

Article

International Perspectives on the Dynamics of Pre-Service Early Childhood Teachers' Digital Competences

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Abstract: Researchers and society in general seem to be conflicted regarding the use of digital technology in early childhood education (ECE). Some are focusing on the positive aspects of using digital technology, while others are critical and position it as an enemy of early childhood practice. It has been argued that digital technology is not appropriate for young children's cognitive, physical, social and emotional development. Nevertheless, supporting and developing young children's beginning digital competence is implemented in curricula and teacher education globally. The need for teachers' professional digital competence (PDC) is increasing according to the development and increased use of digital technology in society as a whole, including in the field of education. The field of research has, to a large extent, been focused on primary and secondary education, and there is a lack of research on PDC in ECE. To gain insight into the dynamics of PDC in ECE, we investigated a range of ECE contexts by including different international perspectives in a comparative study of pre-service early childhood (EC) teachers transitioning to being in-service teachers. The survey was conducted in eight different nations (Norway, Slovenia, Portugal, Poland, Turkey, Ukraine, England and Jordan) and resulted in 772 responses from pre-service teachers in the last year of their education. The paper discusses these international perspectives, considering the differences found between nations. It also investigates the dynamics of PDC, understood in this article as comprising attitudes, skills and knowledge. Following this, it also investigates how these dynamics are affecting the pre-service teachers' expectations related to their future application of digital tools as teachers to be. The results indicate large differences between nations for both single items and multi-item scales. At the same time, the dynamics of digital practices across nations reveal that attitudes, digital skills and knowledge are statistically strong predictors of pre-service teachers' future use of educational digital technology (EDT). This indicates both similarities and differences across nations and could serve as insight regarding the development of teacher programmes and the importance of including all aspects when developing pre-service teachers' PDC. This article, due to its limitation, will not elaborate in depth on contextual differences, and further qualitative research is needed to understand the complexity related to educational culture and practice.

Keywords: pre-service early childhood teachers; early childhood education; digital technology; digital skills; comparative study; attitudes; digital competence

1. Introduction

Many attempts have been made to define ‘digital competence’ in educational settings. Researchers have been exploring what kind of digital competence is needed for educators, while others are discussing the pedagogical aspects of such competence from a contextual perspective. In Petterson’s [1] review of how the pedagogical aspects of digital competence have been addressed in international research, the author concludes that there is a need to develop knowledge of organisational infrastructures and that digitally competent leadership must be further addressed. As there are several knowledge gaps related to the bigger picture of digital competence in education, the review highlights the complexity of such competence when applied to educational contexts in general. An even bigger knowledge gap is evident when focusing on lower levels of education. In a review by Tveiterås and Madsen [2], the results showed that the concept of ‘digital competence’ has not yet been clearly defined when used in an educational context. Moreover, whilst teachers’ professional digital competence has gained attention in both empirical research and conceptual development, the review reveals that early childhood education (ECE) seems to be less prioritised, even though formal policy often includes the use of educational digital technology (EDT) in ECE.

Professional digital competence for EC teachers is important because digital devices for young children are evolving at a rapid rate [3]. Nevertheless, researchers and society in general also seem to be conflicted and critical towards the use of digital technology in ECE when compared with other educational levels. Fler [4] describes that a ‘moral panic’ surrounding screen time appears to have positioned digital technology as an enemy of early childhood practice—one that could hinder the implementation and development of digital practices in ECE. It has been continuously debated whether digital technology even belongs in ECE, and if so, to what degree and for what purpose. However, as pointed out by Chuang and Ho [5], digital technology is already here and is here to stay. Experience related to education, especially during the COVID-19 pandemic, has shown the importance of digital competence for teachers around the globe.

Regardless of the extent of implementation and application of EDT in ECE, the use of EDT with young children requires EC teachers with a high level of PDC. This study investigates pre-service EC teachers’ PDC by analysing the dynamics between their perceived degree of knowledge and skills, and their expressed attitudes towards the use of digital technology in educational settings. Following this, we investigate how these dynamics are related to the pre-service EC teachers expectations related to their future application of digital tools as teachers to be. The goal is to gain a deeper understanding of the dynamics of digital competence within different educational contexts. Based on data from EC teacher programmes within eight different nations, the paper presents an overview of the perspectives of pre-service EC-teachers (n = 772) regarding EDT and dynamics related to their professional practices.

Research Questions

- (1) When comparing different national contexts, what differences are found when investigating pre-service EC teachers’ perspectives on the use of digital technology in ECE?
- (2) What differences are found when investigating the dynamics between perceived skills and knowledge, expressed attitude and expected professional application of digital tools in their future occupation?

2. Professional Digital Competence (PDC)

It is stated in the European Commission's digital education action plan for 2021–2027: 'a key aspect of digital education is the need to equip all learners with digital competence, which involves knowledge, skills and attitude' [6]. The Council of the European Union also adopted a recommendation for lifelong learning in May 2018, which identifies eight key competences, where digital competence is one of the eight. This recommendation gives a general definition of how to understand what knowledge, skills and attitudes make up the components of digital competence [7]. PDC, on the other hand, is a contextual digital competence and refers to the specific digital competence needed within certain professional contexts. When building on the definition provided by the European Commission, we conclude that PDC for EC teachers is the knowledge, skills and attitudes needed for teaching in ECE.

3. Background to the Study

When digital technologies are used in pre-schools and homes, they can productively contribute to children's communication, play and learning [3,8–10]. Research also suggests that there are many missed opportunities for homes and kindergartens to work together to define and promote effective practices with digital technologies, especially in the early years [11]. It is important to understand the dynamics of digital practices in the process of working towards developing professional digital competence in the ECE setting. Considering the description of digital technology proposed by Fleer [4], in which it is positioned as an enemy of early childhood practice, it is not surprising that research shows that practitioners' attitudes are a strong component in the dynamics of digital competence, compared with knowledge and skills. Furthermore, digital technology has often been understood as contradictory to traditional beliefs about children's play.

Only a few studies have been conducted in this research area, and the findings indicate that practitioners' attitudes are an important component in understanding the dynamics of digital practices. Researchers have long discussed whether young children should use digital technology, with some arguing that it is not appropriate for young children's cognitive, physical, social and emotional development [12]. However, a study on EC teachers and parents in Kosovo found that parents of young children believed that the use of digital technology could contribute to their cognitive development as well as their language, early learning and digital skills. Despite the parents' attitudes, the same study found that EC teachers had different attitudes regarding the matter: Only one of the eight pre-school teachers reported positive attitudes regarding the impact of digital technology on children's development. Interviews showed that teachers' attitudes were mostly affected by four factors: (1) previous experience, (2) availability of digital technology, (3) professional development and (4) their own beliefs about digital technology [12].

A literature review by Undheim [13] drew on studies conducted in several countries across the world in which researchers mostly described the use of digital technology in a positive way. The research focused on the pedagogical and educational uses of digital technology (emphasised in 24 of the 35 articles), such as play and learning, creative processes and teachers' pedagogical beliefs, often from a socio-cultural perspective. The span of attitudes seemed to be wide, and the field seemed complex. The same notion was reported in a paper on the Australian ECE sector regarding adult perspectives on young children and digital technology. Through answers to several Likert scale items, the results of the study indicated diverse participant perspectives. For instance, a statement such as 'Young children don't need to be skilled users of digital technologies' resulted in 22% strongly disagreeing and 19% strongly agreeing [14]. Meanwhile, a Spanish study on ECE showed that teachers generally harboured positive attitudes towards the use of digital technology, although they were conscious of the risk of digital tools hindering children's attention. However, the teachers explained their willingness to use digital technology by believing that using digital technology could improve students' motivation and develop greater adaptability to different interests and learning styles [15].

Some studies have suggested that practitioners' attitudes have the greatest influence on digital technology use in ECE. For example, a large American study of EC teachers ($n = 1234$) concluded through path model analysis that attitudes towards the value of digital technology had the greatest impact on their use of digital technology [16]. Mueller et al. [17] found that teachers' attitudes towards computer technology proved to be a critical contributor when distinguishing between successful and less successful integrators of digital technology in teacher education. Hew and Brush [18] reported that the integration of digital technology was directly influenced by four barriers including teachers' attitudes and beliefs towards using digital technology, among others. A newer study of Spanish pre-service ECE teachers ($n = 332$) concluded that pre-service teachers acknowledged the importance of ICT for their future careers and wanted to become proficient in their use of information and communication technology (ICT). The study assessed that pre-service ECE teachers' attitudes towards ICT seemed very positive, but they described their use of ICT as moderate and their knowledge as limited [19]. Palomino [20] also found that Spanish pre-service EC teachers showed favourable attitudes towards the use of ICT, but that their attitudes were conditioned by appropriate training. This study concluded that teachers' negative attitudes regarding the use of digital technology were related to training deficiencies. Furthermore, most EC teachers in another study felt positive about using ICT with children, and such positive ICT pedagogical beliefs were mainly based on their perceptions of how the technology would facilitate potential learning for the children [21].

Several attempts have been made in conceptualising PDC, but a fitting model for EC teachers is still lacking. In light of this described background for the study, attitude seems to be a central element in understanding ECE teachers' professional digital competence. In the next section, we build on the TPACK-model, but also add the notion of competence as comprising attitude, knowledge and skills. Attitude is not included in the TPACK model but is understood in the current study as an important consideration in making sense of the dynamics within pre-service ECE teachers' digital competence.

4. Theoretical Frameworks

Thus far, there has been a strong focus on teachers' professional digital competence. However, research has mainly focused on teachers at other educational levels, and there is currently a lack of research on EC teachers [2]. For teachers implementing digital technology in classrooms, the technological pedagogical content knowledge (TPACK) framework is widely used [22]. This framework focuses on three areas of knowledge: technological, content and pedagogical (see Figure 1).

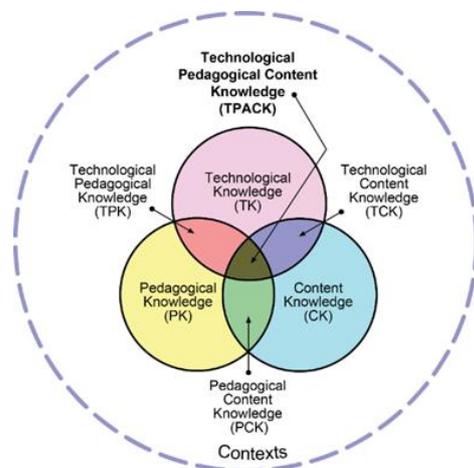


Figure 1. The TPACK Model. Reproduced by permission of the publisher, © 2023 by tpack.org.

Apart from technological knowledge, the TPACK framework adds the larger context of education including both pedagogical and content knowledge. Technological pedagogical

content knowledge, referred to as TPACK in this model, occurs when the teacher applies all three elements when teaching. Despite being widely used, the lack of research on this model's application in ECE is evident. In a review by Park and Hargis [23], they found only one research study addressing EC teachers when researching TPACK in the ECE context. As the contexts for teaching in ECE and teaching in primary or secondary education are qualitatively different, a fitting theoretical framework for EC teachers might still be lacking. In ECE, the content is not subject organised and to a lesser degree predefined through the teacher or formal curricula. The children make a greater contribution to defining the content in their learning processes, compared to primary and secondary education. When exploring the TPACK framework within the context of ECE, Park [24] concluded that EC teachers must develop TPACK to become effective teachers of today. Furthermore, she presented the unique characteristics of teachers of young children and how they bring new perspectives on how TPACK might apply.

For this study, we have chosen to focus on the area of technological knowledge in Mishra and Koehlers' model [22] and supplemented it with a model defining skills, knowledge and attitudes as important components of digital competence (See Figure 2). This builds upon an established understanding of the concept of 'digital competence' [25–27].

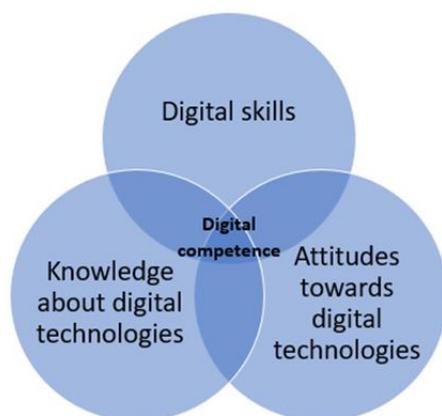


Figure 2. Model of Digital Competence [26].

This article will, in line with this model, focus on pre-service teachers' knowledge of digital technology, their perceived digital skills and their attitudes. From this perspective, all three elements are understood as components of digital competence. Further, we aim to investigate how these factors are considered part of the dynamics of pre-service teachers' expectations related to their own future digital practices as professional EC teachers.

5. Materials and Methods

Included in this study are eight international institutions from several countries providing their respective ECE programmes. Included in the study are perspectives from Norway, Slovenia, Portugal, Poland, Turkey, Ukraine, England and Jordan. Data were collected from institutions providing teacher education within each nation, applying the same survey structure for all institutions. The study follows the design of a survey based on the Theory of Action [28]. This theoretical framework offers a distinction between attitudes towards practices (espoused theory) and actions in practice (theory in use). The survey has previously been tested in smaller studies of educational contexts [29] and is developed with the intention of analysing dynamics of digital competence. In this study, we tested the use of the survey by including additional international perspectives.

The survey consists of three construct variables comprising a range of 5-point Likert-scale statements ranging from 1 (Strongly disagree) to 5 (Strongly agree). The three constructs are (1) Attitudes towards digital technology—8 variables, (2) Digital skills and knowledge—8 variables and (3) Expected future use of digital technology as EC teachers—17 variables (see Appendix A). To make it clearer for the respondents, how we define EDT

the survey is structured to initially get the respondent to rate the extent of use of different digital tools and work methods. This is used as a multi-item scale for use, but also serves as guidance and common ground for the respondent when interpreting the following statements in the survey.

The questionnaire has been thoroughly tested across time and nations and has so far proven to be a valid tool for these construct variables and for the target groups included in previous studies [29–31]. An English version of the survey was used as a template for translating the survey into the different languages needed. Data were collected through the use of online survey tools, mainly through Nettskjema. This is a Norwegian tool made for the university and college sector for the design and implementation of surveys and secure online data collection [32].

5.1. Reliability

Regarding reliability for this study, McDonald's omega and Cronbach's alpha were calculated as measures of internal consistency for all constructs and the results were satisfactory (see Table 1). Cronbach's alpha has long been regarded as the best way to estimate the internal consistency of multi-item scales [33] but the omega has later proven to be a better measure for internal consistency [34]. Due to this development, both Cronbach's alpha (α) and McDonald's omega (ω) with 95% confidence interval, (CI) were calculated for all constructs. McDonald's ω is argued to have better and more realistic data assumptions [35]. Both resulted in satisfactory results, within the range of 0.7 and 0.9 [36].

Table 1. Internal consistency using McDonald's omega and Cronbach's alpha.

	ω	α
Digital skills and knowledge (8 items)	0.701	0.710
Attitudes towards digital technology in educational contexts (8 items)	0.742	0.747
Expected use of digital technology in future occupation (17 items)	0.822	0.823

5.2. Population and Sample

This study is based on the survey results of 772 pre-service EC teachers from eight countries (see distribution in Table 2). The countries included in the study are the result of a research network, aiming to recruit as many national perspectives as possible. The criteria for participating in the study was being associated with teacher education as an employed educator and researcher at the university, with access to collecting data from pre-service EC teachers. Following this, we only included the datasets with a 70% response rate or higher (69.23% was also accepted). Data were collected locally by the researcher in charge. All participants were informed of the content of the study that participation was voluntary and that the survey was conducted anonymously. The survey questionnaires were digitally distributed either during lectures or through learning management systems, pre-service EC teachers' networks or by email. Those invited to participate were in the third or fourth year of their education, soon to become in-service teachers.

Table 2. Samples and response rates for each nation (N = total number in the target group, n = number of respondents).

Organisation (Nation)	Time of Data Collection	N	n	Response Rate
UiT the Arctic University of Norway and NLA University College (Norway)	Spring semester 2021 and 2022	262	191	73.18%
University of Primorska (Slovenia)	Spring semester 2022	200	177	88.50%
ISEC Lisboa (Portugal)	The academic year 2021/22	103	93	90.29%

Table 2. Cont.

Organisation (Nation)	Time of Data Collection	N	n	Response Rate
Uniwersytet Pedagogiczny w Krakowie (Poland)	Fall semester 2021	110	83	75.45%
Erciyes University (Turkey)	Spring semester 2021	112	82	72.32%
H. S. Skovoroda Kharkiv National Pedagogical University (Ukraine)	Spring semester 2021	73	55	75.36%
Birmingham City University (England)	Spring semester 2021	60	46	76.67%
Al-Hussein Bin Talal University (Jordan)	The academic year 2021/22	65	45	69.23%
Overall		985	772	78.38%

These nations differ from one another in terms of the contexts for educating EC teachers. In Appendix B, each nation's educational context is presented, with a focus on formal policies for both ECE and EC teacher programmes. A short overview of the status of the prevailing practices in each country is also included.

5.3. Summary of the Educational Contexts for Each Participating Nation (See Appendix B for More Detail)

All the countries in this study have specialised teacher education programmes for pre-service practitioners in ECE, which are underpinned by centrally directed educational policies. As expected, these programmes differ in scope and content according to dominant cultural ideologies and traditions regarding ECE, as well as the specific details of what pre-school children are expected to learn in each country. These directives and guidelines for ECE are generally presented as frameworks of learning areas broadly connected to the goal of fostering the development of children's knowledge, play and creativity.

The inclusion of digital technology in these frameworks and whether these are governed from the top-down or depend on the teacher and institutional discretion differ according to the national context. For example, in Norway, the use of digital technology is mandatory across ECE learning areas, whereas in Slovenia, the ECE curricula do not contain direct objectives related to the development of digital competencies of educators and pre-school children. Instead, it has guidelines for the use of digital technologies in the pre-school period.

In Portugal, digital technology is integrated into curricula guidelines, as technologies are seen as resources for collecting and communicating information rather than as a discreet area of learning. This is similar to England, where there is no longer a specific digital technology strand in The Early Years Foundation Stage, but rather a requirement for children to 'select and use technology', with the expectation that this should be embedded across all areas of learning. In comparison, in Poland, the emphasis in pre-service teacher education is on ensuring that pre-service teachers have appropriate digital competences for the level they will be teaching and are able to effectively use digital technologies in their practice, rather than on centrally dictated policies on how and when to use digital technologies in the classroom.

In Ukraine, Jordan and Turkey, the use of digital technology in ECE and pre-service training is recognised as important but is still emerging in practice. For example, in Ukraine, the integration of digital technologies into the early years' classroom is being developed through the inclusion of 'Computer literacy' as a basic component of pre-school education. Similarly, in Jordan, the effective implementation of digital technology is limited in pre-school educational settings, although a centrally directed set of programmes to use digital technology in kindergartens and enrich educational programmes is currently being actualised.

Turkey has yet to establish a policy or guideline to direct EC teachers to use digital technologies in their classrooms, although research indicates that Turkish EC teachers have

positive attitudes towards using digital technologies in their classrooms and are finding ways to integrate this into their practice.

What implications the differences in international policy and practice have on the dynamics of pre-service EC teachers' digital competences need to be further discussed and subjected to qualitative analysis, but due to text limitations this article will report on the differences found in the quantitative data.

5.4. Limitations

An obvious risk of conducting such a study is the challenges involved in including different languages and translating across nations. To minimise the risk, the translation for each nation was conducted by native speakers in our group of researchers. Also, using vague quantifiers such as "often" and "strongly agreeing" has limitations as they are flexible and context-dependent terms. As the context for the various nations are different in terms of economic status and access to different digital tools, "often" for one nation that could mean something different than "often" for another nation. In addition, the English and Jordanian results may suffer from low statistical power because of low sample size ($n < 50$). These issues must be taken into consideration when reading and interpreting the following results.

6. Results: Differences between Nations

The first part of the results section will present data and results for the first research question: When comparing different national contexts, what differences are found when investigating pre-service EC teachers' perspectives on the use of digital technology in ECE?

6.1. Single Variables

The results of the single variables revealed large differences amongst the different nations. These differences are presented in Tables 3–5, using mean scores and standard deviations.

The differences are further reported by calculating the effect size (Cohen's d) between the nation in most agreement with the statement and that in the least agreement with the statement. As reported in Table 6, there are big differences amongst nations for all items (2 = small, 5 = medium and 8 = large).

Table 3. Mean Scores for 'The use of digital tools is essential for good pedagogical programmes in kindergartens' and 'I will often use digital tools in my future pedagogical work in kindergartens'.

'The Use of Digital Tools is Essential for Good Pedagogical Programmes in Early Childhood Education'.	Mean Score (SD):	'I Will Often Use Digital Tools in My Future Pedagogical Work in Early Childhood Education'.	Mean Score (SD):
Turkey	4.04 (0.69)	Turkey	4.32 (0.58)
Ukraine	3.82 (0.86)	Portugal	4.27 (0.51)
Portugal	3.75 (0.70)	England	4.26 (0.58)
England	3.72 (0.83)	Poland	4.13 (1.11)
DigiCross average	3.53 (0.93)	Norway	4.12 (0.99)
Jordan	3.49 (1.12)	DigiCross average	4.04 (0.76)
Poland	3.30 (1.21)	Ukraine	4.00 (0.64)
Norway	3.08 (1.17)	Jordan	3.69 (0.85)
Slovenia	3.07 (0.89)	Slovenia	3.56 (0.82)

Note: Red indicates the above and below average.

Table 4. Mean Scores ‘I wish there were more digital tools available in early childhood education’ and ‘The economic situation in kindergartens makes it difficult to provide digital tools’.

‘I Wish There Were More Digital Tools Available in Early Childhood Education’.	Mean Score (SD):	‘The Economic Situation in Early Childhood Education Makes It Difficult to Provide Digital Tools’.	Mean Score (SD):
Portugal	4.12 (0.69)	Portugal	4.31 (0.59)
Norway	3.96 (1.02)	Norway	4.16 (0.91)
Turkey	3.95 (0.87)	Jordan	4.07 (0.99)
England	3.76 (0.85)	Turkey	4.05 (0.72)
DigiCross average	3.74 (0.97)	England	4.04 (0.76)
Ukraine	3.67 (1.07)	Ukraine	4.04 (0.86)
Poland	3.65 (1.08)	DigiCross average	4.02 (0.84)
Jordan	3.53 (1.14)	Poland	3.77 (1.03)
Slovenia	3.33 (1.05)	Slovenia	3.69 (0.83)

Note: Red indicates the above and below average.

Table 5. Mean Scores for ‘I mainly use digital technology because it is expected by others’ and ‘Expectations related to the use of digital tools in early childhood education frustrate me’.

‘I Mainly Use Digital Technology Because It Is Expected by Others’.	Mean Score (SD):	‘Expectations Related to the Use of Digital Tools in Early Childhood Education Frustrate Me’.	Mean Score (SD):
Jordan	3.58 (0.72)	Jordan	3.20 (1.10)
Poland	2.83 (1.24)	Slovenia	2.84 (0.96)
DigiCross average	2.51 (1.00)	Ukraine	2.75 (1.02)
England	2.48 (0.84)	England	2.63 (0.74)
Ukraine	2.42 (0.98)	DigiCross average	2.63 (1.02)
Slovenia	2.42 (0.95)	Turkey	2.52 (0.92)
Portugal	2.21 (1.30)	Portugal	2.45 (1.23)
Norway	2.16 (1.02)	Poland	2.34 (1.11)
Turkey	2.00 (0.96)	Norway	2.30 (1.11)

Note: Red indicates the above and below average.

Table 6. Effect sizes between the highest and lowest scoring nations for single items.

Items	Effect size (d)
I mainly use digital technology because it is expected by others.	1.88
The use of digital tools is essential for good pedagogical programmes in early childhood education.	1.22
I will often use digital tools in my future pedagogical work in early childhood education.	1.09
I wish there were more digital tools available in early childhood education.	0.91
The economic situation in kindergartens makes it difficult to provide digital tools.	0.87
Expectations related to the use of digital tools in early childhood education frustrate me.	0.81

6.2. Construct Variables

Initially, the study was designed to conduct regression analysis using the three developed constructs, namely, attitudes towards digital technology, digital skills and knowledge, and expected future use of digital technology by EC teachers. Due to miscommunication in the process of translating the surveys and collecting the data, the Polish question regarding use was asking for use in ‘the last year’ instead of asking what tools and work methods would be used in the respondents’ future occupations. Therefore, this is marked as ‘missing data’ in Table 7.

Table 7. Mean scores for construct variables for each nation.

Nation	Attitudes (Construct)	Nation	Digital Skills and Knowledge (Construct)	Nation	Exp. Use (Construct)	Nation	Exp. Use (Single Variable)
Turkey	3.73 (0.49)	England	3.80 (0.43)	England	3.65 (0.39)	Turkey	4.32 (0.59)
Portugal	3.73 (0.36)	Portugal	3.77 (0.43)	Turkey	3.60 (0.52)	Portugal	4.27 (0.51)
Ukraine	3.57 (0.54)	Norway	3.75 (0.61)	Average	3.39 (0.49)	England	4.26 (0.58)
Norway	3.55 (0.56)	Turkey	3.74 (0.53)	Portugal	3.35 (0.40)	Poland	4.13 (1.11)
England	3.54 (0.50)	Poland	3.64 (0.53)	Poland	Miss. data	Norway	4.12 (0.99)
Average	3.52 (0.54)	Average	3.58 (0.49)	Norway	3.35 (0.60)	Average	4.04 (0.76)
Poland	3.49 (0.64)	Ukraine	3.45 (0.54)	Ukraine	3.34 (0.50)	Ukraine	4.00 (0.64)
Jordan	3.26 (0.68)	Slovenia	3.30 (0.50)	Jordan	3.24 (0.48)	Jordan	3.69 (0.85)
Slovenia	3.26 (0.58)	Jordan	3.24 (0.41)	Slovenia	3.19 (0.53)	Slovenia	3.56 (0.82)

Note: Red indicates the above and below average.

The subsequent regression analysis was, therefore, also conducted based on the single variable ‘I will often use digital tools in my future pedagogical work in kindergartens’. This single variable was compared to the scores of the construct to validate the single variable as an indicator of the pre-service EC teachers’ expected use. As shown in Table 7, this single variable is a good indicator of the respondents’ reported future use, when compared with the mean of the construct reporting on the respondents’ expected future use (based on 17 different tools and work methods). Furthermore, when using the single variable, the tools is not explicitly defined. This allowed respondents to base the answer on their expected use without limitations that could follow our predefined list of tools. The similarities between the results of the multi-item construct and the single variable could be seen as an indication that the list of tools and work methods used in the survey (see Appendix A) is complementary with participants’ notions of EDT in ECE.

When calculating effect sizes and comparing the nations with the highest and lowest scores, large differences were found for all three constructs as well as the single variable (see Table 8). The largest difference between nations was found when comparing the respondents’ levels of self-perceived digital skills and knowledge.

Table 8. Effect sizes between the highest and lowest scoring nations for construct variables.

Construct	Effect Size (d)
Attitudes towards digital technology (8 variables)	0.87
Digital skills and knowledge (8 variables)	1.33
Expected future use as ECE teachers (17 variables)	1.10
Expected use as ECE teachers (single variable)	1.00

7. Results: The Dynamics between PERCEIVED Skills and Knowledge, Expressed Attitude, and Expected Professional Application of Digital Tools

When conducting the correlation analysis of the construct variables for all nations, the constructs ‘attitudes towards digital technology’ and ‘digital skills and knowledge’ strongly correlated with the item ‘I will often use digital tools in my future pedagogical work in kindergartens’ (see Table 9).

Table 9. Correlation (Pearson’s R) between construct variables for all nations (n = 772).

Correlation	Attitudes	Digital Skills and Knowledge
Use (single variable)	0.52 ** ($p < 0.001$)	0.46 ** ($p < 0.001$)

** Significant at the 0.01 level (2-tailed).

Standardised multiple linear regression for all nations predicting the future use of digital technology showed that the regression model explained 30.7% of the respondents' expected use when including all nations (see Table 10).

Table 10. Standardised multiple linear regression predicting the future use of digital technology (n = 772).

Predictor: Attitudes	Predictor: Skills and Knowledge	Based on Adjusted R-Squared
0.23 *** ($p < 0.001$)	0.39 *** ($p < 0.001$)	30.7%

*** Significant at the 0.001 level (2-tailed).

Standardised Multiple Linear Regression Analysis for Each Nation

The individual regression analysis for each nation reveals a slightly more scattered and complex picture, indicating different dynamics of digital practices across nations. Using the constructs 'skills and knowledge' and 'attitude' as independent variables and the single item 'I will often use digital tools in my future pedagogical work in kindergartens' as the dependent variable, the pre-service teachers' expected future use of digital technology in ECE was measured (see Table 11). The standardised coefficient (Beta), p -value and explanatory power were also reported based on adjusted R-squared. The table is sorted by explanatory power using the adjusted R-squared values. Correlation analysis between skills and knowledge, and attitudes within each nation is also conducted (see Table 12).

Table 11. Standardised multiple linear regression analysis for each nation.

Nation	Predictor: Attitudes	Predictor: Skills and Knowledge	Based on Adjusted R-Squared
Slovenia	0.37 *** ($p < 0.001$)	0.30 *** ($p < 0.001$)	36.3%
Ukraine	0.39 ** ($p = 0.005$)	0.28 * ($p = 0.040$)	33.7%
Poland	0.30 * ($p = 0.018$)	0.32 * ($p = 0.012$)	30.8%
Norway	0.02 ($p = 0.791$)	0.53 *** ($p < 0.001$)	28.1%
Turkey	0.40 ** ($p = 0.004$)	0.11 ($p = 0.393$)	21.8%
DigiCross average			21.1%
Jordan	0.38 * ($p = 0.027$)	0.03 ($p = 0.853$)	12%
England	0.23 ($p = 0.166$)	0.08 ($p = 0.653$)	3.4%
Portugal	-0.06 ($p = 0.615$)	0.22 * ($p = 0.042$)	2.4%

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed). *** Significant at the 0.001 level (2-tailed).

Table 12. Internal correlation between skills and knowledge and attitudes within each nation.

Nation:	Pearson's R	Sig. (2-Tailed)
Turkey	0.683 **	<0.001
Poland	0.677 **	<0.001
Slovenia	0.656 **	<0.001
Ukraine	0.570 **	<0.001
DigiCross average	0.549 **	<0.001
Jordan	0.534 **	<0.001
Norway	0.495 **	<0.001
England	0.474 **	<0.001
Portugal	0.304 **	0.003

** Significant at the 0.01 level (2-tailed).

8. Discussion

When predicting pre-service EC teachers' expectations related to the use of EDT, with 'attitudes' and 'skills and knowledge' as predictors, the regression model explains 30.7% of the pre-service EC teachers predicted future use of digital technology in their professional practices. To a greater degree, future use is explained by their perceived level of skills and knowledge, as compared with the degree to which they have either critical or positive views towards digital technology in educational settings. However, both are strong predictors.

When comparing nations' mean scores independently, the results tended to vary and the differences between the lowest and highest-scoring countries are large. The effect sizes between the lower and higher-scoring nations are big for all variables (both single and construct variables). The differences when looking at the different nations' dynamics of PDC are also evident. Based on the regression model, for some nations, it is only a skill as a predictor that is statistically significant, whilst for others, it is the only attitude that is significant as a predictor of future use. For Poland, Slovenia and Ukraine, both predictors are significant, and the model explains 30.8%–36.3% of the respondents' expected use. For England, neither of the predictors is significant, whilst, for Portugal, the model only explains 2.4% of their expected use. This indicates that the dynamics of pre-service EC teachers' practices are quite diverse across nations and that the premise for digital practice may not always be based on their digital competencies or attitudes towards EDT.

When looking at differences between nations, there is a big difference between the pre-service EC teachers' expected use of EDT ($d = 1.10$). One suggestion is that this could be related to context and actual access to digital technology. However, the same nations who scored the lowest on expected use (Ukraine, Jordan and Slovenia) are also the nations in the least agreement with the statement 'I wish there were more digital tools available in early childhood education'. The same is true for Slovenia when the respondents answered whether 'The economic situation in kindergartens makes it difficult to provide digital tools'. This is nevertheless consistent with the score related to the item 'The use of digital tools is essential for good pedagogical programmes in kindergartens', where Slovenian pre-service teachers are in the least agreement with this statement. This is consistent with previous studies on teaching professionals, which showed that teachers' attitudes regarding the use of digital technology do not only depend on its availability [27].

A large difference between the lowest- and highest-scoring nations can also be found when looking at the mean scores for 'skills and knowledge' and 'attitude'. The results are consistent with previous studies on teaching professionals in primary, secondary and upper secondary education. Based on the PIAAC and TALIS datasets, Hämäläinen et al. [26] found a notable variation in teaching professionals' skills and knowledge but less variety in their attitudes when looking at data across nations.

However, the overall picture is complex, diverse and, at times, paradoxical. An example of an internal paradox can be found when looking at Norwegian responses to the statement, 'The use of digital tools is essential for good pedagogical programmes in early childhood education'. About 59.7% of the respondents are neutral, disagree or strongly disagree with the statement, whilst 79% of the same respondents agree or strongly agree with the statement 'I will often use digital tools in my future pedagogical work in early childhood education'.

What is more interesting is the dynamics of the nations expressing a more critical stance. Slovenia and Jordan have the lowest scores in attitudes, digital skills and knowledge and use. However, Slovenia is the nation with the best explanatory power when looking at the multiple regression analysis for each nation, where both attitudes and skills explain 36.3% of the pre-service teachers' expectations of future use. As for Jordan, attitudes are a strong statistical predictor, explaining 12%. However, attitudes as a predictor are not statistical for Norway, England or Portugal for this regression model.

Great variations have also been observed regarding the model's strong explanatory power within the different nations (2.4–36.4%). A relevant question to ask is as follows: If it is not mainly skills and knowledge or attitudes, what factors are affecting pre-service

teachers' expectations of future digital practices? Previous research has shown that educational policy regarding digital technology in education has an evident effect on practitioners' professional digital practices and attitudes [30]. Other studies indicate that the extent of the use of digital technology regarding online education impacts pre-service teachers' attitudes towards digital technology and whether such attitudes are a statistical predictor of the use of EDT. Madsen and Thorvaldsen's study reveals that top-down governing of education when it comes to digital technology and the mandatory use of extensive online education also have negative effects on the dynamics of professional digital practices [31]. Based on the understanding of digital competence as comprising both attitudes, skills and knowledge, a high level of digital competence should result in coherence when looking at how attitudes and skills predict the pre-service teachers' predictions of their future digital practices.

Whilst investing in digital technologies is expensive, there is no doubt that providing access to digital tools is important for developing professional digital competence. Nevertheless, when looking at numbers from The International Monetary Fund (IMF) (see Table 13), a major financial agency of the United Nations, we find no pattern in the material suggesting that the different nations' GDP per capita can be considered the main factor explaining the differences in the respondents' use of EDT, attitudes and digital skills and knowledge.

Table 13. Each Nation's GDP based on statistics from World Bank [37].

Nation	GDP per Capita in 2021 (US Dollar)
Norway	89,154
England	46,510
Slovenia	29,291
Portugal	24,568
Poland	18,000
Turkey	9661
Ukraine	4836
Jordan	4103

9. Conclusions

Overall, the dynamics of digital practices across nations reveal that both attitudes and digital skills and knowledge are statistically strong predictors of pre-service teachers' future use of EDT. However, in terms of differences among nations, there are some contradictions when looking at digital skills, attitudes towards digital technology in ECE settings and what level of digital usage the pre-service teachers are predicting for their future occupations. This finding calls for a closer examination to determine whether certain factors can explain the different nations' strong explanatory power and statistical significance in terms of attitudes and skills as predictors. At the same time, other nations have lower explanatory power and non-statistically significant results on either one or both predictors. As a central part of teachers' contexts, policies have proven to be a relevant aspect in understanding the dynamics of professionals' digital competence. Related to this, qualitative studies of different educational contexts are needed to understand the complexity of our results. Finally, further research into the emerging digital pedagogies in ECE is needed so that there can be more discussion and development of education built on knowledge and research.

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Appendix A. Items Used in the Analysis

The following variables are scored using the following options: 1—Strongly disagree, 2—Disagree, 3—Neutral, 4—Agree and 5—Strongly agree.

Single variables

- I will often use digital tools in my future pedagogical work in early childhood education.
- I wish there were more digital tools available in early childhood education.
- The economic situation in early childhood education makes it difficult to provide digital tools.
- I mainly use digital tools in early childhood education because it is expected by others.

Construct variables

Digital skills and knowledge:

- I am familiar with digital tools that can help diversify activities when working with children's play, learning and development.
- I am, in general, confident when using digital tools.
- I find it easy to become familiar with new digital tools.
- I can use digital tools according to premises in early childhood education when working pedagogically with children.
- It is difficult to use digital tools as a pedagogical resource in early childhood education.
- When I am using digital tools, it is difficult to adjust the content to the individual child's needs.
- I have no clear idea of learning outcomes when using digital tools in my pedagogical work with children.
- I use digital tools when assessing a child's development.

Attitudes:

- When I use digital tools in early childhood education, I find that it adds value to the pedagogical work.
- The use of digital tools is essential for good pedagogical programmes in early childhood education.
- Society's expectations of the impact of digital tools are exaggerated.
- Expectations related to the use of digital tools in early childhood education frustrate me.
- In professional debates at my university, the expectations of the impact of digital tools are exaggerated.
- The use of digital tools disrupts the relationship between the child and the early childhood teacher.
- Digital tools can make the children more interested in the planned activity.
- I like testing new digital tools in my pedagogical work in early childhood education.

Expected use of EDT in future occupation:

Which digital tools and work methods do you think you will be using in your future pedagogical activities with children? (1—Never, 2—Rarely, 3—Occasionally, 4—Often and 5—Extensively)

- Quiz
- Digital tools for presentations (e.g., PowerPoint or Prezi)
- Programmes to create texts (e.g., Word)
- Use of video
- Production of film/video/animation
- The Internet as a source of knowledge
- iPad
- Pedagogical apps
- Toys and technology for coding (e.g., Micro:bit, Ozmo, Spero, Lego Boost)
- Digital camera
- Digital microscope
- Digital storytelling
- Digital music and sounds (as a producer)
- Digital music and sounds (as a consumer)
- Art or drawing using digital technology
- Smart board
- Digital programmes for communicating with parents

Appendix B. Review of Formal Policy for ECE, EC Teacher Programmes and Practice and Status for Digital Technology in ECE

Norway

Formal Policy for ECE

According to a national report called *Young Children (0–8) and Digital Technology*, most Norwegian children have easy access to a wide range of digital technologies, and the use of such technologies has become an integrated part of Norwegian childhood [38]. This is reflected in the contents and tasks for Norwegian ECE regulated through the Framework Plan for Kindergartens [39]. The contents and tasks for ECE in Norway are strongly linked to professional digital competence. In Chapter 8, where work methods, in general, are described, a section is dedicated to digital practices:

Digital practices in kindergarten shall encourage the children to play, be creative and learn. The use of digital tools must support the children’s learning processes and help implement the principles of the Framework Plan on creating a rich and varied learning environment for all children [39] (p. 44)

The framework plan also provides guidelines stating that staff should be actively involved with children when using digital tools. Furthermore, digital practice must involve digital judgment and staff must support the children in developing an early ethical understanding of digital media. Four bullet points are listed as mandatory guidelines for digital practice in kindergarten [39] (p. 45), indicating that ‘Staff in kindergartens shall:

- Exercise sound digital judgment with regard to searching for information, be conscious of copyright issues, critically analyse sources and safeguard the children’s privacy.
- Enable the children to explore, play, learn and create using digital forms of expression.
- Evaluate relevance and suitability and participate in the children’s media usage.
- Explore the creative and inventive use of digital tools together with the children’.

Furthermore, a range of technologies and digital tools are to be used when working with the various learning areas described in the framework plan. For example, for the learning area ‘Nature, environment and technology’, it is stated that staff shall use digital tools to inspire children’s mathematical thinking [39].

Formal Policy for Early Childhood Teacher Programmes

Formal frameworks guiding the preparation for pre-service EC teachers indicate that graduated teachers must have obtained broad knowledge of children's beginning digital competencies [40] (Section 2). In the National Framework for Early Childhood Teacher Education, professional digital competence is identified as one of six areas to be emphasized when educating pre-service early childhood teachers [41].

Practice and Status of ECE

A national report on ICT in Education concluded that staff in kindergartens have a balanced use of digital technology in pedagogical work, with the majority using such technology on either a daily or a weekly basis. The reasons given for using digital technologies are the possibilities they create in pedagogical work and the fact that it is mandatory through formal policy [42]. When it comes to educational research in Norway, several researchers have pointed out the need for more development and research in the field of ICT [43,44]. Furthermore, it has been pointed out that ECE research is lagging compared to research aimed at the primary and secondary educational levels [2,45]. This corresponds to recent investigations in the field of ECE [42].

Slovenia

Formal Policy for ECE

Slovenia has an integrated pre-school system of ECE and pre-primary education for children aged 1–6 years, although pre-school education is not compulsory. The core national programming document is the Pre-school Curriculum in Slovenia [46], which defines pre-school education in kindergartens as part of the educational system and is thus under the auspices of the ministry responsible for education. The Curriculum is based on the developmental process approach, which includes the high-quality planning, implementation and evaluation of the learning process that considers children's individual traits and their development as a more important goal than achieving prescribed results.

The Pre-school Curriculum in Slovenia indirectly sets goals to be followed in educating pre-school children on ICT and media-related topics [46]. These are partially covered under the area of 'Arts as part of audio-visual media', in which it is outlined that children should learn about films, games and educational and television programmes for children and adults. Through these activities, children are supposed to observe, record, explore, take photos, identify, comment and use media, among others; shape their first experiences with media; acquire media literacy. Within the area of 'Languages', the majority of goals refer to literature, reading and books. Digital technologies are intended for listening to fairy tales, stories, puzzles and songs. Furthermore, it includes plans for children to visit cinemas, watch cartoons, listen to audio and watch video materials containing various literary texts for children. Pre-school teachers should also give children the opportunity to independently create a book and a cartoon. Topics related to digital technologies are also included in the Pre-school Curriculum within the area of 'Society', in which it is planned that a child should have an opportunity to discuss prejudices, stereotypes, fashion trends, commercials and so on, which are commonly transmitted through media messages [47].

However, the Pre-school Curriculum in Slovenia does not contain direct objectives or guidelines related to the development of the digital competencies of educators and pre-school children [46], which is why the National Institute of Education has prepared guidelines for the use of digital technologies in kindergarten [48]. The most recent update of these guidelines was undertaken in 2021. The guidelines for the use of digital technologies in kindergarten highlight the role of adults in ensuring the meaningful use of digital technologies in the following four areas of digital literacy:

- Digital pedagogy, through which a child should acquire the ability to learn and critically use digital resources and the ability to search, collect, process, evaluate (critically assess) data, information and concepts;

- Use of digital technology and digital production, along which a child should begin to acquire the ability to make and create products, which also means the creative use of digital technology;
- Digital communication and collaboration, in which a child should begin to acquire the ability to communicate and collaborate remotely;
- Digital citizenship, in which a child should begin to acquire the ability to use digital resources safely and to respect the legal and ethical principles of using and publishing information.

Formal Policy for Early Childhood Teacher Programmes

Teacher education in Slovenia contains various programmes aimed at different levels of the educational system—ranging from EC teacher programmes for EC teachers to teacher programmes for the primary and secondary education levels. These teacher programmes were developed to prepare pre-service teachers to work in line with the given policy. The approaches to digital competence and its position in the curricula and educational policy differ amongst these programmes. At all levels of education (from kindergartens to faculties), the authorities are currently in the process of upgrading the curricula, where digital competence is taking on a central and important role across all programmes and subjects. At some faculties in teacher programmes for ECE and primary education, there is a compulsory subject called ‘Educational Technology’, which aims to develop the digital competencies of future pre-school and primary school teachers.

The programmes at the kindergarten level are delivered by the pre-school education staff, namely, the pre-school teacher and the pre-school assistant, working together in a group. Their simultaneous presence is regulated at the national level: They must both be present together for at least six hours per day in the first age group and for at least four hours per day in the second age group. Together, they prepare and plan the education process, cooperate with parents and take part in the organisation of life and work in the kindergarten. The child-to-adult ratio in the first age group is six children per adult during the time when they are both present and 11 children per adult in the second age group.

Pre-school teachers for both age groups must hold bachelor’s degrees in pre-school education, and pre-school assistants of both age groups must hold upper secondary qualifications in pre-school education. Continuing professional development is a professional duty and right, according to the Organisation and Financing of Education Act and the Collective Agreement for Education in the Republic of Slovenia. The Collective Agreement also determines the right of the education staff to five days of in-service training per year or 15 days over a period of three years.

Teachers in Slovenia are required to have five years of initial teacher education (master’s level). Exceptions are pre-school teachers and teachers of professional subjects in vocational and technical upper secondary education, who must have at least three years of initial teacher education. All teachers must pass a state professional examination.

Practice and Status of ECE

Slovenian teachers should have developed digital competences for teachers (in line with the DigCompEdu framework) for the effective and innovative use of digital technologies in the planning, implementing and assessing of teaching and learning. In Slovenia, there is an ongoing transition from traditional teaching to a teaching mode wherein teachers use and develop student-centred teaching and learning strategies using digital technologies. They start with computer literacy in Slovenia, normally in the first class of basic schools (ages 5–6 years), but some kindergartens start even earlier. Despite various national projects aimed at developing digital competencies, the equipment of kindergartens and the training of educators for the meaningful integration of digital technologies into kindergarten activities are highly diverse.

Portugal

Formal Policy for ECE

In Portugal, the Curricular Guidelines for Pre-school Education document guides all practices in pre-school education. This document is divided into two main points: 'Fundamentals and Principles of Pedagogy for Childhood' and 'Content Areas'. The fundamentals constitute a common basis for the development of pedagogical action in day care centres and kindergartens. These reflect a particular perspective on how children develop and learn, highlighting the quality of the relational climate in which educating and caring are closely intertwined. The content areas take into account an integrated and global approach to the different content areas: 'Personal and social formation', 'Expression and communication' and 'Knowledge of the world'. In this document, the point 'Technological world and use of technologies' is within the 'Knowledge of the world' area. Here, technologies are considered resources for collecting information, communicating, organising, processing data, etc. Thus, it enables learning, not only in the field of knowledge of the world but also in artistic languages, written language, mathematics and so on.

Formal Policy for Early Childhood Teacher Programmes

In Portugal, students can become kindergarten teachers by first completing a degree in basic education which consists of six semesters. After completing their degree, students can choose to apply for a master's degree in pre-school education (three semesters) or a master's degree in pre-school education and primary teaching (four semesters), where they can be kindergarten teachers and primary teachers teaching children up to nine years old. The study plans of some universities have been updated to include teaching with the pedagogical use of technologies with children. However, not all of them have a curricular unit with this theme.

Practice and status of ECE

The Portuguese Ministry of Education has implemented several projects in Portugal with the aim of introducing technologies into teaching at the primary to secondary educational levels [49]. Pre-school education is covered but not as heavily as mandatory education (from primary to secondary). The Ministry of Education has provided schools with digital devices, such as tablets and laptops, as well as improved Wi-Fi networks. Furthermore, the Ministry has also provided training to teachers.

Poland

Policy for ECE

Pre-school education in Poland is the first stage of the education system and is supervised by the Ministry of National Education. The main legal regulation is the Act of 7 September 1991, which lists various types of ECE. The cost of public kindergartens is usually established by municipal and city councils after considering the funds for maintaining these kindergartens in their budgets. Public kindergartens are typically open for around 10 h a day and are regulated by the provisions of each kindergarten's statute. These kindergartens support the provision of children's activities that raise their level of sensory integration and their ability to use their developing cognitive processes. These also foster conditions that are conducive to acquiring experiences that will enable adaptation processes and help those children who may develop in an imbalanced, slower or accelerated way. A child who may need special education based on assessments made by a psychological and pedagogical clinic can still be admitted to kindergarten [50].

Policy for Early Childhood Teacher Programmes

Teacher education is part of the Polish educational system, especially at the higher educational level, and it reflects the characteristics of this system. At present, teacher education in the field of pre-school and early school education and special education is

continuous (five-year master's degree), whilst other fields of education for teachers of various school subjects employ a two-level (3 + 2) system. However, a new provision has been implemented that obliges universities to admit first-degree graduates of the same degree to the second degree. The first degree (bachelor's degree), however, does not currently allow a graduate to work immediately as a schoolteacher. In addition, teachers can be educated only at universities that meet the highest criteria for the quality of education. Thus, there is a great emphasis on high-quality teaching and preparation of teachers at the highest level [51].

Currently, initial teacher training is provided only by higher education institutions (HEIs). Until 2016, prospective early childhood and school education teachers were also trained in teacher training colleges and foreign language teacher training colleges. These are referred to as initial teacher training institutions and are classified as post-secondary non-tertiary institutions in national legislation.

Initial teacher training comprises compulsory subject-specific training as well as training in psychology, pedagogy and teaching methodology. Two models of initial training exist side by side:

- A concurrent model, which is the predominating one, wherein following a degree programme in a given field of study, students can choose a teacher specialisation track. This would allow them to complete professional teacher training and acquire a teaching qualification as part of their degree programme in parallel to their subject-specific training.
- A consecutive model, which is available to those who have not taken a teacher specialisation track as part of a degree programme in a given field of study. Here, students can choose the teaching profession later and obtain a teaching qualification upon completion of a non-degree postgraduate programme or qualification course.

Practice and Status of ECE

In Poland, the high quality of pre-school education is guaranteed by well-prepared teaching staff at nursery schools. Mostly, they are university graduates holding a master's degree (84.0% of teaching staff) and less often holding a bachelor's degree (11.8%) [52]. At each level, in addition to the general digital competencies for life and work, teachers must acquire educator-specific digital skills to effectively use digital technologies for teaching [53]. According to a study conducted by Polish scientists, there are three areas of professional-pedagogical digital competence of teachers that should be developed to achieve full digitalisation in Polish schools: subject matter, methodological and technological competencies [54]. Teachers with the latter kind of qualification usually work in pre-school classes or with after-school activities, where ICT is less commonly used, which means that they will not acquire the same degree of ICT experience as teachers teaching compulsory school classes [55]. The digital literacy of Polish teachers varies, especially regarding the different areas of digital competence. According to the literature [56], the highest results were recorded in the area of ergonomics (time spent using new media, maintaining proper posture and workspace organisation), whilst the weakest component involved copyright awareness (using musical works, videos and applications in the didactic process or modification of other copyrighted materials). The educational aspect of new media is particularly important when considering its potential to improve the efficiency and presence of multimedia in the didactic process [57].

Turkey

Formal Policy for ECE

The latest curriculum was implemented in 2013 by the Ministry of National Education (MoNE) in Turkey. The curriculum is designed for children aged 36–72 months. It aims to support children's development, to provide enriched learning environments and to prepare children for successful transition to formal education [58]. The curriculum is

defined as developmental and has two main components: a spiral approach and an eclectic model. The curriculum provides objectives and indicators to teachers under five content areas: (1) Cognitive, (2) Language, (3) Social and emotional, (4) Motor and (5) Self-care development. Teachers design daily and monthly plans based on the curriculum by matching the curriculum objectives with the developmental capabilities of the children. Teachers can also define and add new objectives to their plans, if necessary. However, upon examination, the curriculum does not mention digital media and technologies [58].

Policy for Early Childhood Teacher Programmes

In Turkey, the Ministry of National Education oversees early childhood education, which is accredited by the Higher Education Council. Early childhood teachers must obtain a four-year bachelor's degree in early childhood education, which includes coursework in child development, educational theories, pedagogy and practical teaching experiences. The program prioritizes child-centred approaches and play-based learning. Its curriculum and methods are designed to support a child's overall development. Additionally, the Ministry of National Education encourages early childhood teachers to participate in ongoing professional development, offering in-service training at the beginning and end of each semester.

Practice and Status of ECE

Based on the country's formal policy for ECE, there is no established policy or guideline requiring early childhood teachers to use digital technologies in their classrooms. Although recent studies have revealed that Turkish ECE teachers have positive attitudes towards using digital technologies in their classrooms [59], they only use such technologies in limited ways such as for children to watch cartoons and listen to music [60,61].

Ukraine

Formal Policy for ECE

The government recognizes the importance of preschool education. The state provides comprehensive assistance to the family in supporting the development, upbringing and education of young children. Public institutions offering early childhood education are free of charge to ensure availability for all. Preschool education, as part of early childhood education, is a mandatory component of the primary education system. The system is designed as a holistic process, aimed at ensuring the comprehensive development of a preschool child in accordance with the child's aptitudes, inclinations, abilities, individual, mental and physical characteristics, cultural needs, the formation of moral norms in a preschool child and the child's acquisition of social competence.

In Ukraine, there are different types of preschool education institutions: (1) preschool education institutions for children aged one to six (seven) years old, (2) preschool education institutions of the compensatory type, for children with special educational needs aged two to seven (eight) years, (3) children's homes (4) preschool education institutions for orphans and children deprived of parental care, run by the health care system for medical and social protection. This also includes children with physical and (or) intellectual disabilities from birth to three (for healthy children) and up to four (for sick children), (5) preschool education institutions (orphanage) boarding type, (6) family-type preschool education institutions for children aged two months to six (seven) years. These institutions are characterized as those providing and supporting the children's need for care, development, education and training.

The care and education must be provided in accordance with the requirements of the basic components of preschool education. This also applies to the combined preschool education institutions for children aged one to six (seven and eight), the preschool education institutions which provide physical, mental and psychological development, correction of psychological and physical development, rehabilitation of children who attend other

educational institutions (child development center) and for those who receive education at home [62].

Formal Policy for Early Childhood Teacher Programmes

Ukraine's system of pedagogical education includes HEIs of all forms of ownership, institutions of postgraduate pedagogical education and management structures in the field of higher education. The training of pedagogical teachers is carried out in pedagogical colleges, pedagogical universities, classical universities and other HEIs. Pedagogical and classical universities provide training and retraining of teaching staff at the bachelor's and master's educational qualification levels [63]. The contents of pedagogical education in the relevant specialties for different educational and qualification levels are determined by the industry standards of higher pedagogical education and the standard of higher education of an HEI. They provide fundamental, methodical, psychological-pedagogical, practical, information-technological and social-humanitarian training of teachers in the following specialties: ECE, primary education and basic education. The variable aspect of the basic component of pre-school education includes the educational line 'Computer Literacy', which is aimed at forming the informative competence of pre-schoolers [64].

Practice and Status of ECE

The development of ICT has contributed to the digitalisation of education and the spread of distance education. The use of ICT in the educational systems of ECE institutions is an urgent pedagogical concern in Ukraine.

England

Formal Policy for ECE

The Early Years Foundation Stage (EYFS) for children aged 0–5 years consists of seven areas of learning and development: Communication and language; Physical development; Personal, social and emotional development; Literacy; Maths; Understanding the world; and Expressive arts and design. Whilst there is no longer a specific digital technology strand in the EYFS, there is a requirement for children to 'select and use technology', and this should be embedded across all areas of learning. All schools and registered early years providers, including childminders, pre-schools, nurseries and school reception classes, must follow the EYFS.

Formal Policy for Early Childhood Teacher Programmes

Digital technology is widely used in teaching and learning across all phases of education in England. In 2019, the Department for Education published a report entitled 'Realising the Potential of Technology in Education', which focused on strategies to support the education sector to 'develop and embed technology in a way that cuts workload, fosters efficiencies, supports inclusion and ultimately drives improvements in educational outcomes' [65] (p. 3). To become an early years teacher, students must complete an Early Years Initial Teacher Training (EYITT) course to achieve Early Years Teacher Status (EYTS). EYTS is different from qualified teacher status (QTS), which is the equivalent of teaching children aged 3–18 years. Practitioners and trainee early years teachers must provide sufficient opportunities for children to use technologies within a variety of contexts and across a range of purposes so that children can begin to understand when and how such technologies can be used to support learning.

Practice and Status of ECE

Some early years practitioners lack confidence and skills in using digital technology with young children in early years settings [66], and the need for training and continued professional development for teachers in this area has been identified [67].

Jordan

Formal Policy for ECE

The interactive national curriculum for kindergarten in Jordan consists of the following axes: ethics–religion, affective–social, linguistic, physical–health, intellect–cognitive and aesthetic. The strategic plan of the Ministry of Education (MOE) includes the employment of digital tools in the context of the interactive curriculum axes. Thus, a project was designed and implemented to develop kindergarten software for the Hashemite Kingdom of Jordan in cooperation with the Jordanian MOE in 2009. The project covers all kindergarten units in the Kingdom and aims to use digital technology to strengthen the foundations of the educational situation, which has been designed to motivate kindergarten children to learn by raising their motivation to do so through multimedia software, as stated on the website of the Regional Center for Educational Software Development (www.redsoft.prg). In its strategic plan (2018–2022), the MOE has prepared a set of programmes to use digital technology in kindergartens and enrich the existing educational programmes [68] (p. 21).

Formal Policy for Early Childhood Teacher Programmes

Teacher education in Jordan includes three different programmes aimed at various levels of the educational system. Of these, two programmes require a specialty in classroom–teacher education, namely, early childhood (kindergarten) education and basic education (from Grades 1–3). The third programme concerns basic and secondary education (from Grades 4–12), where teachers are recruited according to their specific major of university education. Teachers in this programme receive a diploma in educational rehabilitation from the faculties of educational sciences, in-service or pre-service, after graduation. Accordingly, digital competencies are developed through different courses according to the nature of each programme. Hence, the Jordanian Ministry of Education has cooperated with the Ministry of Higher Education to accredit these programmes according to the educational policies of teacher competencies. For instance, the digital competencies applied in kindergarten education basically rely on an interactive curriculum, which has been emphasised by the MOE through the creation of the DARSAK Platform during the COVID-19 pandemic as a tool for delivering and tailoring learning situations as well as fostering interactions between teachers and students. Academics have greatly emphasised this approach to be used as an educational tool by kindergarten teachers as it helps in developing their capacities in teaching.

Practice and Status of ECE

Considering the MOE’s keenness to keep up with the rapid development of ICT and its constant endeavours to integrate digital technology and its tools into education, the MOE annually studies and evaluates the existing digital tools to determine their effectiveness and suitability for the educational environment. They also evaluate their efficiency in serving the learning/teaching situation, all with the aim of attaining ideal school environments for students and teachers [68] (p. 29).

However, despite efforts made to integrate digital technology into education in Jordan, the effective implementation of this technology remains limited. Hence, the MOE intends to execute several relevant projects to enhance the efficiency of digital technology. Furthermore, a specialised committee of experts and consultants from the Ministry and outside has identified a strategy to employ digital technology. Therefore, the emphasis on supporting teachers in using digital tools and helping students deal with them is one of the most crucial goals of the MOE in Jordan under three important dimensions:

1. providing teachers with the competences of using digital tools and e-learning,
2. training students through the teachers on how to use digital tools in learning and
3. controlling the quality of education considering e-learning.

Meanwhile, researchers in Jordan have pointed out the need for more development and research in the field of ICT in the ECE context [69,70]. Furthermore, there is also a need to study the use and application of e-learning [71] and how teachers face obstacles whilst using it.

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