing components from the curriculum among many subjects overshadowed the concerns about which components of the TC curriculum that were meaningful were recognised in relation to the individual subjects they were included in. However, Respondent 1 also argued that the general idea of distributing components from a curriculum developed for a stand-alone subject raises certain issues:

> Some of what we see in the pilot is rather strange. [From] the outset, [it was] defined by the Ministry [of Education] that TC should be phrased as a subject, and that subject was what should be integrated into existing subjects. But I am not sure this approach is at all meaningful when you have a specialisation in one place and a more literacy-oriented approach in another. Would the goals look different if you developed [the new subject] closer to the individual subject? (Respondent 1)

The respondents thus raised concerns about the practical approach to distributing TC elements into other subjects and the general legitimacy of taking outset in the same curriculum elements.

The TC pilot project was evaluated twice. The midway conclusion found that Danish students who had been taught TC had increased their abilities in the subject, and the teaching staff were generally positive towards the topic, but they found it difficult to understand and make use of the curriculum, the reading plan, and teaching plans during their lessons (UVM, 2020). The final evaluation (UVM, 2021b) found that all parties involved in the pilot project believed TC to be an important and relevant subject, but that the pedagogical staff found the curriculum and reading plan difficult to understand and use in practice. Although the final
report found that the competencies of students who had received teaching in TC had increased at a similar level to the midway report, it did not provide evidence that this effect was due to teaching or whether this change was caused by increased access to and experience with technology (UVM, 2021b).

Sweden: DC in schools to ensure equality

Cross-national attraction
In September 2015, the Swedish National Agency for Education (Skolverket) undertook the task of updating the compulsory school curriculum to strengthen students’ DC and introduce programming at this level (Heintz et al., 2017). The impulse for this strategy was dual. First, the Swedish government highlighted that being digitally competent has become a prerequisite for being an active part of a democratic society (Utbildingsdepartementet, 2017). Second, reports from the Statens Medieråd⁶ (2015) identified substantial differences in digital habits and competencies among young Swedish people based on differences in their gender, ethnicity, demographics, and socioeconomic background (Digitaliseringskommissionen, 2015). The Swedish government referred to the increased focus on DC in compulsory schools as an approach to address this inequality issue (Digitaliseringskommissionen, 2015; Utbildingsdepartementet, 2017). This resulted in a new IT strategy for the Swedish educational system that stated:

Digital competence is basically a matter of democracy. In school, we learn to understand the world in order to change it. All children and students need to understand how digitalisation affects the world and our lives, how programming controls both the flow of information we reach and the tools we use, as well as gaining knowledge about how technology works to be able to apply it ourselves. (Utbildingsdepartementet, 2017, p. 3, my translation)

There were, however, other aspects to the impulse. Although informatics was not an explicit core element of Swedish policy revisions as such, the interpretation of DC in Sweden contained elements of programming, for example, in the curriculum for mathematics and the subject “teknik” (Heintz et al., 2017). According to Williamson et al. (2019), the presence of programming and coding as part of DC in the strategy was a reaction to strong pressure from the IT industry and was supported by a number of national and international reports that made for worrying reading for Swedes. Indeed, a report from the IT and Telecom Industries (2012) raised concerns about a shortage of programmers and argued for the introduction of the skill as a mandatory part of the curriculum. Moreover, a report by the Swedish School Inspectorate (2012) was critical of the level of technology use

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⁶ Statens Medieråd is a knowledge centre on children’s and young people’s media use, as well as media and information literacy.
in schools and teachers’ technical competencies, and a report by the European Schoolnet (2015) found Sweden to be behind compared with other countries in terms of implementing programming. According to Williamson et al. (2019), the industry also expressed the need for IT specialists. However, the role of the industry was most apparent in the initiation of curriculum revisions rather than in what content they included, as described by Respondent 7: “There was an influence from industry, but it was more in the kind of getting started than in what was done.”

A key term in the externalising potential part of the Swedish policy was DC. In Swedish policy reports on curriculum revisions (Skolverket, 2016; Utbildningsdepartementet, 2017), DC, as described in European key competencies for lifelong learning presented in 2006, is a recurring reference. The European Council defines DC as mainly related to “the confident and critical use of Information Society Technology (IST) for work, leisure, and communication” (European Council, 2006, p. 6). As argued by Olofsson et al. (2021), the focus on DC in Swedish educational policy reflects the concept of DC as flexible, which should be redefined continuously to reflect the development and use of technologies in the surrounding society. This is apparent in the IT strategy, which states:

In a time characterized by a high rate of change, the meaning of concepts also changes over time. It is difficult to know what, for example, the concept of digital competencies may include in the future. These terms are therefore used in a general way and should also be used and understood in a broad sense. (Utbildningsdepartementet, 2017, p. 7, my translation)

Below, I describe how DC became part of the Swedish curriculum.

**Decision**

The directive from the Swedish government to the National Agency for Education strongly encouraged the involvement of relevant stakeholders, which it accommodated by (among other things) forming a reference group among computer science education researchers (Heintz et al., 2017). This reference group played an important role by suggesting revisions and additions to the existing curriculum to include DC and programming and in providing general advice. A key aspect of the advice given to the National Agency for Education was that DC should be part of as many existing subjects as possible and that it should not be implemented as a subject in its own right (Heintz et al., 2017). However, programming was maintained as a key focus point; as emphasised by Respondent 5, the directive from the Swedish government to the Ministry of Education explicitly requested DC and programming as a central feature:

My impression was that, well, we are being given this task by the government, so we have to do it. And I ask, why don’t you have a dialogue with them, and... I mean if, if you think that there is something better to do... But that does not seem to be the way things work in politics. (Respondent 5)
Moreover, the reference group argued for the adoption of a broad concentration on computer science rather than programming. In addition to these general recommendations, the group suggested concrete revisions of each subject, which were then discussed and negotiated at three workshops with participants from industry, academia, and the school system (Heintz et al., 2017). According to Respondent 5’s experiences, this process was odd at times:

In the end, I would say it was quite strange—some of the things that came out. In some of the suggested revisions, I used the word programming, and then it came back with the word algorithm instead. So, they just replaced program with algorithm and so now it says that all the kids should learn to create algorithms... (Respondent 5)

The processes resulted in a revised curriculum that accommodated some of the advice given by the reference group, which the Skolverket sent to the Swedish government, and they approved it in the spring of 2017; the syllabus was made mandatory from the fall of 2018. As described, DC was labelled a moving target, constantly altering according to changes in the surrounding society (Olofsson et al., 2021). In that respect, we can label the Swedish decision as theoretical in that it includes an overarching idea that will inform future initiatives.

**Implementation**

The process described above led to changes and additions to the syllabus to include DC and programming (the reference group’s advice to use the term “computer science” was rejected). Programming was subsequently included in the mathematics and **teknik** curricula. In mathematics, programming and algorithms became a part of algebra and problem solving; for instance, in problem solving lessons for grades 7–9 (ages 13–16), the curriculum specifies that students should acquire knowledge of “how algorithms can be created, tested, and improved in programming for mathematical problem solving” (Skolverket, 2018, p. 59).

The **teknik** curriculum was changed to address a fundamental understanding of what computers are, their components and the characteristics of IT solutions, skills in programming as a means for controlling and creating technology, and the safety and integrity aspects of digital tools (Skolverket, 2018). Digital competency was, for example, made part of the social science curriculum by concentrating on the responsible usage of digital media from social, ethical, and legal aspects (Skolverket, 2018). The approach to in-service training of teachers, school leaders, and other relevant staff was primarily handled by offering digital training courses on a web portal (Heintz et al., 2017).

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7 **Teknik** is a subject in Swedish compulsory school that aims to develop students’ technical knowledge and awareness so that they can orient themselves and act in a technology-intensive world. See more at the following link under “Skolans uppdrag”: https://www.skolverket.se/undervisning/grundskolan/laroplan-och-kursplaner-for-grundskolan/laroplan-jgr11-for-grundskolan-samt-for-forskoleklassen-och-fritidshemmet?url=1530314731%2Fcompulsorycw%2Fjsp%2Fssubject.htm%3FsubjectCode%3DGRGRTEK01%26tos%3Dgr%26p%3Dp&sv.url=12.5dfee44715d35a5cdfa219f
Internalisation
The respondents highlighted a number of issues relating to curriculum revisions, particularly regarding the mathematics syllabus. Respondent 6 argued that she found it difficult to understand how programming is related to algebra. In her experience, this placement of programming within that syllabus happened by chance more than anything: “So we have actually asked someone who has been working with the National Agency for Education, and they put it in the algebra section because she said that they didn’t know where to put it.” (Respondent 6)

As described in the decision stage, Respondent 5 saw that the National Agency for Education, in some cases, changed words (from program to algorithms) in the suggestions put forward by the reference group of computer science education. The quote below illustrates how this contributor thought of this as problematic:

For example, in mathematics, you don’t work with programs, you work with algorithms. So, to make sense [of it], from a maths teacher’s perspective, they just replaced the word, and then from a computer science perspective, I would say, well it’s not nonsense. (Respondent 5)

Other central aspects of the internalisation stage were the issues relating to teachers’ capacities to teach the new elements in the curriculum, which were mentioned as the biggest hurdle by Respondent 6: “I think teacher education is, to me, the biggest hurdle.” This is also reflected in the literature, particularly among mathematics teachers who are now obliged to teach programming. For the most part, mathematics teachers see meaningful connections between their subject and programming (Misfeldt, Szabo, & Helenius, 2019). However, they did not feel prepared to teach programming within their lessons. Similarly, Rolandsson and Skogh (2014) argued that there was a strong need to better understand teachers’ difficulties related to both the content of such curriculum revisions and the subject-specific pedagogies. Since programming is now a mandatory part of the curriculum, several mathematics textbooks include programming. However, analyses of these textbooks found that programming is often treated as tangential to mathematics and that there is a primary focus on introducing students to programming procedures rather than programming concepts (Bråting & Kilhamn, 2022). A recent study of mathematics teachers’ teaching of these new subjects in the context of their specialisation (Kilhamn et al., 2021) showed that one third of the lessons that include programming did not connect it to mathematical content, and few explicit connections were made to algebra. Moreover, further research by Håkansson Lindqvist and Pettersson (2019) showed that this had made the role of school leaders more complicated. School managers perceived digitalisation as a complex and broad concept, which brought challenges relating to technicalities, pedagogics, administration, and organisation at all levels of school life, and which were now the formal responsibilities of school managers.
England:
A computing subject to ensure a qualified workforce for the future

Cross-national attraction
In 2014, England implemented a new computing subject (Department for Education, 2014). Computing replaced ICT, which had been mandatory in Key Stages 1 and 2 (students aged 5–7 and 7–11) and mostly covered basic usage of ICT tools and information searches (Department for Education and Employment, 1999). A central aspect of this impulse was dissatisfaction with the former subject curriculum. In the years prior to the implementation of the new computing syllabus, representatives from the IT industry heavily criticised the inadequacy of the content of the ICT curriculum (Council of Professors and Heads of Computing, 2008; Microsoft, 2007). A central theme of the arguments was that the syllabus fell short in preparing students to contribute to the IT industry, which was described as a cornerstone for developing economic growth in England. Meanwhile, a report from 2007 sponsored by Microsoft asserted that “there is evidence to suggest that the problems relating to the shortage of people entering the IT industry starts at or during Key Stage 2 in the education system” (Microsoft, 2007, p. 56). In addition, the Council of Professors and Heads of Computing (2009) documented a steady decrease in the number of applicants to computing courses, which they argued was related to the unappealing content of the ICT curriculum. The same line of argument was found in a report by the Royal Society (2012) with the telling title “Shut down or restart”. It concluded that “every child should have the opportunity to learn Computing at school, including exposure to Computer Science as a rigorous academic discipline” (Royal Society, 2012, p. 6). This was a particular soft spot for England, which historically had been a leading light in producing tech pioneers such as Alan Turing and Tim Berners-Lee, but was at this point seemingly not able to continue to attract and educate new generations in computing subjects (Larke, 2018). Larke (2019) has pointed out that Google’s former CEO, Eric Schmidt, touched on the crux of the problem in a speech given during the MacTaggart Lecture at the annual Edinburgh International Television Festival. He addressed this issue explicitly by saying:

In the 1980s, the BBC not only broadcast programming for kids about coding, but... shipped over a million BBC Micro computers into schools and homes... I was flabbergasted to learn that today computer science isn’t even taught as standard. Your ICT curriculum focuses on teaching how to use software, but gives no insight into how it’s made. That is just throwing away your great computing heritage.8

David Cameron, the then Prime Minister of England, seemingly acknowledged this analysis, agreeing in a speech shortly after that “we’re not doing enough to actually teach the next generation of programmers... and I think that’s a real wakeup call for us in terms of our education system, and we’re acting on that”

(Computing at School Working Group, 2012). This same dissatisfaction with the ICT curriculum was also brought up by Respondent 8 as a central aspect of the impulse in the country: “England was looking at its ICT curriculum as it was and recognising that that wasn’t something that was fit for purpose anymore.”

The impulse in England thus consisted of an acknowledgement that the then-current ICT curriculum was inadequate and an ambition to reclaim England’s historical position as a tech pioneer. Concerning the externalising potential, there was little explicit mention of inspiration for developing the computing subject. A likely explanation is that the English were first-movers in integrating computing as a part of compulsory school (Gov.UK, 2013), which Respondent 9 also emphasised: “There was a big perception that England was the first to do it, and the first to do it right. If you are the first, then who are you actually learning from?”

From early on, representatives from the industry were thought of as important stakeholders when defining the final curriculum. Respondent 10 also mentioned this: “But well, the government didn’t really know what to include, so let’s bring in, you know, the big names, like Google and Facebook, etc., and they will decide for us, will tell us what matters.”

**Decision**

When the decision to revise the former ICT curriculum had been made, the subject association for ICT (NAACE), the Association for ICT in Teacher Education (ITTE), and Computing at School (CAS) declared their intention in a joint statement to collaborate to ensure teachers were properly prepared to teach the revised curriculum; in addition, there was a joint interest in improving the representation of digital skills in the curriculum (Larke, 2018; NAACE, ITTE, & Computing at School, 2012). Although the Department for Education emphasised the importance of developing the new programme of study in collaboration with stakeholders across the sector (Twining, 2012), a draft of the revised curriculum was developed by a working group consisting mainly of representatives from the industry and only three secondary teachers with computer science backgrounds (Larke, 2018). This draft recommended adding computer science to the then ICT curriculum, but this suggestion was not well received by NAACE, ITTE, and CAS; for example, they argued for the importance of digital literacy or information technology and raised concerns relating to the willingness of the Department for Education to fund the much-needed teacher training for this project (Larke, 2018; Twining, 2012). These comments on the draft were discussed in two workshops, which involved participation from the tech industry, commercial associations, professional associations, and the chair of the consultation group who had developed the initial draft. According to Twining (2012), the workshops resulted in an agreement on the issues raised by NAACR, ITTE, and CAS, and a new draft reflecting this consensus was sent to the Department for Education in 2012 (Larke, 2018). However, the British Computer Society Ltd (BCS) and the Royal Association for Engineering sent a letter to the Secretary for Education at the eleventh
hour, in which they asked him to change the name ICT to computing and for the subject to have a clear focus on computer science as opposed to a broader concentration on ICT, which he decided to accommodate (Larke, 2018).

The result was a curriculum that resembles a down-scaled, simplified version of computer science at the university level. It aims to 1) understand and apply fundamental principles of computer science, 2) teach the ability to analyse problems in computational terms, 3) evaluate new and familiar technologies, and 4) educate students to become responsible, competent, confident, and creative users of technology (Department for Education, 2013). The curriculum content consists of algorithms and programming, logical and computational thinking, digital content and potential uses for digital technology, safety and citizenship, and systems, searching, and software. Examples of the aims of the subject are that students should learn “what algorithms are, how they are implemented as programs on digital devices, and that programs execute by following precise and unambiguous instructions” (Department for Education, 2013, p. 2). Considering the above process, the decision in England resembles the descriptor of a quick fix in that the infrastructure for the professional development of existing teacher staff was not in place.

Implementation

Although the computing subject was very different from its ICT predecessor, it was former teachers of the ICT subject who were assigned the responsibility of teaching computing lessons (Larke, 2018). However, the new content of the computing subject required substantial training for both in- and pre-service teachers. This challenge was identified early in the implementation process, and researchers contributed by developing national networks for teaching excellence related to the computing curriculum (see Brown et al., 2014). These networks sought to build English teachers’ confidence, pedagogy, and support or guidance to teach the computing curriculum (Brown et al., 2014). There were also centrally developed initiatives to address this challenge. The Department for Education in England formed a collaborative partnership with three non-profit organisations, namely BCS9, STEM Learning,10 and Raspberry Pi11 (Fowler & Vegas, 2021). By delivering face-to-face training to in- and pre-service teachers and by commissioning 40 regional hubs where educators could find support, STEM Learning assisted in teacher education programmes (Sentance, 2018). The role of the Raspberry Pi Foundation was to create lesson plans, resources, online courses, and work schemes while drawing on both existing materials and innovating new ones. Moreover, this foundation conducted research on best teaching practices and disseminated the results (Fowler & Vegas, 2021).


10 https://www.stem.org.uk/

**Internalisation**

As described, the impulse partly consisted of concerns relating to the decreasing number of applicants for computer science topics. An overview of the number of students undertaking the General Certificate of Secondary Education (GSCE), which is the certification needed to apply for a bachelor’s-level qualification in computer science, indeed documented an increase from 2013 to 2019 (Fowler & Vegas, 2021). Although the Department for Education distributed the responsibility for teachers’ professional development to the BCS, they did not manage to fulfil their teacher training targets (Fowler & Vegas, 2021). A survey by the Royal Society (2017) found that one third of the teachers in England participating in the survey had not received professional development training in computing, and another third had only spent one to nine hours in such training. The lack of professional development had already been documented in 2015 (Swidenbank, 2015), and teachers were found to have limited computing skills and a lack of confidence in teaching the new subject. The study recognised that such training had been insufficient and that many teachers felt that they needed to learn more by their own volition. In fact, the teachers in Larke’s (2018) study handled this by continuing to teach content from the former ICT curriculum, which they labelled part of the computing subject.

**Discussion and conclusion**

In the spirit of this special issue of *Acta Didactica*, I have framed this study as an investigation of curriculum revisions in Denmark, Sweden, and England that concern informatics-related subjects. In international reports, such as those from the European Schoolnet, there has been a tendency to label similar curricular revisions as concerning computational thinking (e.g., Bocconi et al., 2022). Computational thinking is often described as an umbrella term, and Fessakis and Prantsoudi (2019) have argued that computational thinking was coined to facilitate dialogue on the role of informatics in general education. The call for papers to this special issue argues that the choice of the term informatics reflects that it is one of the most widely used internationally. However, as documented in this paper and elsewhere (e.g., Bocconi, 2016, 2018, 2022), the content of computational thinking or informatics-related curriculum revisions internationally remains broad and diverse. Similar to the call for papers, this study has used informatics-related curriculum revisions as an umbrella term that covers revisions in recent times with explicit reference to computing, programming, and skills that meet increasingly digitised societies. A key recommendation in the recent European report on compulsory schooling was to consolidate the understanding of computational thinking (Bocconi et al., 2022). However, as noted

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12 [https://journals.uio.no/adnorden/announcement/view/353](https://journals.uio.no/adnorden/announcement/view/353)
above, there are indications that such consolidations should not only consider ade-
quate content but also adequate terms. This is important since specific terms are
often associated with a normative stance on what content we consider adequate.

This paper has operationalised the policy borrowing framework to study the
origin and implementation of informatics-related subjects in Denmark, Sweden,
and England. As indicated by the name, the policy borrowing framework was
developed to study how educational policy may move from one specific context
to another. As I have shown in this paper, the respective implementations of
informatics-related subjects in Danish, Swedish, and English compulsory schools
are not necessarily clear-cut examples of explicit borrowing processes, where
curriculum revisions in one country seek to import well-defined solutions from
another nation. Nevertheless, a key strength in the policy borrowing framework
is the analytical sensitivity towards the internal logic of policy developments:
How were the problems that curriculum revisions target defined in the three coun-
tries? What was considered to be an adequate solution to this problem, and what
changes did the solutions undergo to fit the existing structure of the educational
system? In this respect, the policy borrowing analysis takes a step back to examine
the genesis of informatics-related curriculum revisions rather than describing their
immediate differences. This is particularly relevant to this study, since national
informatics-related curriculum revisions, in spite of their variations from country
to country, seem to be targeting the internationally agreed-upon challenge of
preparing students to participate in a digitised society.

The analyses in this paper found that revisions in Denmark aimed to educate
critical, democratic citizens. Revisions in England were related to a strong push
from the IT industry and an aim to reclaim the historical role of being tech
pioneers, while Sweden was oriented towards creating equal digital competencies
across demographic and socioeconomic factors. Moreover, the analyses found
that, while the externalisation potential may be in line with such impulses,
changes are likely to happen when sources of inspiration are converted into
concrete policy by fitting it into the structure of an existing system. The overview
studies that have been conducted (Bocconi et al., 2016, 2018) no doubt provide
valuable insights in discussing what opportunities we have available in navigating
the still muddy waters of informatics education. One could be tempted to think of
these overview studies as presenting a catalogue of different paths from which
nations can choose. However, this paper shows that curriculum revisions are the
product of complex, highly nationally situated, and, to some extent, contingent
processes. Even if inspiration could be found in such overviews, it is highly likely
that such externalising potential would undergo substantial changes when sub-
ordinated to the structure in the borrower countries’ structures. Likewise, while it
is important to understand the lobbying role of industry in informatics education
policy, as stated by Williamson et al. (2019), such studies quickly risk idealising
policy decisions as products of rationally calculated decisions. However, there is
a substantial element of contingency at play; decisions sometimes reflect what
was possible or mere chance, rather than painstaking planning. That is simply how policy works.

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