Digital competences in Nordic teacher education – an expanding agenda

Sanne Lisborg[1]
> University College Copenhagen (KP) and Aalborg University

Vici Daphne Händel
> University College Copenhagen (KP) and Aalborg University

Vibeke Schrøder
> University College Copenhagen (KP)

Mads Middelboe Rehder
> University College Copenhagen (KP)

Abstract

We investigate how digital competences are being integrated into teacher education (TE) across the Nordic countries - Denmark, Sweden, Norway, and Finland in this article. We make the case that there has been an expansion of the agenda for digital competences in education. Digital competences have developed from an information and communication technology perspective to also include a critical, social, and creative understanding of digital technologies and computing competences. Methodologically, we make use of document analyses, qualitative questionnaires, and interviews with participants in the field. With an emphasis on Danish TE, we explore how TE in the Nordic countries has responded to this agenda on policy and institutional levels. We suggest that the Danish approach to the expanded agenda can augment tendencies and challenges in Nordic responses to digitalisation in TE. A key finding is that Nordic countries respond to the expanded agenda in different ways regarding policy regulation, content areas, and how digital competences are organised and distributed on a local level. Tendencies and challenges identified across Nordic countries are valuable to ensure the continual development of teachers' digital competences.

Introduction

Digitalisation of education should be understood as formed by various understandings, interests, and agendas, according to sociologist of education Neil Selwyn. He argues that it is important to pay attention to these perspectives when studying the growth of digital

---

[1] Corresponding author: sali@kp.dk

technology in education (Selwyn, 2013). Moreover, the political focus on digital technologies has grown at all levels of education, as Selwyn and Facer state:

> Governments of nearly every country in the world now have well-established policy drives and programs seeking to encourage and support the use of digital technologies in schools, colleges, and universities (Selwyn & Facer, 2013, p. 1).

Teacher education (TE) is no exception. In this paper, we pay attention to how the agenda on digital technologies has expanded in recent years from focusing on the use of information and communication technology (ICT) in teaching to include critical, social, and creative aspects of digital technologies. The expansion of digital competences is an international development. In 2006, the European Parliament recommended that all Member States establish key competences with lifelong learning, one of which is ICT. At this point, emphasis was on the 'confident and critical use of Information Society Technology (IST) for work, leisure, and communication' (European Parliament, 2006). In 2018, the recommendation was updated, and the definition of digital competence was expanded to include topics such as:

> Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property related questions, problem solving and critical thinking (European Council, 2018).

In the European Union's understanding of digital competences, developing a broader perspective of digital technologies in learning means including competences such as creating, problem-solving, and critical thinking. Furthermore, the focus on developing digital competences in education is reflected in the extensive amount of international policy initiatives and frameworks (e.g., OECD, 2016; Ferrari, 2013; Redecker, 2017).

ICT in education has more recently been pushed to also include programming and computational thinking in education. *Computing education* was included in the EU's new digital action plan for 2021–2027. Basic digital skills and competences are described as needed from an early age and include digital literacy, computing education, and knowledge and understanding of data-intensive technologies (European Commission, 2020). This introduction of computing into educational strategies is also seen in the US strategy of 'computer science for all' (Smith, 2016). More generally, several philanthropic and charitable organisations, companies, academic scholars, entrepreneurs, and government agencies have promoted a major educational movement around the idea that young people should learn to code and create digital goods. This movement has spread across educational systems globally (Williamson et al., 2019; Williamson, 2017).

However, studies describe the implementation of ICT in TE as a 'slow uptake' (Granberg, 2011; So et al., 2012; Tømte, 2015) and find that teacher educators must improve their ICT competences for pedagogical purposes and invest more in developing students'

digital competences (Tømte et al., 2013; Tømte et al., 2015). An evaluation conducted by the Danish Agency for Research and Education found that even though digital learning materials and IT are included in the competence goals for each subject, there is a significant difference in how systematically and to what extent University Colleges integrate these aspects into the curriculum (Styrelsen for Forskning og Uddannelse, 2018). A Swedish research project reached a similar conclusion, stating that the development of student teachers' digital competences happens on a limited and unsystematic basis. Students encounter digitalisation through individual elements in courses rather than being instilled with a coherent idea of professional digital competence (Hashemi et al., 2019).

The overall picture is that there is still some way to go before TE has effectively incorporated the ICT agenda and systematically integrated digital competences. Moreover, TE is to respond to the expanded agenda for the digital competences by including critical, creative, and computing aspects. In this paper, the consequences of this multiplicity for Nordic TE in educating students to be digitally competent are detailed. In Denmark, TE has undergone increasing change over the last couple of years in preparation for evaluation and political decisions made following the testing of a new subject, 'Technology Comprehension' in compulsory school 2018-2021. The new subject is on the verge of possibly being implemented as either a separate subject, as a new aspect of existing subjects, or a combination of the two in compulsory school and TE. Danish TE is at a crossroads where different approaches are being tried out to decide which path to follow in the future. The Danish approach towards digital competences makes an interesting case since the testing has caused an intensified focus on digital competences in both compulsory school and TE. We describe how different approaches to integrating digital competences have been applied and point towards new challenges for TE with special attention to the transitions in Danish TE. We raise the following research question:

How has Nordic teacher education responded to the expanded agenda on digital competences on a political and institutional level?

Digital competences in Danish teacher education

Digital technology was first included in the Danish TE curriculum in 1991. The policy language from then on referred to technology as ICT and has been described in metaphors of craftsmanship, using notions such as 'tool', 'instrument', and 'device' (Arstorp, 2015). This framing of digital technologies as ICT use is still valid in the current government directives on TE (Uddannelses- og Forskningsministeriet, 2020). Digital learning skills and knowledge are consistently part of all subject descriptions.

In 2018, the Danish Ministry of Education published the 'Action plan for technology in education'. Two general goals were outlined. The first is to uphold the frequent use of ICT in education. The second is to strengthen technology comprehension and 'create opportunities to take a critical stance on technology and create with it, rather than just use it' (Undervisningsministeriet, 2018). This focus on creation and critics connects to the

term 'technology comprehension' (*teknologiforståelse* in Danish). This notion was initially introduced in Denmark as a translation of 'digital literacy' through a major research project on technology use in professions. The concept includes the use and understanding of technologies as agents in complex material practices in everyday social and working life (Hasse & Wallace, 2020).
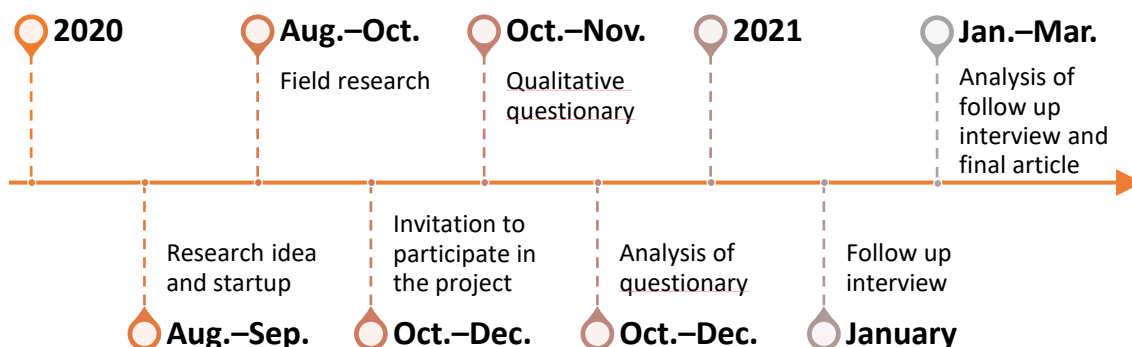
An experimental programme was initiated at compulsory school levels running from 2019–2021. A new subject, 'Technology Comprehension', was piloted both as a part of existing subjects and as an individual subject for K–9 pupils in 46 schools. Technology Comprehension comprises four competency areas: digital empowerment, computational thinking, technology capability, and working with digital design and design processes (Caeli & Bundsgaard, 2020). The initiation of this experiment is a core initiative in the Danish computing education agenda. One of the main goals of the experiment is to evaluate whether Technology Comprehension should be implemented as a new subject per se or if the subject matter should be integrated into pre-existing subjects.

With the national experiment of Technology Comprehension as a compulsory subject in schools, there has been a call for action in Danish TE to meet the demands posed if Technology Comprehension is implemented as a subject in compulsory school. Moreover, as described earlier, there is a general demand for TE to further include digital learning practices to help future teachers become digitally competent. Different initiatives have been launched in Danish TE to further develop student teachers' digital competences. One key initiative is a developmental project led by the University College Copenhagen (KP) to create a national mandatory module (10-ECTS) in Technology Comprehension. The project is funded by the Danish Ministry of Higher Education and Science. The project aims to establish a field of study and a module that cuts across subjects and general teacher competences in TE. The module consists of four content areas that correspond closely to the experimental subject in compulsory school: empowerment and Bildung in a digitalised society; technology comprehension (society, pedagogy, and school didactics); computational thinking; and digital design and design processes (Rehder et al., 2019). Throughout the paper, we use the module as a case to discuss and highlight tendencies and differences across Nordic TE.

Method and coding

The methods used in this study are document analysis, a qualitative questionnaire, and follow-up interviews. Three participants representing some of the largest TE institutions in the Nordic countries (Sweden, Norway, and Finland) answered the questionnaire and participated in the follow-up interviews. An overall process and timeline of the research are given in Table 1. The criterion for selecting the participants was that they hold central positions in the research and development of digital technologies in education. The study was conducted over eight months.

Table 1. An overall timeline of the data collection

2020	Aug.–Oct.	Oct.–Nov.	2021	Jan.–Mar.
	Field research	Qualitative questionary		Analysis of follow up interview and final article

Aug.–Sep.	Oct.–Dec.	Oct.–Dec.	January
Research idea and startup	Invitation to participate in the project	Analysis of questionary	Follow up interview

The participants answered a qualitative questionnaire with a series of open-ended questions (Braun & Clarke, 2013; Braun et al., 2020). The key themes were: 1) political visions and ambitions of digital competences, 2) central discourses concerning digital competences in education, and 3) how digital competences are organised and distributed locally. The participants also pointed at relevant institutional and political documentation.

The documents provided by the participants were supplemented with other materials, such as policy documents, journal articles, book chapters, webpages, press releases, and organisational and institutional reports. There seem to be four types of documents being included in similar comparative studies across TE, (Weisdorf, 2020; Gohde, 2019; Krumsvik, 2011). These documents are divided into 1) regulation documents, such as from the Department of Education (e.g., Norway, White Papers; Denmark, Bekendtgørelsen), 2) evaluation documents from TE, 3) European directions or guidelines, and 4) course descriptions. The authors provide all relevant Danish documents. They are employed in TE at University College Copenhagen (KP) as part of the research programme Digitalisation in the Schools (DiS).

An overview of the key documents is given in Table 2. The countries are listed by level of regulation from the most detailed national regulations (Norway) to the highest level of autonomy (Finland). Concerning Norway the regulations, guidelines, and framework used in the analysis all operationalise the White Papers (McGarr et al., 2021), which themselves are not included in the analysis.

Table 2. An overview of key documents used in this study

Country	Name of document, original Title [Title translated into English]	Type of document
Norway	Forskrift om rammeplan for grunnskolelærerutdanningerne for trinn 1- 7 + 5-10 [Regulations for Primary and Lower Secondary Teacher Education Programmes for Years 1–7 + 5-10]	These two regulations apply to universities and university colleges which offer primary and lower secondary teacher education programmes for Years 1-7 and 5–10' (Kunndskabsdepartementet, 2016a; 2016b).
	Nasjonale retningslinjer for femårig grunnskolelærerutdanning, trinn 1-7 + 5-10 [National guidelines for the primary and lower secondary teacher program for years 1- 7 + 5-10]	'These two guidelines complement the regulations and are intended to ensure a teacher education programme that is coordinated at a national level, and that satisfies the quality requirements' (Universitets- og høgskolerådet, 2018a; 2018b).
	Rammeverk for lærerens profesjonsfaglige digitale kompetanse. [Professional Digital Competence Framework for Teachers in Norway]	'A guidance document that policy developers, heads of department, teacher educators, teachers, student teachers and others can use as a reference in their work on improving the quality of teacher education and systematic continuing professional development of teachers' (Kelentrić et al., 2017).
Denmark	Bekendtgørelse om ændring af bekendtgørelse om uddannelsen til professionsbachelor som lærer i folkeskolen. [Ministerial order about the changes of ministerial order on the education of Bachelor of Education]	The ministerial order regulates the education of Bachelor of Education (Uddannelses- og Forskningsministeriet, 2020).
Sweden	Högskoleförordningen [Higher Education Ordinance]	The ordinance regulates universities and colleges for which the state is the principal (Sveriges Riksdag, 1993).
Finland	Statsrådets förordning om universitets-examina [Government Decreeabout university degrees]	The ordinance regulates the lower and higher university degrees and scientific and artistic postgraduate degrees (Finlex, 2004).

We conducted online semi-structured interviews with the three participants based on the answers from the questionnaires and sampling of documents (Brinkmann & Kvale, 2015). The interviews were held on an online communication platform chosen by the participant. The researchers ensured there was an institutional agreement that these chosen platforms could be used securely. All participants gave fully informed consent, which they had the opportunity to withdraw at any time before publishing. The participants are not mentioned by name in the article, as they represent the institutions at which they are employed.

Inspired by Grounded Theory, our coding strategy was an iterative process. We went back and forth between the data and the analysis, thereby letting the analytical categories emerge from the empirical data (Charmaz, 2014). On this basis, we established the meanings of the different empirical materials and determined how they contribute to the aim of the study (Bowen, 2009).

In the next section, we present different themes across TE in Nordic countries regarding digital competences. The two themes are 1) Education policy frames according to digitalisation, and 2) Meeting increasing demands of digitalisation in TE.

Education policy frames according to digitalisation

In this part of the analysis, we show how education policy at different levels creates different frames for TE to meet the demands of digital competences. We look at some of the overall national frameworks of TE regulation in the four Nordic countries and investigate the content according to digital competences in national policy documents.

The national regulation and policy documents

In Norway, the two governing documents are the 'Regulations for Primary and Lower Secondary Teacher Education Programmes' for Years 1–7 and 5-10 (Kunndskabsdepartementet, 2016a; 2016b). These regulations complement the 'National guidelines for the primary and lower secondary teacher education programme' for years 1–7 and 5–10 (Universitets- og høgskolerådet, 2018a; 2018b). The guidelines are translated and elaborated into local course regulations. In addition, the framework for teachers' professional digital competence is a guideline that cuts across all subjects and deals with how teachers can apply digital competences in teaching (Kelentrić et al., 2017).

In Norway, digital competency has been considered a basic educational competence since 2006 and is integrated into all subjects and levels, including TE. Since 2020, computational thinking and programming have been included in the mathematics, science, arts and crafts, and music curricula. In the National guidelines for the primary and lower secondary teacher program', it is stated that all subjects should include some basic digital skills as part of developing teacher students' academic knowledge and competence. In addition, similar to Denmark, the subjects that include digital competences are described. For example, in science, technology, engineering, and mathematics (STEM), there is a focus on digital learning resources. In social science, there is a focus on social issues linked to pupils' everyday digital life (Uddannelses- og Forskningsministeriet, 2020¸ Universitets- og høgskolerådet, 2018a; 2018b). Moreover, in the professional digital competence framework, digital competences are specified as seven important interrelated competence areas: the school in society, subject and basic skills, pedagogics and subject didactics, and ethics (Kelentrić et al., 2017).

Denmark has a similar way of structuring the regulation of TE. Danish TE is regulated through a national curriculum. The content of each subject is described under the general headings of competences, skills, and knowledge (see Table 1). The TE programmes elaborate this in their individual course regulations (Uddannelses- og Forskningsministeriet, 2020).

The recurrent description of digital competences in the Danish national TE curriculum from 2020 consists of practical skills and productive, creative, and critical competences. The content descriptions of subjects in the Danish curriculum promote varied forms of digital competences concerning ethics on the Internet, improving digital literacy, and critical assessment of digital learning resources. In addition, there is a stance on digital technologies in the social science curriculum that goes beyond seeing the technologies only

as learning tools. Social science includes the pupil's use of digital media to develop their critical thinking (Uddannelses- og Forskningsministeriet, 2020).

In addition to using ICT as a learning tool, a focus on creating with technologies has emerged in the national TE curriculum. The technical, social, and critical understanding of technologies is included in the mandatory subject of pedagogy. One of the skill descriptions for student teachers is that they should be able to:

> Plan, teach and develop instruction through and about information technology and media, promoting a pupil's ability to act as a critical investigator, an analysing receiver, a goal-oriented and creative producer, and a responsive participant (Uddannelses- og Forskningsministeriet, 2020).

In Sweden, TE is regulated by the Higher Education Ordinance (Sveriges Riksdag, 1993). The ordinance describes the national purpose and structure for the universities and university colleges but not the content. A general remark is attached to the content descriptions in the 'Higher Education Ordinance' in Sweden. It says student teachers should 'Show the ability to safely and critically use digital tools in the educational activity and consider the importance of different media and digital environments for the activity' (Sveriges Riksdag, 1993).

In Finland, TE is regulated in 'Government Decree about university degrees' (Finlex, 2004). These decrees set the overall regulations of the bachelor's and master's degrees (Weisdorf, 2020). Finnish universities have a strong degree of autonomy in organising TE locally and designing their curricula. The regulation states that 'higher education institutions decide independently on the content of teacher education' (Ministry of Education and Culture, 2016). Therefore, there is no detailed national curriculum of TE (OECD, 2016; Zuljan & Vogrinc, 2011). Under the high degree of autonomy in Finnish TE, digital competences are not described at a national level (OECD, 2016).

TE programmes are, thus, regulated differently across the Nordic countries, from systems with high professional autonomy in the organisation of programmes to systems where the form and content of the education are closely regulated by a central authority (Weisdorf, 2020). What the degree of regulation entails concerning digital competences will be pursued in the discussion section.

When we compare the Nordic national policy documents, we find very different degrees of prescription regarding the content of digital competences. We find the most detailed descriptions in Norwegian TE. Digital competence, skills, and knowledge are described in all subjects in the national curriculum, and professional digital competence is outlined in the framework of teachers' digital competences. The national curriculum of Danish TE includes various digital competences in different subjects, while in Sweden, digital competence in the national curriculum is described in general terms. In Finland, responsibility for the content, including digital competences, is entrusted to the local TE programmes.

In Norway and Denmark, the two countries with the most detailed national regulations regarding digital competences, three kinds of digital agendas in the policy documents can

be identified. The first concerns the use of digital tools for learning purposes, where digital competences are understood as mastering digital tools (the ICT agenda). The second regards more critical, investigative, and creative ways to handle digital technologies. The third, computing, is entered as a central agenda. Computational thinking recently became part of mathematics, science, arts and crafts, and music in the Norwegian national curriculum. The second and third agendas may be answers to the increasing demands of digital competences in TE. The second form of expansion of digital competences applies to all subject areas, while the third only appears as content in selected subjects on a national level in Norway.

Meeting increasing demands of digitalisation in teacher education

In this part of the analysis, we examine how Nordic TE on a local level responds to the expanded agenda to see how it materialises in TE practice. First, we give two examples of which kind of content knowledge is applied when teaching digital competences. The first is how TE has responded to the agenda on computing, where Denmark has applied a more design-orientated approach than the other countries. The second is how critical thinking and ethics are central elements in the Nordic approach to digital competences and how the countries have emphasised and implemented these aspects in different ways. Second, we investigate how digital competences are organised and distributed in different TE programmes.

Design processes and computational thinking

Through the 'Technology Comprehension' module, KP implements the expanded agenda in TE curricula. Design thinking and design processes are a central didactic approach to Technology Comprehension in compulsory school and teacher education. The work with digital design is connected to the work with computational thinking. It is an alternative approach to developing computing skills in compulsory school, as described by Tuhkala et al. (2019):

> (1) integrating computing and design skills into the learning process as means, rather than viewing these skills as mere learning outcomes; (2) supporting creativity through the development of technology to understand the impacts of technology; and (3) to critically reflect the role of technology in the society more broadly (p. 55).

In this sense, the creative and critically reflective element is put in the foreground, and computing is seen more as a *means* rather than a *learning outcome*. This approach is also adopted in the national module Technology Comprehension at KP (Rehder et al., 2019). None of the Nordic countries other than Denmark has the same emphasis on digital design and design processes as a means to gain digital competences. Computational thinking is understood through understanding and working with algorithms, models, and programming as a part of iterative design processes in teaching (Iversen et al., 2019).

In the other Nordic countries, computational thinking is implemented through the existing subjects, both in compulsory school and teacher education, mostly as a part of STEM subjects and to a lesser extent creative subjects such as music and arts and crafts. In Finland, computational thinking ('algorithmic thinking' in Finnish) and programming have become established parts of mathematics. The focus is on programming and problem solving through programming (interview, Teacher education institution in Finland). In Norway, computational thinking and programming are also a part of mathematics and science, and aesthetic subjects. Here, there is more focus on creative aspects in programming, 'not only as creating the script and the algorithm but also the thinking about sequencing, logic, and de-bugging' (interview, Teacher education institution in Norway). In contrast to other Nordic countries, computational thinking and programming are not mandatory parts of STEM or creative subjects in Danish TE but a part of the Technology Comprehension module. Although recently, Technology Comprehension has been added to all individual subjects at KP. In this way, Denmark differs from the other Nordic countries in terms of TE by adapting design thinking as the didactic approach to computing and by not including computational thinking as a mandatory part of science and/or creative subjects.

Critical thinking and ethics

Nordic TE emphasises critical and ethical perspectives on digital technologies in slightly different ways. In Norway, ethics is one of the seven professional teacher digital competences relating to areas such as copyright, digital judgment, data security, and source criticism (Kelentrić et al., 2017). Our participant at the teacher education in Norway describes the ethical part as an overall theme in teaching digital competences through the study:

> If we, for example, teach blogging in English, we try to ensure that we also talk about posting things online. Or if we teach creating multimodal things in Norwegian, e.g., films, we also teach about copyright (interview, Teacher education institution in Norway).

The focus on the critical and reflective use of digital technologies is also cited by our participant at the teacher education institution in Sweden as an important dimension of digital competences in TE, which is stressed in the Swedish Higher Education Ordinance. She explains how she works with the content areas in her teaching:

> The critical dimension is reflecting on digital media (…), for instance, reflection about advertisements on the Internet and YouTube. The ethical dimension is in how we communicate with each other and how we take social responsibility in our communication, for instance, on social media (interview, Teacher education institution in Sweden).

The focus on developing a critical and socially responsible approach to our interaction on digital media or digital empowerment is emphasised. Digital empowerment is also a central aspect of the Danish approach to digital competences and is one of the four content

areas in the Technology Comprehension module. Here, the focus is on analysing technologies and their purposes, examining their use, and assessing their consequences. In Technology Comprehension, the ethical and critical dimension is connected to understanding digital technologies and analysing and evaluating possible challenges and problems. Digital competences are not only about being able to use digital technologies (the early ICT agenda) but also about using technologies in a critical, socially responsible, and reflective way and thereby gaining digital empowerment.

Consequently, there is a difference in understanding digital competences as more technical narrow competence, such as knowledge on the copyright, or as a more complex socio-material competence that includes the relationship between technology and communication (the Swedish example) or as assessing consequences (the Danish example). Therefore, these different understandings of digital competences can be related to more or less instrumental or culture-oriented technology comprehension (Borgmann, 2006; Schrøder, 2019).

Organisation and integration of digital competences

In this part of the analysis, we examine how TE has integrated digital competences in practice. In a literature review by Kay (2006), ten strategies for introducing student teachers to technology were identified. The two most used strategies were a single-course strategy, typically where a standalone course covers a range of basic computer skills, and a full integration strategy, where the use of technology was applied in all courses in the teacher programme. In Nordic TE, the full integration strategy is commonly used. In all countries, the work involving digital competences is integrated into other subjects. In addition, elective subjects concerning teachers' digital competences are offered in the different TE programmes that cut across subjects.

The participating teacher education from Norway has taken a special approach to the integration of digital technologies in subjects. They have established a separate ICT unit responsible for teaching areas related to ICT and digital competences in the subject. The unit teachers work closely with the subject teachers to ensure that the work with digital technologies is integrated in a meaningful way. As our participant explains:

> In English, the students have compulsory coursework, some of which is to show digital media. For example, they must create a blog, so they [the digital assignments] are tailor-made to the specific subject (interview, Teacher education institution in Norway).

This way of implementing digital competences could be seen as a mixture of a single- and a full-integration strategy, where digital technologies are integrated as an independent part of the subjects. A central reason for having a separate ICT unit is that 'the subject teachers are not trained well enough to teach ICT alongside their subject' (Tømte et al., 2009, p. 19). By allocating the ICT teaching to a separate unit, the aim is to ensure that the educators are equipped with sufficient competences.

Danish TE also integrates digital technologies into other subjects. However, a mixture of a single- and a full integration model is also applied in the module 'Technology Comprehension' at KP. This module is taught by a technology teacher and a subject teacher (in Danish, English, or Mathematics). The technology teacher is usually from the pedagogical subjects but could also be from other units working with digital technologies. Unlike at the teacher education institution in Norway, there is no separate ICT unit; rather, the digital competences are distributed to different parts of the organisation.

Moreover, the teaching in Technology Comprehension is handled by both the technology teacher and the subject teacher. A guideline is developed to support the teachers in planning how to cover the four elements (Rehder et al., 2019) but not about the individual subjects. It is up to the teachers to ensure that it is subject-related. On the one hand, this model makes it more challenging to streamline the teaching in digital technologies, as done at the teacher education institution in Norway. On the other hand, when the subject teachers are involved in the Technology Comprehension teaching, the integration of digital competences into the subject may become more coherent.

Computational thinking competences in teacher education

Computing and computational thinking are key aspects of the expanded agenda. In this section, we examine which strategies are applied in TE to upgrade and ensure that TE has the competences needed. Danish university colleges and Danish universities have established a capacity-building group (KATEFO). This group conducted a gap analysis and mapped the research and development environments related to Technology Comprehension at all levels of the education system. One of their conclusions was that if Technology Comprehension is implemented as a subject, there is a lack of competency in informatics and Technology Comprehension throughout the entire educational system (Basballe et al., 2021). The need to upgrade the informatics and computational thinking competences within TE is also stressed by Yadav et al. (2017). They argue that TE must offer preservice teachers' courses on programming and computational thinking and suggest that education and computer science faculties should 'work collaboratively, using their complementary expertise in computing and teacher development' (Yadav et al., 2017, p. 55).

In contrast to Denmark, where TE is anchored in university colleges (Weisdorf, 2020), TE is offered exclusively by universities in Finland. Because of this, competences in programming and computational thinking are covered 'in-house'. Our participant from the teacher education institution in Finland explains that Finland is normally reluctant to add new subject areas to the educational system. Algorithmic thinking was included as a part of mathematics because many mathematics teachers have studied computer science as a part of their education. Furthermore, a lot has been invested in in-service training in which, for example, universities have offered courses in teaching programming and algorithmic thinking (interview, Teacher education institution in Finland). The link between education and computer science faculties in Finland is already in place as a natural consequence of anchoring TE in universities. Denmark does not have this natural alignment,

but KATEFO might be a step towards closer collaboration between universities and university colleges on the capacity-building of informatics and technology competences. The challenges of ensuring computing and computational thinking capacity will be further elaborated in the discussion below.

Findings and discussion

This article describes an expansion of the agenda for digital competences in TE. The goal of student teachers being competent users of digital technologies is supplemented with a focus on understanding, creating, and critically reflecting. This expansion is reflected in international strategies, political initiatives, and frameworks, and the international movement of including programming and computational thinking in schools. When the understanding of digital competences is expanded, it becomes interesting to investigate how TE responds to this new agenda. We have identified different political and institutional ways of responding to the expansion of goals for digital competences in TE across the Nordic countries.

In the first part of the analysis, we examined the Nordic TE systems' obligations regarding digital competences. In Denmark and Norway, digital competences are explicitly described in the national subject curriculums. According to the descriptions of the aims and goals in the subjects, the use of digital tools and learning resources is still a central part of the curriculum. However, there are also some tendencies toward a broader understanding of digital competences. In Norway, the understanding of professional digital teacher competences is well-established within the national framework. However, in Sweden and Finland, the obligations of TE concerning digital competences are less explicit. Finland does not have a policy description of how TE is to apply digital competences, and there is great confidence in universities to organise TE locally, including education for digital competences.

The Nordic countries have quite different ways of organising curricula and describing digital competences on a policy level. Further investigation could potentially shed light on the role the different approaches play when implementing digital competences in TE. Is Norway, for example, better at incorporating digital competences because they are well described in various policy documents? Or is the Finnish model with full autonomy vis-à-vis TE programmes better? It is difficult to answer such questions adequately but doing so could reveal new insights into the involvement and organisation of digital competences on a policy level.

The second part of the analysis draws attention to how digital competences are implemented locally in TE programmes. First, it is shown that there are different approaches to integrate computing and computational thinking. In Denmark, the focus on computational thinking is intertwined with a digital design purpose. In the rest of the Nordic countries, computational thinking and programming are integrated as content areas in individual subjects, especially through problem-solving in STEM subjects. Here, computational

thinking is understood as a part of subject content knowledge, whereas the Danish approach is more interdisciplinary. If pursued further, these different strategies might also reveal patterns on how systematically, and to what extent computational thinking is integrated into TE.

Moreover, an ethical and critical perspective on digital technologies (digital empowerment) has been identified in the Nordic countries as a central aspect of digital competences. This focus on digital empowerment can also be understood as a way of moving beyond the focus on using ICT as a tool to a critical, socially responsible, and ethical perspective on digital technologies. There is a comprehensive effort to work in-depth with digital empowerment in the Danish Technology Comprehension module. Again, it can be questioned if, for example, the more specified approach to work with digital empowerment in the subjects at the teacher education institution in Norway is a better way of ensuring a systematic integration. However, a broader understanding of digital empowerment might ensure a richer perspective on digital technologies.

We also examined how TE programmes have organised and integrated digital competences into curricula locally. The most used strategy is 'full integration', in which digital competences are part of all subjects. Denmark is the only country that has experimented with creating a mandatory module as a supplement to integration into different subjects. At the teacher education institution in Norway, a separate ICT unit has been established to specialise in teaching digital competences in the subjects. Whereas Finland has computing and programming competences covered in-house at the universities, Danish TE needs more competence capacity in informatics and technology comprehension, especially if the subject is to be mandatory.

Even though the Nordic countries have some of the most advanced digital infrastructure (Randall & Berlina, 2019) and a shared technological point of departure, various policies and practices are applied. This approach emphasises that digital competences is a fluid and expanding term, making it difficult to find a one-size-fits-all approach, and also considering the different traditions of understanding and conducting TE. The technology philosopher Alfred Borgmann defines the dominant perspective on technologies as an 'engineering sense of technology', whereas 'social theorists are interested in technology as a cultural force' (Borgmann, 2006, p. 353). The point is that understanding technology is never neutral but is rooted in a socio-cultural context. Understanding the different approaches to the expansion of digital competences in TE also includes mapping and analysing the attached perspectives on technology.

Moreover, the implementation of the ICT agenda and use of technologies is not yet realised, as earlier studies have shown. This implementation makes it relevant to ask how TE can integrate the expanded agenda of digital competences when the earlier agenda still challenges it. Perhaps the different technology understandings could contribute to each other in a constructive way instead of being parallel agendas; this approach might be a way to handle the slow uptake of digital competences in TE. Exploring these possibilities is beyond the scope of this article, but reflections on the different approaches in Nordic countries may open up some themes to pursue in future empirical research.

Acknowledgements

References

Arstorp, A.-T. (2015). *Ph.d.-afhandling: Teknologi på læreruddannelsen - en forestillet eller en realiseret praksis?: En virksomhedsteoretisk analyse af objekter, motiver og rettetheder på samfunds.* Institut for Uddannelse og Pædagogik, Aarhus Universitet.

Basballe, D., Caspersen, M., Hansen, B. L., Hjorth, M., Iversen, O. S., & Kanstrup, K. H. (2021). *Gap-analyse af teknologiforståelse i det danske uddannelsessystem fra grundskole til ungdomsuddannelser (Resumé).* Danske Professionshøjskoler & Danske Universiteter.

Borgmann, A. (2006). Technology as a cultural force: For Alena and Griffin. *The Canadian Journal of Sociology*, *31*(3), 351–360. https://doi.org/10.2307/20058714

Bowen, G. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9,* 27–40. https://doi.org/10.3316/QRJ0902027

Braun, V., & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners.* Sage. https://doi.org/10.1177/0959353515614115

Braun, V., Clarke, V., Boulton, E., Daey, L., & McEvoy, C. (2020). The online survey as a qualitative research tool. *International Journal of Social Research Methodology*. 1-14. https://doi.org/10.1080/13645579.2020.1805550

Brinkmann, S., & Kvale, S. (2015). *InterViews: Learning the craft of qualitative research interviewing* (3rd ed.). Sage.

Caeli, E. N., & Bundsgaaard, J. (2020). Computational thinking in compulsory education: A survey study on initiatives and conceptions. *Educational Technology Research and Development, 68*(1), 551–573. https://doi.org/10.1007/s11423-019-09694-z

Charmaz, K. (2014). *Constructing grounded theory.* Sage.

European Commission. (2020). *Digital education action plan (2021–2027): Resetting education and training for the digital age.* European Union. https://ec.europa.eu/education/sites/default/files/document-library-docs/deap-communication-sept2020_en.pdf

European Council. (2018). *Council recommendation of 22 May 2018 on key competences for lifelong learning, 2018/C 189/01.* European Council. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.C_.2018.189.01.0001.01.ENG

European Parliament. (2006). *Recommendation of the European parliament and of the council 2006/962/EG on key competence for lifelong learning.* European Parliament. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32006H0962

Ferrari, A. (2013). *DIGCOMP: A framework for developing and understanding digital competence in Europe.* Institute for Prospective TechnologicalStudies, JRC Technical Reports. European Union. https://doi.org/10.2788/52966

Finlex. (2004). *Statsrådets förordning om examina och specialiseringsutbildningar vid universitet (SE).* https://finlex.fi/sv/laki/smur/2014/20141439

Granberg, C. (2011). *ICT and learning in teacher education: The social construction of pedagogical ICT discourse and design.* Umeå Universitet, Department of Applied Education/Interactive Media and Learning (IML).

Gohde, A. (2019). Digital literacies or digital competence: Conceptualizations in Nordic curricula. *Media and Communication*, *7*(2), 25–35. https://doi.org/10.17645/mac.v7i2.1888

Hashemi, S. S., Playa-Koro, C., Brante, E. V., Franck, O., von Otter, A.-M., & Pihl, A.-L. (2019). Lärerutbildningen och den digitala kompetensen. In O. Franck (red.), *Vetenskaplighet i högre utbildning: Erfarenheter från lärarutbildningen* (261–290). Studentlitteratur AB.

Hasse, C., & Wallace, J. (2020). *Teknologiforståelse: Mod et nyt begreb om teknologiforståelse*. Technucation: Technological literacy and new employee driven innovation trough education. https://technucation.dk/begreber-og-fokusomraader/teknologiforstaaelse/

Iversen, O. S., Dindler, C., & Smith, R. C. (2019). *En designtilgang til teknologiforståelse.* Dafolo.

Kay, R. H. (2006). Evaluating strategies used to incorporate technology into pre-service education: A review of the literature. *Journal of Research on Technology, 38*(4), 383–408. https://doi.org/10.1080/15391523.2006.10782466

Kelentrić, M., Helland, K., & Arstorp, A.-T. (2017). *Professional digital competence framework for teachers in Norway.* The Norwegian Centre for ICT in Education. https://www.udir.no/contentassets/081d3aef2e4747b096387aba163691e4/pfdk-framework.pdf

Krumsvik, R. (2011). Digital competence in Norweigian teacher education and school. *Högre utbuilding, 1,* 39–51.

Kunndskabsdepartementet. (2016a). *Forskrift om rammeplan for grunnskolelærerutdanningene for trinn 1- 7.* https://lovdata.no/dokument/SF/forskrift/2016-06-07-860?q=forskrift%20grunnskolel%C3%A6rerutdanning

Kunndskabsdepartementet. (2016b). *Forskrift om rammeplan for grunnskolelærerutdanningene for trinn 5- 10.* https://lovdata.no/dokument/SF/forskrift/2016-06-07-861?q=forskrift%20grunnskolel%C3%A6rerutdanning

McGarr, O., Mifsud, L., & Rubio J. C. C. (2021): Digital competence in teacher education: comparing national policies in Norway, Ireland and Spain*, Learning, Media and Technology*, https://doi.org/10.1080/17439884.2021.1913182

Ministry of Education and Culture. (2016). *Teacher education in Finland.* https://minedu.fi/documents/1410845/4150027/Teacher+education+in+Finland/57c88304-216b-41a7-ab36-7ddd4597b925/Teacher+education+in+Finland.pdf

OECD. (2016). *Skills for a digital world: Policy brief on the future of work.* OECD. http://www.oecd.org/els/emp/Skills-for-a-Digital-World.pdf

Randall, L., & Berlina, A. (2019). Governing the digital transition in Nordic Regions : The human element. https://doi.org/10.30689/R2019:4.1403-2503

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu.* Joint Research Centre. https://doi.org/10.2760/159770

Rehder, M. M., Møller, T. E., Hjorth, M., Fibiger, J., Hansbøl, M., Jensen, J. J., Kornholt, B., Laier, B., Møller, L. D., & Schrøder, V. (2019). *Teknologiforståelse og digital dannelse – undervisningsvejledning til et nyt modul på læreruddannelsen*. Københavns Professionshøjskole.

Schrøder, V. (2019). Digitale teknologiers kulturkraft i daginstitutionen: Børn og pædagogers teknologiforståelse. *Forskning i pædagogers profession og uddannelse, 3*(1), 103-119. https://tidsskrift.dk/FPPU/article/view/113979/162557

Selwyn, N. (2013). *Discourses of digital 'disruption' in education: A critical analysis*. Paper presented to Fifth International Roundtable on Discourse Analysis, City University, Hong Kong, May 23–25, 2013.

Selwyn, N., & Facer, K. (2013). Introduction: The need for a politics of education and eechnology In: N. Selwyn, & K. Facer (Eds.) *The Politics of Education and Technology: Palgrave Macmillan's Digital Education and Learning* (pp 1-17). Palgrave Macmillan. https://doi.org/10.1057/9781137031983_1

Smith, M. (2016). *Computer science for all*. https://obamawhitehouse.archives.gov/blog/2016/01/30/computer-science-all

So, H.-J., Choi, H., Lim, W. Y., & Xionga, Y. (2012). Little experience with ICT: Are they really the Net Generation student-teachers? *Computers & Education, 59*(1), 1234–1245. https://doi.org/10.1016/j.compedu.2012.05.008

Styrelsen for Forskning og Uddannelse. (2018). *Bilag 1 til delanalyse 2 i evaluering af læreruddanelsen. Sammenfatning af professionshøjskolernes redegørelser.* https://ufm.dk/aktuelt/nyheder/2018/filer/bilag1.pdf

Sveriges Riksdag. (1993). *Högskoleförordning (1993:100)*. https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/hogskoleforordning-1993100_sfs-1993-100

Tuhkala, A., Wagner, M.-L., Iversen, O. S., & Kärkkäinena, T. (2019). Technology comprehension — Combining computing, design, and societal reflection as a national subject. *International Journal of Child–Computer Interaction, 20*, 54–63. https://doi.org/10.1016/j.ijcci.2019.03.004

Tømte, C. E. (2015). Educating teachers for the new millennium? Teacher training, ICT and digital competence. *Nordic Journal of Digital Literacy Special Iissue 2006–2016*. 74-89. https://doi.org/10.18261/ISSN1891-943X-2015-Jubileumsnummer-10

Tømte, C., Enochsson, A. B., Buskqvist, U., & Kårstein, A. (2015). Educating online student teachers to master professional digital competence: The TPACK framework goes online. *Computers & Education, 84,* 26–35. https://doi.org/10.1016/j.compedu.2015.01.005

Tømte, C., Hovdhaugen, E., & Solum, N. H. (2009). *ICT in initial teacher training: Norway country report.* Organisation for Economic Co-operation and Development. https://www.oecd.org/norway/45128319.pdf

Tømte, C., Kårstein, A., & Olsen, D. S. (2013). IKT i lærerutdanningen. På vei mot profesjonsfaglig digital kompetanse? Nordic Institute for Studies in Innovation, Research and Education. http://hdl.handle.net/11250/280429

Uddannelses- og Forskningsministeriet. (2020). *Bekendtgørelse om ændring af bekendtgørelse om uddannelsen til professionsbachelor som lærer i folkeskolen. BEK nr 1140 af 03/07/2020.* https://www.retsinformation.dk/eli/lta/2020/1140

Universitets- og høgskolerådet. (2018a). Nasjonale retningslinjer for femårig grunnskolelærerutdanning, trinn 1-7. https://www.uhr.no/_f/p1/ibda59a76-750c-43f2-b95a-a7690820ccf4/revidert-171018-nasjonale-retningslinjer-for-grunnskolelarerutdanning-trinn-1-7_fin.pdf

Universitets- og høgskolerådet. (2018b). Nasjonale retningslinjer for femårig grunnskolelærerutdanning, trinn 5-10. https://www.uhr.no/_f/p1/iffeaf9b9-6786-45f5-8f31-e384b45195e4/revidert-171018-nasjonale-retningslinjer-for-grunnskoleutdanning-trinn-5-10_fin.pdf

Undervisningsministeriet (2018). *Handlingsplan for teknologi i undervisningen.* https://www.uvm.dk/publikationer/folkeskolen/2018-handlingsplan-for-teknologi-i-undervisningen

Weisdorf, A. K. (2020). *Læreruddannelsen i globalt perspektiv: Et komparativt studie af læreruddannelsen i Danmark, England, Finland, Holland, New Zealand, Norge, Ontario, Singapore, Sverige og Tyskland.* Danske Professionshøjskoler.

Williamson, B. (2017). *Big data in education: The digital future of learning, policy and practice.* Sage. https://doi.org/10.4135/9781529714920

Williamson, B., Rensfeldt, A. B., Player-Koro, C., & Selwin, N. (2019). Education recoded: Policy mobilities in the international 'learning to code' agenda. *Journal of Education Policy, 34*, 705–725. https://doi.org/10.1080/02680939.2018.1476735

Yadav, A., Stephenson, C., & Hong, H. (2017). Computational thinking for teacher education. *Communications of the ACM*, *60*(4), 55–62. https://doi.org/10.1145/29945 91

Zuljan, M. V., & Vogrinc, J. (2011). *European dimensions of teacher education: Similarities and differences*. Faculty of Education, University of Ljubljana & The National School of Leadership in Education, Kranj. https://doi.org/10.13140/2.1.4136.1282