Education and Information Technologies
https://doi.org/10.1007/s10639-024-12646-7

Framing adequate digital competence in early childhood education

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Received: 23 August 2023 / Accepted: 21 March 2024

Abstract
Developing children's abilities to act safely, respectfully, and responsibly in digital environments has been an essential component of educational systems for all ages. This study aims to explore what adequate digital competence is in early childhood education and how preschool teachers characterise young children's adequate digital competence. The research seeks to address these questions by conducting in-depth interviews with 13 preschool teachers at three preschools in Sweden. The collected data were analysed using thematic analysis in accordance with the Grounded Theory perspective.

Preschool teachers characterize adequate digital competence in early childhood education as more than just a skillful and safe use of digital technologies. The study reveals seven key themes in which preschool teachers characterise children's adequate digital competence: (a) to become familiar with digital technologies; (b) to dare try digital technologies; (c) to use digital technologies; (d) to have a critical approach toward digital technologies; (e) to have ethical media competence, which includes moral, formal, and legal responsibilities; (f) to have problem-solving skills; (g) and to be producer, not just a consumer of digital technologies. By framing and exemplifying children's adequate digital competence, the findings of this study offer a potential framework for preschools and preschool teachers to foster children's digital competences at an appropriate level.

Keywords Adequate digital competence · Young children · Early childhood education · Preschool teachers · Digital technologies

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Published online: 23 April 2024

1 Introduction

What does adequate digital competence in early childhood education mean for young children experiencing a digital childhood? Numerous studies have documented the increasing screen time among young children, with over 80% of preschool children spending an average of 2–3 h per day on screens (Figueira et al., 2023; McNeill et al., 2019). Digital technologies have been now for some time an indispensable part of children's everyday lives while computational thinking and chatbots are already shaping and transforming their beliefs and behavioural patterns (Mills et al., 2023; Selwyn, 2012). With the continuing advances in digital technologies, preschools have been mandated to prepare children for the ever-changing information and knowledge-based society (Bourbour, 2020a).

The Swedish national digitalization strategy underlines the importance and value of developing children's abilities to act safely, respectfully and responsibly in digital environments (The Swedish National Agency for Education, 2017b, 2022). Early childhood education, accordingly, is obliged to ensure that all young children have the opportunity to develop what they describe as an adequate level of digital competence (The Swedish National Agency for Education, 2018). Equal opportunities in this context is concerned with children's right to an equal education (Kjällander, 2019). A growing body of literature, however, has been critical of the attempt to integrate digital technology into early education, arguing it can negatively affect young children's physical, emotional and social development (Selwyn, 2012; Stiglic & Viner, 2019; Zabatiero et al., 2018). These arguments are increasingly more apparent in the findings of other researchers, for instance, Lan et al. (2020) found that nearly three-quarters of young children in preschools in Hong Kong spend more than one hour per day on screens, which negatively affects their sleep duration and circadian rhythm.

The notion of developing children's *digital competence* to an *adequate* level, however, is rather vague (Olofsson et al., 2020; Su & Yang, 2023). Digital competence in general and teacher's professional digital competence in particular have been described and defined in a large number of studies and frameworks (see European et al., 2017; International Society for Technology in Education (ISTE), 2017; Koehler et al., 2013; UNESCO, 2018; Vuorikari et al., 2022). Many of these frameworks and models, such as the European Digital Competence Framework for Citizens (DigComp 2.2), stress digital competence and identify its key components. Nonetheless, in early childhood education, as far as we are aware, there are virtually no studies examining young children's digital competence and none that propose a framework for defining what that might be.

Developing children's digital competence to an adequate level is a context-sensitive notion encompassing a wide range of skills which can be defined and enacted in different ways. Thus, developing children's digital competence depends primarily on preschool teachers' agency (Bourbour, 2020b; Johnston et al., 2020; Lund et al., 2019; Stephen & Plowman, 2008). It also relies on the ways teachers translate the curriculum's goals, as indicated in the Swedish national strategy for digitalisation (The Swedish National Agency for Education, 2017b, 2022), into practices that are intended to develop children's digital competence to an adequate level. Along the

same lines, a report published by UNICEF shows that unskilled and unmotivated preschool teachers are the main barrier to developing children's digital competence (Nascimbeni & Vosloo, 2019). It seems self-evident that a preschool teacher's digital competence and the way they understand and conceptualize the role and value of technologies in early education inform if and how a child's adequate digital competence can be developed. There have been increasing calls, as results, for developing preschool teachers' digital competence (Forsling, 2023; Vidal-Hall et al., 2020).

The ways preschool teachers integrate digital technologies into their educational practices to develop children's adequate digital competence, however, can be influenced by other actors such as policy-makers, technology companies, content providers and parents (Selwyn, 2011). Their expectations regarding digitalization in early childhood education and their understandings of what adequate digital competence should be only adds to the complexity of characterising what adequate digital competence is in early childhood education and how preschool teachers' professional digital competences can be developed as part of a preschool digitalisation process (Forsling, 2023; Lindfors et al., 2021). Some of the definitions of digital competence and how it can be developed that these actors promote can be aligned with the commercial interests of for-profit entities (Selwyn, 2012).

Against this background, this study investigates the phenomenon addressed as developing children's adequate level of digital competence in early childhood education. It aims to explore what adequate digital competence is in early childhood education and how preschool teachers characterise young children's adequate digital competence.

2 Digital competence and adequate digital competence

Digital competence, one of the eight key competences for lifelong learning (European Commission, 2006), is a complex notion that extends beyond knowledge and skill. It "involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context' (The Organisation for Economic Co-operation and Development, 2005, p. 4). This competence has harboured a myriad of concepts and definitions, including digital literacy, ICT literacy, digital skills and 21st century skills (cf. Hatlevik & Christophersen, 2013).

However, a clear definition of what entail digital competence and what individuals should be able to demonstrate when engaging with digital technology is elusive and open to varying interpretations (Masoumi & Noroozi, 2023). In their review of literature on digital competence in higher education research, Spante et al. (2018) indicate that 'overall there is a striking tendency of using the concepts without any reference to the terms' meanings' (p. 5). They further pinpoint that over time these concepts have transformed from 'a solely operational and technical focus on technology use towards knowledge-oriented cognitive, critical and responsible perspectives' (Spante et al., 2018, p. 15).

The European Commission's definition of digital competence (European Commission, 2019), which addresses a wide range of technical skills and cognitive and socio-

cultural competences, has also worked to broaden the concept of digital competence. In the European Digital Competence Framework for Citizens, digital competence is characterized in a set of 21 competencies organized into five competency areas:

a) Information and data literacy: the ability to browsing, searching, filtering, evaluating, and organizing digital information and content.
b) Communication and collaboration: the ability to communicate and interact in digital environments, share resources on digital platforms, connect and collaborate through digital tools, and manage his/her digital identity.
c) Digital content-creation: the ability to create and edit digital content, integrate and re-elaborate digital content, program and coding, and deal with intellectual property.
d) Safety: the ability to protect personal data and privacy (competences related to cybersecurity), health and well-being and environment.
e) Problem-solving: the ability to identify needs and problems, and creatively use digital technologies to solve conceptual and technical problems.

These competency areas address technical, practical and attitudinal aspects of digital competence (Carretero et al., 2017) and can be graded on a six point proficiency scale ranging from foundation level (1) through to advanced (6) (Vuorikari et al., 2022). Digital competence, accordingly, entails the 'confident, critical, responsible and creative use of and engagement with' everyday digital technologies (Vuorikari et al., 2022, p. 2). Defining digital competence in this way may signify an epistemological shift, moving 'beyond acquisition of facts that are right or wrong, towards opportunities for self-generated ideas in digital spaces as people learn to make meaning in immersive virtual worlds' (Mills et al., 2023, p. 228).

As the European Commission's definition makes clear, digital competence is multidimensional, involving a number of complex skills that go beyond basic 'know-how'. This understanding - of digital competence as highly nuanced and complex - lies at the heart of many national and international digitalization strategies, including the Swedish national strategy for the digitalization of education (2017, 2022). These policies and strategies underline the importance of providing children and young people with the opportunity to discover and be able to learn to creatively use digital technologies in their everyday lives and the world around them. Despite this, the conceptualization of digital competence in early education remains ambiguous (Kontkanen et al., 2023; Su & Yang, 2023).

3 Contextualisation: Adequate digital competence in Swedish early childhood education

The Swedish preschool is based on a model that is labelled internationally as *educare* (education and care). This model combines care and teaching; it regards childhood as having value in itself and not merely as a time of preparation for adulthood (Masoumi, 2021; Pramling Samuelsson & Asplund Carlsson, 2008). The Swedish preschool learning environment is mostly informed by a socio-cultural perspective

which seeks to actively engage children in learning activities and to encourage them to construct and create their own knowledge through interaction with others in a social context (Author 2, 2020).

Informed by the European Commission's digital competence framework, The Swedish National Agency for Education (2017a) outlines four focus areas for the development of children's digital competence: (a) understanding the impact of digitization on society; (b) becoming familiar with and using digital tools and media; (c) having a critical and responsible approach; (d) solving problems and turning ideas into action.

These focus areas map a continuum of digital competence which can be seen as a part of a digital *Bildung*, a term used across the Nordic countries to describe 'how knowledge, competencies, skills and attitudes make it possible for us to function as citizens in an increasingly complex society' (Amdam et al., 2022, p. 18). Accordingly, developing children's digital competence is seen as a process which goes beyond children's basic use of digital tools (see The Swedish National Agency for Education, 2017b; The Swedish National Agency for Education, 2022). The Swedish National Agency for Education therefore presents adequate digital competence as a capability that is in constant flux, changing both in response to the evolving needs of society and the particular circumstances in which a child is located (Erstad et al., 2021; Olofsson et al., 2020). Developing digital competence at an 'adequate' level, accordingly, concerns not only children in early education but also preschool teachers, leaders, and other staff members.

4 Method

In order to examine this notion of adequate digital competence for early years education, this study adopted a qualitative approach and collected empirical data through semi-structured interviews with thirteen preschool teachers. The semi-structured interviews provide an in-depth insight into preschool teachers' lived experiences and perceptions as they characterise the phenomenon of children's digital competence (Gubrium, 2012).

4.1 The participants

The participants in this study were qualified preschool teachers from three preschools located in the central region of Sweden. The preschool teachers were located using convenience sampling. They were recruited by their principals, who identified members of their staff who belonged to a group of preschool teachers working with digitalization issues in preschools as a part of their professional development (Creswell & Creswell, 2018).

An overview of the interviews conducted with the preschool teachers is provided in Table 1. All of the participants were qualified preschool teachers with more than three years of teaching experience. Two of the participants were men and 11 were women.

Table 1 An overview of the interviews conducted with preschool teachers

Participating preschools	Preschool teacher	Length of interview	Date of interview
Preschool A	Teacher 1	58 min	8 November 2022
	Teacher 2	47 min	9 November 2022
	Teacher 3	55 min	10 November 2022
	Teacher 4	50 min	
	Teacher 5	43 min	
Preschool B	Teacher 6	45 min	3 December,2022
	Teacher 7	40 min	13 December 2022
	Teacher 8	52 min	14 December 2022
	Teacher 9	50 min	
Preschool C	Teacher 10	50 min	12 January 2023
	Teacher 11	55 min	17 January 2023
	Teacher 12	38 min	18 January 2023
	Teacher 13	40 min	24 January 2023

4.2 Data collection

One-on-one semi-structured interviews were conducted with the preschool teachers. Each interview lasted approximately 45 min and was conducted by both authors. An interview guide based on the research questions and a literature review was developed (please see appendix 1). This interview guide consisted of six open-ended questions designed to address what constitutes an adequate digital competence for young children and how it can be characterised in early education. During the interviews, the participant preschool teachers were encouraged to provide concrete examples from their teaching experience to illustrate their answers to the questions. To ensure the credibility and dependability of the study, the interview questions were expert-piloted by four experienced teachers.

4.3 Data analysis

The empirical data was recorded and subsequently transcribed verbatim. The transcribed data was then subjected to thematic analysis (Braun & Clarke, 2022) in accordance with the Grounded Theory perspective (Glaser & Strauss, 1999). The analysis procedure, guided by the steps proposed by Braun and Clarke (2022), is detailed below:

a) Addressing the aim of the study, in the analysis process, initially, the collected data were thoroughly read and reread to establish familiarity. To ensure a systematic examination of all collected data, the transcribed interviews were entered into a qualitative data analysis program, ATLAS.ti (Version 22).
b) In the next step, each of individual transcribed interviews were reviewed through open and selective coding where codes or unit of analysis were generated and selected characterizing young children's digital competence. However, the last four transcribed interviews did not generate any new codes. The analysis followed an inductive approach, incorporating line-by-line coding where the codes originated directly from the interviews.

c) Using an iterative process, the similar codes were merged into themes until all codes had been assigned or put into distinct themes.
d) Final themes were developed inductively through a careful examination of relationships among sub-themes and their connections to the identified codes. The process of thematically analysing of the data seamlessly continued throughout the writing of the study's final report.

In this analysis process, no theory or predefined coding scheme (Glaser & Strauss, 1999) was applied to the data collected. Instead, the data was used to explore and extract meaning from preschool teachers about what they considered to be adequate digital competence in early childhood education and how they characterised young children's digital competence.

4.4 Ethical issues

The ethical dimension of this study was conducted in accordance with Swedish regulations for ethical research (The Swedish Research Council, 2017). The preschool teachers taking part in this study, therefore, were given information about the terms and conditions of their participation in the study. In the letters sent out prior to interviews, the participants were specifically informed that they could withdraw from the study at any time and that the collected data would be confidential and used solely for research purposes. The names of the participating preschools and teachers, as well as their neighbourhoods have been changed in the final text.

5 Findings

The preschool teachers in this study considered the integration of digital technologies into their preschool teaching as an artifact that acted not only to mediate their educational practices but also to promote the equality of educational opportunities among children. All of the preschool teachers underlined the importance of developing children's digital competence as well as stressing the vital role that using digital technologies can play in children's learning and development.

The preschool teachers articulate *adequate digital competence* in early education as the digital skills, knowledge and attitudes that children should be able to acquire by the time they complete preschool. Adequate digital competence in early education is 'about understanding of digital tools [technologies]- grasping how these tools work, how can we use these to solve everyday problems, and what's okay to do with these tools?' (Preschool teacher 1).

One of the preschool teachers, when highlighting the complexity of defining young children's digital competence noted that 'I do know it [what adequate digital competence is], but it's hard to explain it. It's because it depends on the situation and the children. We're the ones [preschool teachers] who are deciding what is adequate for a one, two, three, four or five year old' (Preschool teacher 3).

Another preschool teacher, highlighting the increasing advances in digital technologies, said that 'it is difficult to define what adequate digital skills is'. In this context, one of the preschool teachers said that 'we try to update our skills based on what adequate digital competence is today, but maybe what we have today won't be relevant tomorrow…' (Preschool teacher 2). Such confusion, according to these preschool teachers, has led to discussions in their working teams about how they should develop children's digital competence in an adequate level. The preschool teachers perceive adequate digital competence in early education as a dynamic and complex set of skills that extends beyond children's readiness to understand and safely use digital technologies.

A number of the preschool teachers addressed the centrality of *educare's* notion in developing of children's digital competence. They said that adequate digital competence in early education is a challenging idea which cannot be separated from children's other competences. They, accordingly, stressed the need for a balance between analogue and digital experiences, arguing that children need to have opportunities for hands-on exploration and interaction with the physical world when developing their digital competences. Some of the preschool teachers further pointed out that analogue activities need to remain a core part of the work teachers do in developing young children's digital competences.

Analysis of the collected empirical data reveals seven distinct themes (see Fig. 1) that teachers characterize young children's digital competence.

5.1 To become familiar with digital technologies

The preschool teachers stressed that understanding digital technologies and becoming familiar with them was an important part of children's digital competence which needed to be adequately developed. Children need to get to acquire a basic understanding of digital technologies. They need to become familiar with what technology is and why and how it works. One of the preschool teachers addressing this notes that 'initially, we need to demonstrate [digital technologies] and explain how it can be done.'

By developing motivating learning environments, they helped children become more familiar with the potential uses technologies have and their possible risks. One preschool teacher explained how, by showing their children what a 'magnifying egg'

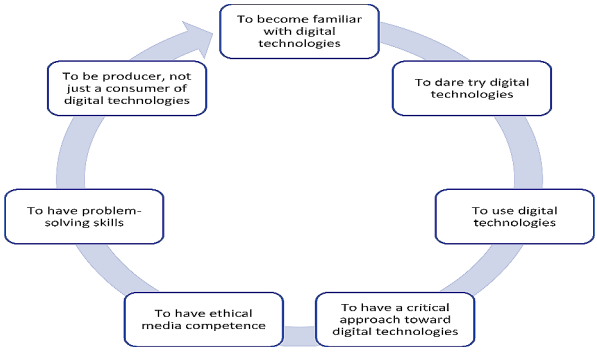

Fig. 1 Children's digital competence in early childhood education

does, helped them to get a closer look at the plants. By becoming more familiar with digital technologies, children have the ability to integrate it into their daily activities and play.

The preschool teachers noted that by making digital technologies available to children, they were able to create an environment where children could encounter them. Almost all of preschool teachers mentioned that in their department's children had access to digital technologies as in digital camera. One preschool teacher describes this:

> …There have been some instances where children have seen the [digital] camera, picked it up and then tossed it to one side. [In most instances] it isn't something that they play with much. I as a teacher show them what it is and how it can be used and then exemplify how you can take a picture…save it, then print a picture. Children can use the camera in the way they want. I can take a picture with a friend, if my friend wants, and I can save it for later. Then the children can demonstrate what they have learned and understood…. (Preschool teacher 5)

5.2 To dare try digital technologies

All of the teachers emphasized the importance of children's daring to try the digital technologies as an expression of adequate digital competence. Daring to try for these teachers involved taking the initiative to explore different technologies and experiment with them. They considered the provision of an environment where children 'can manage and test things without it feeling terribly scary' was essential. One preschool teacher said that children needed to step out of their comfort zone and that:

> Children should dare to try and not be afraid to make mistakes where they can learn new skills and adapt to new ways of doing things… That's the most important skill and of course I want to give the children as much as possible so that they can carry it with them in their 'backpacks', so to speak, when they move on. (Preschool teacher 3)

As this quote shows, children's digital competence begins with their curiosity and their willingness to try something new and different. Preschool teacher 9, while agreeing that children should dare to try digital technologies, stressed that there was no requirement for them to know everything about digitisation or to be able to master fully digital tools and programs.

5.3 To use digital technologies

Young children's ability to use digital technologies (to operate/use digital technologies in an effective way) was another aspect of adequate digital competence that emerged from the interviews with preschool teachers. According to Preschool teacher 6,:

> The children, quite simply, should be able use the tools…. [They should have] basic knowledge about different digital tools, for example, how to start one up, how to turn it off properly, for example, use elementary apps like that…. (Preschool teacher 6)

Preschool teacher 12, similarly, said that 'children need to learn how tablets can be used, it is our most frequently used digital tool, to take a picture, to write the alphabet, to read a book, to explore the facts and to listen to music'.

Several preschool teachers noted that children often had a wide range of experience with digital technologies at home, such as using different apps, playing games and watching movies. They felt that in the home digital technologies were mostly used to entertain children and that children largely used technologies on their own. In preschools, however, the teachers emphasized that children should use digital technologies only under a teacher's guidance. These teacher lead activities, thus, were centred on creative using digital tools in a way that these technologies contribute to children's development and not as a form of babysitter or entertainment. One of the preschool teachers noted that 'we use [Ipads] to underline and make clear for children what's ok [allowed] to do on an Ipad' (Preschool teacher 4).

5.4 To have a critical and responsible approach to digital technologies

Developing children's critical understanding of digital technologies and their use in different contexts and for different purposes was another aspect of adequate digital competence which underlined in the data collected. Preschool teacher 13 said that 'we should develop children's critical approach to digital technologies, their responsibility towards them'. The teachers stated that children encountered a lot of information in their everyday lives, information that was true and much that was based on fantasy or make-believe. This made it important that children developed the skills to critically and responsibly evaluate and use the information they encountered.

> Children should be provided with opportunities to develop their understanding of the digitization they encounter in everyday life and be given the chance to have a critical and responsible approach to digital technologies. (Preschool teacher 10)

In early childhood education, having a critical approach can mean thinking about what is genuine and what has been manipulated on a screen. Preschool teacher 7, for example, pointed this out and stated that:

> Children can't believe everything either…That's one of the hardest parts, I think… [in a teaching situation]. We manipulate pictures so that they couldn't be true. In one teaching situation I showed a picture of me standing in the hand of my colleague. In reality, I was sitting behind her at a certain distance and then the picture was taken. We showed this picture to four-year-old children saying look how strong she is. It's hard for children to understand that we manipulated the picture.

A key part of this critical and responsible approach to digital technologies is source criticism and source confidence, skills which seek to question the credibility and accuracy of provided information. As the quote above illustrates, the preschool teacher here is suggesting that by manipulating pictures and letting children explore the idea that what they are seeing on the screen may not be true, they are trying to develop children's critical approach to digital technologies. But as this quote also shows, grappling with abstract concepts like depth perception is hard for young children to understand. They need guided opportunities to concretize and exemplify different concepts and the creation of structured spaces for them to discover what is true and what is false.

To concretise this issue and to develop children's critical and responsible approach to digital technologies, a majority of the preschool teachers noted that they used a green screen where they could create and manipulate images and videos. Preschool teacher 1 put it this way: 'the children can understand that you can't in reality fly and jump over tall buildings like Superman but that you can create pictures and movies that show this by using applications like a green screen'. When trying to develop children's critical approach to digital technologies, the teachers here indicated that it was possible to discuss with older children what is or is not 'real' on the internet, while with younger children it was necessary to demonstrate and exemplify how pictures and movies can be manipulated.

5.5 To have ethical media competence

The interviewed preschool teachers emphasized ethical media competences as part of the development of adequate digital competence for young children. They characterised it as having a moral, formal and legal responsibility when using digital technologies. One of the issues which the interviews highlighted was that children should learn to not take a picture of other people without getting their permission. One of the teachers put it as follows:

> …Now children are connected and have access to digital technologies …. I personally deal with the fact that you shouldn't really take a photo of somebody without their permission and that this rule applies when using all digital tools. You shouldn't do anything that affects another person without their consent. (Preschool teacher 4)

The teachers further highlighted the importance of learning activities that developed young children's ethical technological competences.

> Ethics and how we work with ethical issues plays a critical role in laying the foundation for children's future achievements …. The 'Camera ABC' (Sw. *Kamerans ABC*) device [a digital camera which is designed to be used in three phases: (A) Shall I take picture of you? (B) Shall I show you the picture? (C) Shall I save the picture?] is used to make it easy for children to understand how digital cameras should be used ethically…to learn to treat each other with respect and kindness.

Preschool teachers, as indicated in the above-mentioned quote, clearly see ethical competence, ability to designate moral situations and dilemmas surrounding the use of digital technologies, as a basic component of what constitutes 'adequate' digital competence for preschool children.

5.6 To have problem-solving skills

How children can use digital technologies to solve problems and turn ideas into action is another aspect of adequate digital competence that emerged from the data. Preschool teacher (5) characterized this competence as children's ability to 'orient themselves around different digital tools or applications to do a task'. Another teacher exemplified it as when children were able to identify a problem and try to find solutions for that problem.

The preschool teachers highlighted the importance of computational thinking practice and encouraging children to understand and practice programming and coding. A large number of the preschool teachers used programming as an example of problem solving within a digital context. As one teacher pointed out, it was also important for children to realize that digital 'things' can be reprogrammed, 'controlled' and that there is 'someone who programmed them to work in a certain way' (Preschool teacher 11). Preschool teacher 12 confirms this issue noting that:

> Programming in preschool is not about teaching children programming languages, but about teaching children the basic mindset behind programming. For this, something called block programming is often used, where programming is done using symbols instead of text. An example of this is the Blue Bot robots that children can program with symbols in the form of arrows. If the child wants the robot to go to a specific location that is three steps ahead and one step to the right, the child needs to program the robot to move so that it reaches this location. This requires that the child can see (or find out) which symbols (or commands) the robot needs and in which order these are needed for the robot to solve the problem. (Preschool teacher 12)

These comments indicate that preschool teachers consider adequate digital competence to include, not necessarily basic coding and programming skills, but the ability to identify and follow a logical sequence of steps to identify and solve a problem. In such activities, as Preschool teacher (1) described it, 'by formulating instructions and commands and creating obstacle paths, children instruct each other how to reach a specific end.'

5.7 To be producer, not just a consumer, of digital technologies

Children's ability to create and produce digital content, rather than just consuming it was another aspect of adequate digital competence which the preschool teachers in this study highlighted. Preschool teacher 13 said that 'adequate digital competence is about the children becoming producers and creators of digital resources in the

preschool rather than just consumers'. Another preschool teacher summarized it as follows:

> …. The children need to be producers rather than consumers, for instance, when they create, develop and listen to stories about different themes. (Preschool teacher 8)
> Children should be able, for instance, to work with QR codes. That there is something called a QR code, [that will send the user to a digital destination], … for example, that by taking pictures of animals and creating a QR code with the learning tablet they can show their interests. The children then become producers and not just consumers. (Preschool teacher 6)

A preschool teacher exemplified how children could go beyond the consumption of digital technologies. 'In one instance, three kids who were not so interested in working with the Bee-Bot [a floor robot] were more interested in seeing how it could fly…. but it didn't have wings. The children, then, made wings and a special button to press to make the robot fly'.

6 Discussion

This study is centred on children's adequate digital competence in early childhood education, an area that has received limited attention in the literature (Masoumi & Noroozi, 2023). Its complexity and dynamic nature make it difficult to define and map. Preschool teachers characterize adequate digital competence in early childhood education as more than just a skillful and safe use of digital technologies (cf. Su & Yang, 2023). Seven themes have been identified that frame how preschool teachers characterize children's adequate digital competence in early education. Five of the identified themes 'to become familiar with digital technologies', 'to use digital technologies', 'to have a critical approach toward digital technologies', 'to have ethical media competence' and 'to have problem-solving skills' can be seen to align with the four areas of digital competence identified by the Swedish National Agency for Education (2017). 'To be producer, not just a consumer of digital technologies' and 'to dare try digital technologies' are two additional themes revealed by the data collected for this study, which reflects preschool teachers' more nuanced perspectives on what constitutes adequate digital competence in early education.

What preschool teachers characterise as 'adequate' digital competence covers a wide spectrum of ability, from basic familiarity to critical and ethical approaches. At the core of these competences is children's ability to use digital technologies in their everyday activities (cf. Kontkanen et al., 2023; Su & Yang, 2023). In alignment with this ability, developing children's critical and ethical approaches is also underlined as an important part of children's digital competence which extends beyond basic 'know-how' (Erstad et al., 2021).

The study also shows that these competencies are often intertwined with each other and that, for preschool teachers, a digitally competent child's ability rests on a dynamic interplay. Children's digital competence is, accordingly, seen as a dynamic

and ongoing process which is informed by socio-technological factors. Other studies have also identified digital competence as an ability that is in constant flux and changes in response to the needs and circumstances of the society in which the child is located (cf. Erstad et al., 2021; Olofsson et al., 2020).

The preschool teachers in this study stressed the importance of children strive in productive and creative use of digital technologies, rather than simply consuming mass-produced digital contents in a passive way. By underlining the importance of children's productive and creative use of digital technologies, the teachers here emphasize the challenges and undesirable consequences of using digital technologies in early education where children are 'being remote controlled by the scripts of others (television, videos, electronic toys), instead of coming up with their own unique stories and problems to solve' (Levin, 2011, p. 61). This concern can be seen to align with the notion of digital *Bildung*, which emphasizes the use of digital technologies as a way of informing children's development in an increasingly complex society (Amdam et al., 2022; Krumsvik, 2009). This shift from passively consuming mass-produced digital contents to productive and creative use of digital technologies (from reception to production) is critical for developing children's digital competences in a digitalized society (Godhe, 2019).

The preschool teachers noted that children often encounter various digital technologies at home for entertainment, where they primarily use these technologies by their own. Nonetheless, they underlined the importance of children using digital technologies under the guidance of a teacher. Teacher-led activities are centred on creatively utilizing digital tools in a way that promotes children's development, rather than viewing them merely as a form of babysitting or entertainment. The findings of a growing body of literature suggests that parking children in front of screens can have adverse effects on their physical, emotional, and social development (Lan et al., 2020; Selwyn, 2012; Stiglic & Viner, 2019; Zabatiero et al., 2018).

This study also highlights the significance of integrating digital and analogue technology in order to foster children's digital competency. Several of the themes identified in this study are closely connected. 'Use and familiarisation', for example, should be balanced with the 'critical, ethical and problem-solving' approaches that require a transformative element. To develop children's digital competence, thus, preschool teachers need more sophisticated skills so they can use both analogue and digital technologies to create stimulating learning spaces. Within such a holistic learning space, analogue and digital technologies do not have to stand in opposition to each other, rather, they function harmoniously, acting as two complementary aspects of the educational experience.

7 Conclusion: Implications for learning

The present study contributes to current knowledge and practices by delineating digital competences in early education. By specifying and exemplifying children's adequate digital competence, the findings of this study offer a potential framework for preschools and preschool teachers to foster children's digital competences at an appropriate level. The framework maps the complex and dynamic interplay between

various meaning-making dimensions and aspects of digital competence in early education in order to inform ongoing research and derive future-oriented educational practices that bring in the ways that young children's digital competences can be developed.

By underlying a dynamic approach in developing of children's digital competence, this study contributes to the understanding that policy documents are interpreted, transformed, and enacted based on the constantly moving nature of society, technology, and education. In addition, this framework can help to ensure that all children have the opportunity to develop their digital competence to an adequate level, an imperative that is of particular importance in the Swedish context where equal access to digital competence is both part of national educational policy (Erstad et al., 2021; The Swedish National Agency for Education, 2022) and has often been flagged up as a matter of justice and democracy.

Understanding children's digital competence as a complex and dynamic process has implications for the design and implementation of educational practices. The development of children's digital competences should be developed alongside their other core competencies, providing opportunities for both analogue and digital experiences. Developing young children's digital competencies in early education is a context sensitive process that is influenced by both the medium (constantly evolving technologies) and the social milieu. In developing young children's digital competencies, it's essential to consider the dynamic exchange between their everyday practices and the wider cultural and societal contexts (cf. Selwyn, 2012). Thus, educational activities need to be designed in an adequate level based on the young children's needs and development (Lund et al., 2019; Olofsson et al., 2020). These conclusions, in addition, should inform the qualifications that teachers need if they are to promote adequate digital competence within both a changing digital environment and the complex educational context of Swedish *educare.*

The findings of this study are drawn from a specific group of preschool teachers in three preschools. Statistical probability-based generalization is not applicable nor the aim in this qualitative study. However, the detailed richness presented in the study offers novel insights to the research field and carries implications for preschool practices.

Future studies on digital competence in early education should pay a closer attention to the origin of definitions. Furthermore, the characterization of adequate digital competence for preschool children, as mentioned earlier, is a complex phenomenon, and more studies are needed to explore how young children's digital competence is enacted in early education.

8 Appendix 1: Interview questions

a) What does digital competence mean to you? / What comes to mind when you hear the term digital competence? (ad hoc reactions).
b) What first comes to mind when addressing adequate digital competence? What significance does adequate digital competence hold for you?

c) Should we address children's adequate digital competence in preschool? Why?
d) How do you perceive the [Swedish] curricular provisions on adequate digital competence? How can it be enacted into early education?
e) What aspects/elements play a crucial role in tackling children's adequate digital competence? What does children's digital competence entail? What constitutes children's digital competence, and what components should be encompassed within it? Have there been any notable changes in recent years regarding children's digital competence?
f) How do you know if the curriculum's goals regarding the development of children's adequate digital competence are achieved?

Funding This work was funded by grants awarded by the ULF (a project that facilitates collaborative educational research between Swedish Universities and local schools), Gävle municipality and University of Gävle, Sweden.
Open access funding provided by University of Gävle.

Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval Ethical approval from the Swedish Ethical Review Authority was provided prior to data collection as detailed in the Methodology section.

Conflict of interest The authors have no conflicts of interest to disclose.

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