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Children's digital competence in early childhood education: A comparative analysis of curricula

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Abstract

Children's digital competence (DC) is often poorly supported in early childhood education (ECE). Furthermore, common definition of DC is difficult to find. Therefore, the aim of this comparative curriculum study was to better understand how objectives and content of DC are defined in ECE. Australia and Finland curricula were analyzed applying theory-driven content analysis. The results indicated that in both countries theoretical basis of DC was present: objectives and content of DC referred to (1) technical skills and practices, (2) applying digital technologies, (3) evaluate digital technologies critically, and (4) motivation to participate in a digital culture. However, aims, content, and practical guidelines on the curricula were unclear. This study recommends that ECE curricula should better emphasis and make explicit the key elements of DC and how to holistically foster children's DC in practice. Further studies to clarify the important elements of DC in ECE curricula frameworks is required.

Keywords: digital competence, early years education, pedagogical issues, 21st-century skills

INTRODUCTION

Today, in almost every aspect of their everyday lives, young children are surrounded by digital technologies, including applications and products that support play, learning, and their development, as well as communication with others. This provides grounds for some researchers to speak in terms of a "digital childhood" (e.g., Danby et al., 2018; Mantilla & Edwards, 2019; Orben, 2021). Early childhood education (ECE) settings are very specific contexts for children (age 0-5 years) to discover and be able to learn to use digital technology. Guiding documents for curricula help teachers instruct children on how to bridge their digital worlds at home and in school, as well as provide an equal starting point for the development of digital skills for the later school path (Danby et al., 2018; Kewalramani et al., 2020; Palaiologou et al., 2021; Plowman et al., 2011).

Digital competence (DC) has been interpreted in various ways in policy papers and research reports (Ilomäki et al., 2016), and a consensus in defining DC has not yet been achieved. Several terms, such as digital literacy (DL), digital skills, and DC, highlight the need to consider what it means to grow up in a digital age and to work with technology meaningfully in different contexts and environments (Ferrari, 2013; Gallardo-Echenique et al., 2015; Ilomäki et al. 2016). For example, Eshet-Alkalai (2004) points out that DC involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological, and emotional skills, which children as future citizens will need to function effectively in digital environments. Children's DC can be outlined also by paying attention to following areas: information and media literacy, digital communication and collaboration, digital content creation, responsible use, and digital problem solving (Redecker & Punie, 2017). Since definitions raise significant perspectives in considering

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Contribution to the literature

- This article presents a comparative study of the understanding about children's DC in curricula of Australia and Finland for ECE.
- Although the definitions of aims, content, and practical guidelines on the curricula were unclear, the texts reflected a broad conception of DC in ECE practices.
- The results of the study highlighted that the curriculum frameworks did not provide a detailed list of requirements for specific digital content, and even the definitions of the learning content of essential digital phenomena remained minimal.

DC in ECE, it becomes obvious that there are many robust models for comparing and making a synopsis of DC in ECE curricula, such as the DigCompEdu–European framework for DC of ECEC professionals (Redecker & Punie, 2017).

In this article, Ilomäki et al.'s (2016) model is chosen for comparing DC definitions in curricula texts. Since in digital society the creative and safe use of versatile digital applications and environments in learning and working activities is often highlighted (e.g., Eshet-Alkalai, 2004; Redecker & Punie, 2017), the question of what the important basic skills children are should learn in achieving these learning goals, becomes vital. Ilomäki et al. (2016) suggest that mastering basic technological skills and knowledge ensures that students are able to apply digital technology to learning and working activities. Their model offers a tool to investigate the multiple perspectives of DC, which are on the one hand separable from each other but on the other hand form a continuum to view children's learning as a process. In the model learning process is seen consisting of the following elements: learning technical skills and practices, applying digital technology, conceptualizing the phenomena of digital technologies, and motivation to participate and engage in a digital culture. Since each element is broadly defined, it can be assumed that the model is suitable for investigating many varieties of definitions written in ECE curricula regarding fostering children's DC.

Since EC educators' attitudes toward the value of technology to aid children's learning have a strong effect on technology use (Blackwell et al., 2014; Ogegbo & Aina, 2020) and teachers do not necessarily have sufficient DC to use information and communication technology (ICT) for their professional career (Martín et al., 2020), curriculum guidelines are key in the process as teachers foster children's evolving DC. Despite this, the research focusing on ECE curricula from the point of view of fostering children's DC has been limited. Recent research has rather focused on examining DC in ECE from teacher's educational practice perspectives (Lauricella et al., 2020; Thorpe et al., 2015) illustrating, for example, benefits of curriculum supplement in learning content of specific subject area (Rosenfeld et al., 2019). Therefore, examining how ECE curricula interpret DC in ECE, from the perspectives of both the practitioner and the child as learner, becomes particularly important.

Traditionally, curriculum development has been understood as primarily a nation-state issue (Hardy & Uljens, 2018). However, there is a need to understand and strengthen the discussion of research-based developments of curricula, which consider globally emerging needs in different cultural contexts. For example, since 2020, COVID-19 has shown the digital divide in children's lives due to school closures and the reliance on online learning (Blundell et al., 2020). In digital society where inequalities are exacerbated, it is critical to examine whether ECE curricula is fulfilling its potential to ensure for social justice and equity by defining robust guidelines to foster children's DC development. As Berson et al. (2022) note, there is still much to be learned about how technology may play a part in curriculum for today's children to narrow the digital divide and acquire DL in their lives. As a response to the globally emerging needs, clarifying DC at conceptual level in ECE curricula is also important: though DC is increasingly used in the European framework (Halász & Michel, 2011; Krumsvik, 2011), in educational research, it is not yet a well understood and standardized concept internationally or in ECE (Berson et al., 2022; Ilomäki et al., 2016). Therefore, comparative curriculum studies aiming to clarify the complex discourses of curricula texts in fulfilling to ensure social justice and equity in children's learning in digitalized society is vital.

This article examines how DC and its development are included in and guided by national curriculum texts written for ECE in Australia and Finland and compares these analyses to identify diverse as well as common elements. Our focus in this paper has been constrained to initially focus on two countries that we are familiar with, and which have similarities and differences in terms of ECE. In both countries research-based attention has been paid to the development of high quality ECE in many ways (e.g., Boyd & Phillips, 2021; Harju-Luukkainen & Kangas, 2021; Krieg, 2010; Taguma et al., 2012). Since population of Australia is five times that of Finland, investigating ECE curriculum of Finland strive to meet the requirements of small country and Australia of a large country.

Recent research has shown interesting similarities and differences between the Australian and the Finnish curricula. For example, similarities and differences related to equity and generic competences are debated in primary school level (see Hardy & Uljens, 2018), global citizenship and acceptance of diversity learning in foreign language learning in ECE (Garvis et al., 2018), and integration of learning and teaching delivery in the context of science learning in ECE (Havu-Nuutinen et al., 2022). Since comparative curriculum analysis regarding DC in ECE is rare, it is valuable to find out possible similarities and differences between the Australian and the Finnish ECE curricula texts. Especially, how above presented important topics, like equity and acceptance of diversity learning, are represented in the curricula.

The research questions are, as follows:

1. How are the elements of DC in the ECE curricula of Australia and Finland defined?
2. What are the similarities and differences in Australian and Finnish ECE curricula regarding the fostering of children's DC?

ELEMENTS OF DIGITAL COMPETENCE IN EARLY CHILDHOOD EDUCATION

This research relied on Ilomäki et al.'s (2016) model of DC. Their model is explicit enough to initiate discussions between various cultures but flexible enough to consider DC by ECE and DL perspectives as well. Importantly, the idea of the model is not to serve curricula analysis in detail but give structure to expand the elements of DC with context-dependent aims and age-appropriate examples. As a flexible model, it gives room to combine DC and DL perspectives as a ground to outline recommendations broadly. This is especially important in this research since DC is widely used concept in European context, including Finland (Redecker & Punie, 2017) while DL is more often used concepts in Australian context (Fox & Diezmann, 2017). In this article DC is an umbrella term including definitions of literacies, like media literacy and information and communication literacy. Also, digital technology is an umbrella term including devices, applications, hardware, software, ICT, computers, tablets, smart toys, robotics, and so forth. In essence, while it is a sub-concept of technology, it refers to *digital* technology.

According to Ilomäki et al. (2016), DC involves four elements: learning technical skills and practices, applying digital technology, conceptualizing the phenomena of digital technologies, and motivation to participate and engage in a digital culture. Since DC and DL are overlapping concepts, the elements of DC in this paper have similarities with DL dimensions, originally literacy dimensions developed by Green (1988), which are operational, cultural, and critical dimensions (i.e., Colvert, 2020; Marsh, 2016). Furthermore, Kumpulainen et al. (2020) have added creative dimension into DL. All these dimensions are included in Ilomäki et al.'s (2016) DC elements.

The **first of DC elements**, *technical skills and practices,* form a central basis for DC. They are not adequate in themselves, but, as defined by Ilomäki et al. (2016), they are a necessary foundation for the other elements of DC. In the case of children, the skills needed to use technology include, for example, the ability to use a mouse and touchscreen (Hsin et al., 2014). Making movies and animations, drawing, and printing pictures, and using computers and tablets are activities that illustrate relevant areas of such skills and practices (Jack & Higgins, 2019a). The ability to search for information and use digital maps and simulations (Ampartzaki & Kalogiannakis, 2016) are also examples where children need relevant technical skills and practices.

Research on children's use of digital technology at home and in ECE settings has increased (Kewalramani et al., 2020, 2021; Marsh et al., 2018), but few studies focus on the learning of technical skills and how to foster these skills. Because these skills create the foundation for other elements of DC (Ilomäki et al., 2016), it is important to pay attention to them and ensure that all children have equal opportunities to foster their competence (United Nations Sustainable Development Goals Together 2030 Agenda [UN SDG], 2019). Generally assumed idea in ECE is that children learn technology skills and knowledge through play. Although, this idea is still not well documented in the literature (Arnott & Duncan, 2019, Arnott & Yelland, 2020; Edwards & Bird, 2017). Overall, given the lack of current research regarding how children learn technical skills and practices, informative curriculum guidelines for teachers' implementation of DC and support of children's technical abilities are important but challenging to establish.

The second element presented in Ilomäki et al.'s (2016) model shows that DC goes beyond mere mastery or control of digital tools and practices. It includes an ability to *apply digital technologies in meaningful ways and as appropriate tools* for working, studying, and various activities in everyday life. Hsin et al. (2014) propose that children's learning with technology is conditioned by several factors, which can be categorized as aspects relating to children, adults, and technology. It is critical to attempt to foster children's understanding of the role of technology in their learning despite the complexity of the relationships between digital technology use and learning. Therefore, EC educators have different responsibilities regarding digital technology in education; they should not only use digital technology when teaching, but they should support children in developing their abilities and understanding of how to apply digital technologies now and in the future.

A promising approach to applying digital technology involves combining digital and traditional activities and tools (Ward, 2007). Nevertheless, the results confirm the importance of developmentally appropriate technology use with children that both respects the unique challenges presented by children's levels of development and capitalizes on children's natural desire to construct knowledge and solve problems (Rosen & Jaruszewicz, 2009) actively and collaboratively. There is evidence supporting that EC educators have controversial perceptions of what developmentally appropriate practices are for young children in relation to digital technology (Blake et al., 2011). Therefore, providing an overview of the possibilities of digital technology for young children in curricula will likely support teachers in making better use of digital technology in ECE and support them in integrating digital technologies into teaching and learning practices.

A further aspect in applying digital technology to learning in the ECE sector emphasizes inquiry as a basis for children's learning (Havu-Nuutinen et al., 2017; Wang et al., 2010). This includes facilitating children to learn to apply digital technology for "doing" research. Contemporary research focuses on considering digital technology as a means for helping children's ideas to emerge in inquiry-based investigations and offering a context for a discussion among children and educators (Kalogiannakis et al., 2018; Kermani & Aldemir, 2015). In this process, research has shown that well-designed technological environments with careful parental monitoring and teachers' guidance increase the level of understanding of complex concepts (Ucar, 2015). Hence, there is an urgent need to explore ECE curriculum frameworks and guidelines to be able to do so.

Wang et al. (2010) underline that children naturally explore and learn about their environment through inquiry, and technology can enrich and provide structure for problem contexts, facilitate resource utilization, and support cognitive and metacognitive processes. Asking questions about an inquiry process and the topic that is under study is a vital but not easy task to accomplish, even for primary school pupils (Pöntinen et al., 2019). This has also been noticed, for example, in children's use of educational magic toys; children played interactively with them, but interaction with multimedia and questioning remained limited (Yilmaz, 2016). Therefore, when enabling access to resources of various perspectives and qualities, activating children's own and shared problem exploration and participation is vital. From this point of view, existing studies suggest that children actively use multimedia tools and educational applications, but they need support in asking and learning to ask questions.

The third element involved in the definition of DC is teaching the *conceptualization of the phenomena of digital technologies* (Ilomäki et al., 2016). It consists of wide-ranging and multidisciplinary aspects such as the consideration and observation of the ethical issues, computational thinking, and basics of robotics. They seem to be loosely related to traditional ECE practices and may be difficult for young children to handle. For this reason, it is necessary to teach young children not only to use digital devices and applications, but also to develop understanding and awaken attention what algorithms are and how they are utilized in digital devices (Manches & Plowman, 2017). Results from empirical studies (e.g., Edwards & Bird, 2017; Sullivan & Bers, 2016) shows that young learners can understand the theoretical concepts and functions of digital technology. Kermani and Aldemir (2015) found that if teachers incorporated technology in the daily happenings of their inquiry classrooms, children started using technology-related phrases such as "let's look at the Internet" or "googling" with increasing frequency to investigate different concepts related to their topic of study.

Previous research shows that the curricular integration of digital technology tools can have dual and wide aims in teaching DC. For example, Jung and Won (2018) suggest in their review article that robotics is used as a means to support the teaching of other subjects, and robotics is used as a tool to teach robotics itself. This refers to learning concepts (such as rotation) through a rich process of creation in both the physical and digital worlds. It requires that children actively engage in problem-solving through building a robot, planning its actions, using physical objects (like wooden blocks) or the computer screen to construct programs, and iteratively improving the robot and programs (Bers et al., 2014).

As a consequence, DC can be a subject with an independent curriculum; however, at the same time, its elements can be a sub-discipline to teach concepts and practices that the STEM disciplines aim to teach, such as early literacy and numeracy (Jung & Won, 2018). Therefore, children's familiarity or unfamiliarity with the use of technology should be considered when assessing study outcomes. This means that children might first need time to learn to use digital technology per se to apply it for learning more complex content.

The three elements of DC presented above–learning technical skills and practices, applying digital technology, and conceptualizing the phenomena of digital technologies–lay the foundation for a **fourth element**: motivating people to engage in digital culture (Ilomäki et al., 2016). Thumin (2012) suggests that digital culture includes attitudes and social issues following from the affordances and restrictions of digital technologies. This means also that digital technology shapes everyday life. Because children regularly use the internet at home to play, communicate, and explore (Jones & Park, 2015), meaningful digital technology use in ECE could refer, for example, to providing richly situated learning experiences, such as virtual field trips

(Jones & Park, 2015), maker pedagogy (Wohlwend et al., 2016), and virtual reality, augmented reality, and virtual worlds (Bailey & Bailenson, 2017; Oranc & Kuntay, 2019; Yilmaz, 2016).

However, digital technology use in ECE has been a debatable topic. Some authors (e.g., Blake et al., 2011; Hatzigianni & Kalaitzidis, 2018; Mantilla & Edwards, 2019; White, 2015) argue that ECE professionals should both recognize the role of technology as developmentally appropriate practice and develop their skills in using it in a child group setting. Therefore, supporting early childhood (EC) educators to see digital technology as an integral component of developmentally appropriate practice for young children is needed (Parette et al., 2010).

These findings suggest that EC educators think that certain technologies are more appropriate for children to use than others. Since the definition of technology varies among researchers, comparisons between research results regarding developmentally appropriate technology becomes challenging. However, many EC teachers are not ready to integrate computers into the classroom (Chen & Chang, 2006; Ogegbo & Aina, 2020), which demonstrates that there is a need for curriculum guidelines that support teachers in finding age-appropriate ways to integrate technology into the classroom. Toward this end, the curriculum should also involve new forms of technology and have, for example, a game-based scenario at its core (Barab & Dede, 2007). This refers to considering "digital learning as a way of being" instead of the notion of just integrating digital technology into teaching and learning practices. For example, learning to code in EC can provide a pathway for young children to express themselves creatively as well as gain problem-solving and critical thinking skills through using technological tools added to existing classroom curricula. Innovative technologies used with age-appropriate curricula can teach children about the digital elements of our world along with skills that are beneficial beyond the computer screen (Kazakoff, 2015).

In sum, a DC framework is an ontological concept that includes not only an understanding of the social nature of knowledge construction but also of the ethical consequences of digital practices and one's own engagement. This kind of holistic approach supports the global understanding of quality ECE by fostering a holistic and equitable approach to life (see Alexiadou & Stadler, 2020). Recognizing culturally significant aspects is essential when aiming to develop policies and practices that lead to change.

Also, it is important to understand the differences in technology use and its relation to DC development, as the current research calls for understanding a larger picture of technology use in ECE. Hence, there is an urgent need to explore the holistic role of DC in the ECE curriculum frameworks. In this paper, a strategy for meet the need of extending understanding of DC in ECE is to investigate the role of DC in two national settings and how these are similar and different. In doing this, it becomes available to identify strengths and shortcomings of existing curricula, which in turn can be taken a basis to outline holistic recommendations for fostering children's DC in ECE.

MATERIAL AND METHOD

Document analysis is a systematic procedure of reviewing documents with the aim of gaining understanding and developing empirical knowledge (Bowen, 2009). For our purposes, document analysis was applied to produce a rich description of the role of digital competencies in two different national curricula. The method provided a culturally contextualized but internationally conceptualized approach to understanding an internationally significant topic (see Arrabal & Zhang, 2016).

Data and Data Analysis

Data for this research were the national core curriculum for ECE in Finland and in Australia. Specifically, this includes two digital documents written in English: *the national core curriculum for EC education and care, 2018* (Finnish National Agency for Education, 2018) and *belonging, being, and becoming–the early years learning framework for Australia* (Australian Government Department of Education and Training, 2019). The first document is the core curriculum document in Finland and the second in Australia. Unfortunately, information of page numbers in the English version of the Finnish curriculum was missing, but the length of the Finnish language version of the curriculum in PDF format was 63 pages. The length of the PDF version of the Australian curriculum used in this research was 51 pages. Later we use abbreviation FNAE (2018) to refer to the English version of Finnish ECE curriculum text and DET (2019) to Australian. Furthermore, EYLF refers to Australian early years of education in general. Data were guiding documents of national educational policy and presented the ideology of ECE in the country (Joseph, 2011).

Early Childhood Curricula in Australia and Finland

The Australian EYLF forms the national curriculum. It is built on the idea that the lives of children (0-5 years old) are presented by belonging, being, and becoming. Children develop their interests and build their own identities and perceptions of the world by participating in everyday life (DET, 2019). The five learning outcomes are as follows: "have a strong sense of identity"; "are connected with and contribute to their world"; "have a strong sense of wellbeing"; "are confident and involved learners"; and "are effective communicators." These support children to achieve the highest expectations for all learning (DET, 2019, p. 8). In particular, the learning

Table 1. Categorization of data according to Ilomäki et al. (2016)

Element	Name
Element 1	Learning technical skills and practices (6/9)
Element 2	Applying digital technology (20/14)
Element 3	Conceptualizing the phenomena of digital technologies (11/5)
Element 4	Motivation to participate and engage in digital culture (10/13)

Note. In the parentheses the frequencies of the analysis units, first Finland then Australia

outcome connected to effective communication offered relevant data for our research. Children's learning is promoted through the planning and accomplishing of learning through play and intentional teaching.

In Finland, the ECE national basic curriculum (FNAE, 2018) is based on the integration of subjects. In Finland, children between the age of one to six can attend ECEC programs. Underlying values of the curriculum are the intrinsic value of childhood; supporting the children's growth as human beings; the rights of the child; equity, equality, and diversity; diversity of families; and a healthy and sustainable way of living. ECE creates a basis for the development of children's interdisciplinary skills by applying knowledge and skills, values, and attitudes in different contexts. These competencies are thinking and learning; cultural competence; interaction and self-expression; taking care of oneself and managing daily life; multiliteracy and competence in ICT; participation; and involvement. Transversal competences form a continuum to the next school level. Especially those sections of the curriculum where multiliteracy and information and competence in ICT are discussed provided relevant data for this research. The ECE core curriculum defines the learning environment in terms of five different learning areas: "rich world of languages"; "diverse forms of expression"; "me and my community"; "exploring and interacting with my environment"; and "I grow, move, and develop." All in all, education, instruction, and care are seen holistically in Finland's ECE curriculum. Furthermore, the Finnish national curriculum for ECE is very wide and general in nature. Therefore, particular, and detailed objectives and approaches are defined in local curricula and strategies created by teachers themselves. In addition, each child receives an individual EC and care plan, which outlines a child's individual strengths, objectives, support, and so forth (FNAE, 2018).

Data Analysis

For our study, the qualitative theory-guided content analysis proceeded in four phases. First, both curriculum texts were read through by the researchers to identify key content for DC. A coding schema was created to compile the initial expressions of the selected analysis areas (Ilomäki et al., 2016), using combinations of the following key terms to identify descriptions of ICT/digital learning: *ICT, information technology, and digital technology, DC, DL, media,* and *media literacy.* Second, original sentences were collected from the curricula and coded using Atlas.ti software. The unit of analysis (n=78) varied from a couple of words to a few sentences. Third, the codes were categorized according to the elements of DC (Ilomäki et al., 2016; see **Table 1**) and conceptualized. Two researchers conducted the analysis of both national curricula, which was then mutually discussed by other respective researchers from both Australia and Finland. Some modifications were made, such as moving some unit of analysis from one category to other category. Finally, after the separated analysis process, the coding schemas were merged to make the comparative analysis, and the main findings were discussed and interpreted together, in line with the four elements of Ilomäki et al.'s (2016) DC analytical framework (**Table 1**).

In the following section, the results obtained are presented according to Ilomäki et al.'s (2016) elements. Quotations from the Finnish curriculum are marked with a paragraph number, and those from the Australian curriculum are indicated with a page number, as cited in their respective framework documents.

RESULTS

Learning Technical Skills and Practices (Element 1)

Both the Australian EYLF and the Finnish ECE core curriculum provide scarce information about the learning goals connected to basic technical skills and practices. With careful examination, the content of the analyzed curricula could be divided into three main types according to their focus on fostering children's management and operating skills.

First, there are recommendations that ICT devices, services, games, and media should be used in ECE, but goals are not expanded in detail. Instead, as is illustrated in the following, in Finland, the basics of technical skills and practices are seen to lie in familiarization with different objects:

> "The instruction includes familiarization with different ICT devices, services, and games" (FNAE 4.5).

> "Children familiarize themselves with ICT devices and their functions" (FNAE 4.5).

In the Australian EYLF, orientation to objects and devices is also defined as a goal of ECE. A concrete

example of this is the following: "Educators promote this learning, for example, when they provide children with access to a range of technologies" (DET, 2019, p. 47). A concrete aim is to support children to "use information and communication technologies to access images and information" (DET, 2019, p. 47). Interestingly, these explicit learning outcomes relating to "children use information and communication technologies to access information, investigate ideas, and represent their thinking" (DET, 2019, p. 47) are missing from the Finnish core curriculum text.

Second, a general overview and reasons for using different kinds of media content were implicit but narrow in scope in the curriculum texts. The Finnish curriculum states that "text may be, among others, written, spoken, audiovisual, or digital" (FNAE 2.7), and Australian EYLF demonstrates that "Many texts are multimodal, integrating images, written words and/or sound." (DET, 2019, p. 42). Thus, both curricula describe what multimodal texts are in general but do not define what skills and practices children need in using them.

Third, careful examination reveals that the learning of principles in digital communication is also one aim of the curricula. The Finnish curriculum mentions the goal of using and producing different kinds of messages, including digital ones. On this account, fostering children's ability to produce a diverse range of messages is one principle in Finnish ECE. In the Australian EYLF, mastery and control of digital tools regarding digital communication can be interpreted from the following extract: "Digital technologies can enable children to access global connections" (DET, 2019, p. 18). Furthermore, it is a set learning outcome that "children are effective communicators" (DET, 2019, p. 47) and a general goal that children use ICT to represent their thinking. However, clear, and concrete examples of what technological skills and practices are essential for children to learn are not mentioned in the Australian EYLF.

Applying Digital Technology (Element 2)

In both curricula, applying digital technology reflects the combination of goals related to fostering children's skills and practices in creating digital content as well as the benefit of using digital tools in learning. To concretize these aims, the teacher's role is introduced similarly in both countries: Teachers are guided to implement experimenting activities to encourage children to take advantage of different technologies in a variety of everyday and learning activities.

In Australia, the guidance offered for experimenting indicates that it should be done with different technologies, and children should use ICT to design, draw, edit, reflect, and compose. Similarly, in Finland, children are meant to "experiment with various methods, tools, and materials for creating an image, for example, painting, drawing, building, and making media presentations" (FNAE 4.5). This combination of producing digital content and experimenting activities demonstrates that the curricula guide teachers to notice broad and complex perspectives in fostering children's competence in applying digital technology. The Australian EYLF aims for children to "identify the uses of technologies in everyday life" (DET, 2019, p. 47), and the Finnish curriculum notes that the "role of ICT in daily life is examined and considered with the children" (FNAE 2.7). Thus, instead of favoring single tools, a focus on integrating digital tools and producing digital content in many media formats in many different settings is supported in both curricula.

The Finnish ECE curriculum has technology education as a formal learning domain, paying close attention to providing children with a capacity to observe, analyze, and understand their surroundings. One aim, among others, in technology education is to create the space and conditions for children "to observe technology in the environment and to come up with their own creative solutions" (FNAE 4.5). However, the Finnish curriculum defines the role of creativity ambiguously, and it remains unclear whether the idea of developing creative solutions refers to designing concrete technological objects or developing skills and practices related to innovative learning processes.

A tendency toward making directly observable links between creativity and abilities to apply digital technology is missing from the Australian EYLF. However, exploring "ideas and theories using imagination, creativity and play" (DET, 2019, p. 40) as well as "experiment with different technologies" (DET, 2019, p. 40) are presented as equal but separate subgoals related to learning outcome number 5: "children are confident and involved learners." To promote this learning outcome, the teacher's role is, for instance, to "introduce appropriate tools, technologies and media and provide the skills, knowledge and techniques to enhance children's learning" (DET, 2019, p. 40). Thus, relying on technologies in the process of creating space for children's creativity is also indirectly considered in the Australian EYLF.

Specific aspects of the Australian EYLF encourage the use of ICT "to investigate and problem solve" (DET, 2019, p. 40) and "explore diverse perspectives" (DET, 2019, p. 47). Furthermore, one aim is that children learn to investigate ideas, represent their thinking, and make meaning by using ICT-based resources. The Finnish curriculum stresses that working methods should be functional and provide children with natural ways of learning. In practice, "ICT is utilized in the activities" (FNAE 4.3), and it is seen as important that the personnel "guide the children to experiment with and use different working methods" (FNAE 4.3). Furthermore, "to ask questions and express wonder as well as to explore and solve problems" (FNAE 4.3) are examples of important

tasks in Finnish ECE. The above-presented aims demonstrate that both countries clearly stress that digital tools provide an important dimension to children's learning in ECE. Furthermore, experimenting with working methods calls for teachers to commit to the idea that digital tools provide a means for developing learning methods in which children are active problem solvers and investigators.

From the curricula, it is apparent that experimenting is an approach to fostering children's abilities and practices for applying digital technology to versatile learning activities. Against this background, experimenting leads to children practicing the ability to judge their own performance in digitalized environments. Although the curricula do not explicitly present this idea, careful examination of the texts supports it. In more detail, the Australian EYLF states that one example of promoting children's learning is to encourage them to "take appropriate risks in their learning" (DET, 2019, p. 38) and "provide the skills, knowledge and techniques to enhance children's learning" (DET, 2019, p. 40). These are clear examples of practices to encourage children to expand their thinking of how they work and learn. In a similar way, the Finnish curriculum stresses supporting children to develop as thinkers and learners. The Finnish curriculum explicitly mentions that "versatile working methods are not only a vehicle for, but also a target of learning" (FNAE 4.3) and describes that in ECE, children are "guided to use different ways of learning" (FNAE 2.6). In summary, the analyzed curricula represent educators' duties to help children develop skills and practices for applying digital technology in versatile ways, not only by utilizing digital tools in teaching and learning activities but also by fostering children's abilities to recognize how they learn and helping them expand their ways of working.

Conceptualizing the Phenomena of Digital Technologies (Element 3)

The level of the conceptualization of the phenomena of digital technologies appears in both countries, especially from the point of view of media education. Both curricula highlight the importance of developing children's source and media criticism:

> "Children practice their developing source and media criticism" (FNAE 4.5).

> "In an increasingly technological world, the ability to critically analyze texts is a key component of literacy" (DET, 2019, p. 41).

A comparison of the analyzed curricula shows that content related to media risks is missing from the Australian EYLF. The Finnish ECE core curriculum emphasizes the importance of media reliability, responsible use of media, and safety issues with ICT. Personnel are urged to guide children in safe use of ICT in a rich textual environment:

> "The children are guided in using media responsibly, taking into account their own and other people's well-being" (FNAE 4.5).

Except for the media aspects, both curricula offer few details about certain dimensions or phenomena of digital technology. This lack of defining what dimensions or phenomena digital technology actually entails leads the curricula to speak mainly about tools, devices, programs, games, toys, and texts in general terms. However, there are some exceptions relating to aims to foster children's abilities to critically evaluate digital technologies. The Finnish ECE curriculum notices that the goal is for "personal experiences [to] help children form an understanding of the fact that technology is an outcome of human activity" (FNAE 4.5). Furthermore, it is suggested in the Finnish ECE curriculum that particular attention should be paid "to the safe use of machines and devices" (FNAE 4.5). Although safety, responsibility, and wellbeing relating to media use and seeing technology as a result of human activities are missing from the Australian EYLF, it is implied that through ICT use, children "make sense of their world" (DET, 2019, p. 47).

A comparison of the Finnish and Australian curricula reveals that descriptions of what children should learn and engage with using ICT/digital technologies vary. Despite the differences between the curricula, a shared vision of the process of supporting children's growth and cognitive learning can be viewed. This is to enable children to make sense of the world they live in, which requires teachers to recognize that digital technology has an impact on how the world is viewed by the children (e.g., Wang et al., 2010; Kazakoff, 2015).

Motivating Others to Participate and Engage in Digital Culture (Element 4)

Within the concept of a digital culture, we can explore the effects digital technology has on human interaction (Deuze, 2020). As this element builds upon previous elements (Ilomäki et al., 2016), many aspects connected to motivation to participate and engage in digital culture are already mentioned in them. In both curricula, connecting everyday life and digital technology can be interpreted as ways to motivate children's participation. A further aspect emerging from the curricula is that connecting play and toys is a way to motivate and engage children in age-appropriate ways (e.g., Yilmaz, 2016). The Australian EYLF integrates technologies into "children's play experiences and projects" (DET, 2019, p. 47), meaning, for example, to "use real or imaginary technologies as props in their play." In the Finnish core curriculum, play is linked to children's learning as well. In this respect, children are engaged in learning when

"producing media content is experimented with playfully … in safe environments" (FNAE 4.5). A practical example is that "technological solutions available in the surroundings, such as toys, can be utilized in the activities" (FNAE 4.5). As shown, the analyzed curricula offer pedagogical tools and strategies for supporting children's engagement through play and using interesting play-based resources to complement their learning environment.

In contrast, providing children with amusing or enjoyable experiences is construed in the Australian curriculum as a way to promote children's engagement. It clearly describes that "engag[ing] with technology for fun and to make meaning" (DET, 2019, p. 47) is a way to promote children's learning through fun rather than concrete ICT-based play experiences. Interestingly, the Finnish curriculum does not explicitly see amusing or enjoyable experiences as providing opportunities to foster children's engagement.

The social and cultural dimension in children's everyday activities can be seen in both curricula as a motivational aspect in early experiences with digital technology. In the Australian EYLF, digital technology is seen as an opportunity for children to participate in global networks, experience materials, and develop new ways of thinking. Also, technologies promote collaborative learning and cultural awareness, as well as interactions between children and between children and educators:

> "For example, digital technologies can enable children to access global connections and resources and encourage new ways of thinking" (DET, 2019, p. 18).

> "Encourage collaborative learning about and through technologies between children, and children and educators" (DET, 2019, p. 47).

Similarly, in the Finnish ECE core curriculum, collaborative working is seen as an important part of ICT use in education. For example, promoting children's curiosity by structuring social experiences in which children actively engage in inquiry activities together is mentioned in the curriculum: "Children are encouraged to ask questions, find explanations together, and draw conclusions" (FNAE 4.5).

Being aware of the relevance of the skills and knowledge of both the personnel and the children is an aspect mentioned in the Finnish curriculum as well. This means not only considering the development of children's skills and knowledge but also that teachers are encouraged to use their own and children's digital experiences and abilities in planning working methods:

> "The competence of personnel and children is utilized in using the working methods and new working methods are experimented with and developed" (FNAE 4.3).

In Australia, EC educators and children sharing experiences and abilities in teaching and learning when applying digital technology in different activities is noticed as well. Interestingly, attention is also paid to teachers gaining self-confidence. Instead of assuming that teachers feel sure of themselves and their abilities, educators are encouraged to "develop their own confidence with technologies available to children in the setting" (DET, 2019, p. 40).

DISCUSSION

The aim of this comparative curriculum study was to better understand how objectives and content of DC are defined in ECE. The results showed that in Australia and Finland theoretical basis of DC was present. Although aims, content, and practical guidelines on the curricula were slightly unclear, objectives and content of DC referred to

1) technical skills and practices,
2) applying digital technologies,
3) evaluate digital technologies critically, and
4) motivation to participate in a digital culture.

Elements of DC in the ECE Curricula of Australia and Finland (RQ1)

Although access to technologies gives teachers the opportunity to integrate technology into the classroom, personal attitudes predict the actual adoption and use of technology: teachers who strongly agree that technology can benefit children's learning use technology more often (Blackwell et al., 2014; Jack & Higgins, 2019b; Marklund, 2020). Against this background, in curriculum design, paying attention to the unique pedagogical characteristics of ECE is vital (Mertala, 2020). One important aspect to consider is that teachers emphasize caring with the youngest children, but promote education with older children (Mertala, 2020); hence, the curriculum framework should provide support for teachers not only by clearly indicating the content areas and targeted learning outcomes in general, but also by supporting teachers to orient appropriate teaching and learning practices for children of different ages. This important aspect was missing from both curricula and therefore we recommend adding more appropriate teaching and learning practices for children of different ages in curricula texts. This was especially evident when looking at the picture provided by the curricula on learning basic technical skills and practices (element 1) in ECE. In the curricula, learning skills and practices with different types of digital tools and media content focused on giving children opportunities to become familiar with digital tools. However, curricula texts had narrow and vague impressions, which do not

give enough support for teachers; that is, concrete guidelines for implementing the learning of basic technical skills and practices are missing. Neither does previous research give clear directions or guidance on how to improve or concretize these. The results of this study further stress the importance of doing research on how to support children's technical abilities and DC, and this cannot be achieved in silos. Teachers' digital competency also needs further research in relation to upskilling their capacities in supporting children's digital skills (Arnott & Yelland, 2020; Palaiogolou et al., 2021).

Whereas descriptions of and content for teaching basic technological skills and practices were scarce, the element of applying digital technology (element 2) was the strongest/widest in both curricula. The curricula suggested that fostering children's DC takes place through introducing, using, providing, and integrating digital technology into teaching and learning practices in ECE, as well as encouraging children to explore the role of digital technology in everyday activities and in the learning process. When children are allowed to examine and reimagine their own community and environment, they can start to solve problems of real significance in their lives (Benenson, 2001). As many scholars have reported, teaching the content of DC is more of a holistic process than a single act or learning outcome (Newhouse et al., 2017) and does not depend on whether digital devices are used or not. The teaching of DC can take place, for example, by using digital photography and giving space for children to talk about their photos in a classroom (Serriere, 2010), as well as by fostering children's problem-framing and problem-solving skills and conducting collaborative discussions (Wyse & Ferrari, 2015).

The need to include ICT and creativity, especially in European curriculum texts, has been increasingly recognized (Wyse & Ferrari, 2015). The idea that creativity is a feature of teaching and learning DC in ECE settings has also been highlighted in our comparative analysis study. The natural place for creativity in DC appears to be in alignment with teachers' roles in supporting children's application of digital technology. The process of creating the conditions for enabling children's DC and creativity requires strategic thinking from the perspectives of international curriculum frameworks in ECE (Caena & Redecker, 2019). In this digital era, we should consider children not as vulnerable and at risk but as capable and potent in a technological landscape (Craft, 2012). This study demonstrates that involving EC educators in upskilling and upscaling their existing practices enhances not only their own, but also the children's experiences and abilities in developing digital working methods, identifying forms of creativity, and being able to shift from what are existing working methods to what might be child-initiated digital ways of working. As presented in the current curriculum analysis, we recommend that DC teaching and learning should be holistically implemented in the co-creation of activities to familiarize and encourage children with experimental and inquiry-based approaches and to make learning meaningful by using ICT.

Conceptualizing the phenomena of digital technologies (element 3) remained vague in both curricula. The curricula especially stressed media education. Interestingly, explicit descriptions, aims, and goals connected to computational thinking or robotics were missing. However, they can be considered representing currently evolving digital phenomena in ECE (e.g., Bers et al., 2019; Mertala, 2021; Vartiainen et al., 2020). There are tools specifically designed for primary education to address them, and research findings have highlighted the positive effects of addressing them in children's learning (e.g., Bers, 2018; Papadakis, 2020). Although both curricula recognized the importance of media education, some viewpoints were not explicit. The curriculum analysis strongly followed the content that has been indicated as significant by media education curriculum experts (Fedorov et al., 2016). The priority of the content of media education in ECE stress types, genres, and functions of media and practicing media criticism. However, our analysis indicated that learning outcomes were not precisely mentioned for children's media criticism. If initial steps towards learning media criticism and related learning objectives and activities do not become clear for EC educators, it can be confusing and leave room for misinterpretation (Mertala, 2020). Based on these results, we recommend clarifying types, genres, and functions of practicing media criticism in curriculum texts and include current technology trends giving examples such as computational thinking and robotics.

Motivating others to participate and engage in digital culture (element 4) emerged in the curricula in connection with everyday life and digital technology. Contradicting previous studies that claim that curriculum documents separate pedagogical perspectives on play from the use of technologies in ECE (Edwards, 2013), both analyzed curricula integrated play and digital technologies. Although play and learning DC were combined, this study does not suggest that curricula are the best sources of play pedagogy. Rather, since educators and preschool student teachers struggle to bridge the gap between pedagogical understandings of play and the use of technologies (Lindahl & Folkesson, 2012), based on our curriculum analysis we suggest it would be necessary for curricula to explicitly describe the pedagogical means and aims for educators to create the conditions for enabling children to become digitally competent through play. As such, the current curriculum analysis continues the debate that pedagogical practices should begin to integrate play and

Table 2. Similarities and different emphases of DC in Finnish and Australian ECE curricula

Element of DC	Similarities in both curricula	Different emphases in FIN/AUS curricula
Learning technical skills & practices	Focus is giving children opportunities to become familiar with digital tools; however, not giving enough support for teachers for implementing learning of basic technical skills & practices	FIN: Digital communication AUS: To use ICT to access information, investigate ideas, & represent thinking
Applying digital technology	The strongest/widest element in both curricula, stressing explorative working methods but defining vaguely creative & play based methods	FIN: Observe, analyze, & understand technology in environment AUS: -
Conceptualizing phenomena of digital technologies	Stressing media education; however, without explicit descriptions of aims & goals, areas of computational thinking & robotics were missing	FIN: Safety use, responsible use of media, critical thinking of digital technology AUS: Make sense of their world through ICT
Motivating others to participate & engage in digital culture	Connecting everyday life & digital technology, play, & collaboration	FIN: Digital collaboration & children's & teacher's partnership AUS: Engaging for fun & teachers' digital confidence

digital technologies more strongly (Arnott & Yelland, 2020; Edwards, 2013).

The Similarities and Differences in ECE Curricula of Children's Digital Competence (RQ2)

In curricula, having clear aims and goals is just as essential as establishing the big picture of educational aims (diSessa, 2018; Wang et al., 2018). Our research revealed that the curriculum frameworks did not provide a detailed list of requirements for specific digital contents, and even definitions of the learning content of essential digital phenomena remained minimal. As is seen the **Table 2**, both texts reflected a broad conception of DC (Ilomäki et al., 2016). All the analyzed elements of DC were presented in both curricula, but some differences between curricula were identified as well.

Recommendations

The role of a curriculum can be viewed from two perspectives; on the one hand, it orients teachers for planning and teaching (Branscombe et al., 2014; van den Akker, 2003, 2010), and on the other hand, it can be seen as a socio-political tool (McKernan, 2008). As practical tools for guiding children's DC, the curricula in this study could not be seen as sufficient. As mentioned earlier, the national curriculum frameworks do not provide a detailed list of requirements for specific digital content, and even definitions of the learning content of essential digital phenomena remain minimal. This might be due to the nature of curriculum texts, where impressions are "tight" and generic (van den Akker, 2010). Of course, there are also local curricula in Finland and in Australia that might open up these practical issues more, but then equality of learning may not be achieved, and it might depend too much on, for example, EC educators' attitudes to technology. Due to the autonomous nature of teachers' work in both countries and their critical role in facilitating children's digital competency skills, there may also be no desire to provide a precise or rigid framework for the use of technology. At the same time, however, it must be borne in mind that the curriculum should guarantee teachers' ability and creativity to develop their own teaching to meet the requirements of the digitalized world. That is why, for example, in Finland and Australia, programs and recommendations have recently emerged that open up the contents of the curriculum to be more concrete, especially from the point of view of digital learning for different age groups (Early Childhood Australia, 2018; Uudet Lukutaidot, 2021). We recommend that these documents should explicitly suggest the elements of DC in more detail in ECE practice and guide teachers to foster children's learning holistically. Concerning element 1 of Ilomäki et al. (2016), we suggest that breaking down implementation barriers related to attitudes of technology in ECE and emphasizing that it is valuable to teach technical skills in ECE. In addition, it is important to open up examples of core technical skills children should learn in ECE. Regarding element 2, we suggest that concrete examples of digital content creation, creativity, explorative working methos and digital play would be helpful for teachers in fostering children to expand their digital ways of working. We propose that conceptualizing the phenomena of digital technologies in element 3, call for teachers to lay emphasis on continuum in children's learning. Since children learn at home and within the ECE community, ECE practices should facilitate and help children's learning in the future. This means teachers being at least aware of new technologies and explore their potential applications in ECE together with children. Opportunities should be created for versatile learners to learn how to use technology and, by doing so, bring opportunities to participate in fostering a digital culture equally. This is connected especially on element 4.

CONCLUSIONS

Our study analyzed the role of DC in Australian and Finnish ECE curriculum texts to determine the similarities and differences between the curricula. This was done with a qualitative theory-guided content analysis according to the concept of DC (Ilomäki et al., 2016). Even though the results are based on the curricula of two countries, the analysis is done from the global point of view, while the Ilomäki et al. (2016) theory of DC is general not national. An analysis of the ECE curricula in Australia and Finland shows how DC appears in the curricula of small and large countries on the one hand, but also offers generalizable perspectives on the curricula of other countries. In the future, it would be important to study how DC appears in the curricula of other countries. The writing style of the curriculum texts is concise, which was one limitation from an analysis perspective. There could be references to more than one element of DC in the same sentence. The concepts referring to DC were also diverse. In these challenges, the perspective and discussion of several researchers helped. Despite above-described limitations, implication of this study related to successful application of DC theory (Ilomäki et al., 2016), which allowed for the identification of key elements of EC in ECE curricula in and between both countries. Further research using mixed methods should be conducted to compare with more data such as questionnaire and focus group feedback from teachers or parents to better understand the needs of ECE teachers' DC development and digital practice.

Curricula are important documents by which society expresses its expectations and goals for quality and accessible ECE. They also reflect social and political values (McKernan, 2008). The requirement for and model of transferable competence has widely permeated curricula around the world. These skills are also called 21st-century or future skills (e.g., Binkley et al., 2012; Kivunja, 2015). Digital skills and competence are closely related to these. At the same time, in line with the UN SDG's (2019) agenda, ECE curricula in Finland and Australia emphasize the creation of equal conditions for the holistic growth, development, and learning of the children involved. For these reasons, it is not insignificant how aspects of DC are presented in curriculum texts. Therefore, our critical analysis and proposed recommendations should not be neglected. For both teachers and children, learning digital competency skills is also relevant to the later school path for which ECE provides an important foundation. And, as we mentioned at the beginning of this article, today's children are experiencing a digital childhood where they also need DC to cope.

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