Exploring Portuguese preschool educators' attitudes and practices on information and communication technology (ICT)

Begum Canaslan Akyar[1] · Angélica Monteiro[2] · Preciosa Fernandes[2]

Abstract

This study aims to explore preschool educators' attitudes towards to information and communication technology (ICT), its factors and implementation of ICT tools in preschool education by the educators. To this end, a mixed-method research approach was applied, comprising qualitative and quantitative data, collected using survey and field observation. The data, gathered from 58 preschool educators from the north of Portugal, were analysed by SPSS and the qualitative data gathered by five classroom observations analysed by thematic analysis method. Findings indicated that preschool educators have positive attitudes towards ICT integration in education regardless of age, years of teaching experience and attending professional course predictors. Additionally, educators use ICT tools as materials to enhance classroom activities, engage children, and conduct research with them. The results of this study reveal that preschool educators hold positive attitudes toward ICT and actively implement activities using ICT. However, educators are still the main users of ICT in the classroom. It was also observed that as these five classrooms lack the technological infrastructure, the educators usually rely on their personal resources. The lack of ICT resources could affect the independent use of ICT by the children. According to the findings, the study recommends that there are some schools in Portugal that lack ICT infrastructure. In order to overcome this situation, school leaders and policymakers should invest in ICT infrastructure in preschool institutions in Portugal that face a lack of ICT tools.

Keywords Preschool educators · ICT integration · Attitudes towards ICT · Mixed method · Early childhood education

✉ Begum Canaslan Akyar
  begumcanaslan@gmail.com

1   Child Development Program, Tarsus University, Tarsus, Mersin, Turkey

2   Centre for Research and Intervention in Education Faculty of Psychology and Education
    Sciences of the University of Porto (FPCEUP), Porto, Portugal

1 Introduction

The society is rapidly evolving due to the continuous advancements in technology. Almost every household now utilizes various technologies. Even children at a very young age are exposed to Information and Communication Technologies (ICT). According to Ofcom (2023), 87% of children aged 3–4 go online to watch videos, make video calls, and access live streaming sites. As a result, they are developing digital skills and knowledge even before they start preschool (Behnamnia et al., 2023) and the digital language has become an integral part of their daily lives (Konok et al., 2021). Given this societal progress and the significant role ICT plays in children's lives, it is crucial for educational researchers, educators, schools, and policymakers to recognize the importance of integrating ICT in preschool education.

The field of ICT encompasses a wide range of devices, including tablets, laptops, desktop computers, smartphones, toys, games, digital cameras, game consoles, and media players. These devices typically contain a computer or microcontroller (Palaiologou, 2016). Preschool educators are increasingly recognizing the importance of incorporating ICT into their classrooms. They understand that young children are naturally drawn to ICT even at a young age, before they have fully matured (Johnston et al., 2020). Furthermore, certain preschool education policies, such as those outlined by Learning and Teaching Scotland (2003) and the NAEYC Fred Rogers Center (2012), emphasize the significance of integrating ICT into the preschool curriculum. The integration of ICT into preschool involves the development of new activities that enhance children's learning experiences (Mertala, 2019).

According to some authors (Clements & Sarama 2003; Enochsson & Ribaeus, 2020; Rahiem, 2021), the use of ICT in pre-school education can have an impact on children, particularly in terms of increasing their motivation to learn, acquiring digital citizenship skills and stimulating creativity. For example, ICT contributes to children's learning, particularly when it provides open-ended activities, exploration, imagination, and creativity, and allows collaboration (Fernández-Cruz & Fernández-Díaz, 2016) and immediate feedback (Amante, 2007). However, preschool education is characterized by a lack of ICT integration, which significantly hinders attempts to incorporate technology into this educational domain (Xie et al., 2019). In addition, sometimes even a classroom is full of ICT tools, a preschool educator is a decision maker on the use or non-use of ICT tools. As using these tools to enrich teaching and facilitate children's learning, the mere use of ICT does not guarantee effective support for children's learning if educators do not know how and when to integrate the tools into teaching (Dore & Dynia, 2020). National Association for the Education of Young Children (NAEYC) has emphasised that the most effective ways of using ICT tools are to engage children actively and avoid placing them in a passive role (NAEYC, 2022). For this reason, studies that go beyond educators' self-reporting and conduct observations to gain a more objective and detailed understanding of educators' use of ICT in the classroom, reducing subjectivity and reliance on educators' memories, are essential to reflect actual implementation in preschool classrooms.

2 Theoretical background

2.1 Constructivist learning

Constructivism is a philosophical and psychological approach in which learners shape and construct what they learn and understand (Bruning et al., 2004) and experience is a function of learning (Schunk, 2012). This approach brought a new vision to learning, shifting the idea of how knowledge can be transferred to learners to how learners can construct knowledge (Schunk, 2012). Learning is accepted as active and socially dependent regardless of age or developmental status. However, it is very crucial that learners should be engaged with the design and implementation of personally significant projects (Harel & Papert, 1991).

According to constructivist learning, a curriculum must be integrated, which means that learners should experience multiple perspectives. Another important feature of constructivist learning is that teaching should not be realized as it is done in traditional learning, rather educators should design the learning environment and learners should explore these materials through active involvement by manipulating materials and social interactions (Schunk, 2012).

Educators are undoubtedly the most important elements of children's learning as educators' knowledge, beliefs and implementations impact successful learning (Gilakjani et al., 2013). The role of educators in the constructivist approach was identified as reinforcing the social and intellectual climate in which collaborative and cooperative learning took place (Nanjappa & Grant, 2003). Preparing the learning environment as interactive, immersive and informative is also the role of educators in constructivist approach (Papert, 1999) so educators become as a coach or facilitator (Gilakjani et al., 2013).

The use of ICT is consistent with the constructivist approach, as ICT facilitates the construction of knowledge by individuals (Er & Eram, 2013) and different types of ICT tools can be used to facilitate learning (Junie, 2006). ICT tools in constructivist approach can help to replace teacher-centered learning with learner-centered learning as learners can become active recipients, work collaboratively in small or large groups and take responsibility for their learning. In addition, ICT is used in meaningful activities such as problem-solving and critical thinking, and they can learn how to search the Internet, which stimulates learners' curiosity (Dawson et al., 2008). The use of ICT in a constructivist learning means that learners can be freed from the dominance of the educator (Jha, 2017), learners' previous learning can be actively used, individual differences can be easily accommodated, access to different types of information can be provided, and individual and collaborative learning can be supported (Isik, 2018).

It should always be recognized that educators should prepare the learning environment through educational materials, that ICT tools are part of these materials, and that learners should build knowledge through their own active use. However, six factors may hinder the integration of ICT in education have been identified: lack of resources, specific knowledge and skills, institutional structures, educators' attitudes and beliefs towards technology, and types of assessment and subject culture that affect the successful integration of technology in education (Hew & Brush, 2007).

2.2 ICT implementation and barriers in preschool education

Researchers shows that incorporating ICT in preschool enhances children's motivation to learn, develops digital citizenship skills, and fosters children's creativity (Clements & Sarama, 2003; Enochsson & Ribaeus, 2020; Rahiem, 2021). Additionally, ICT is an appropriate tool to help children build their academic and social skills covering computational thinking, language development and information processing (Rideout & Robb, 2020). NAEYC (2022) states in Developmentally Appropriate Practices (DAP) that ICT tools can be beneficial when interactive tools are integrated in a purposeful way. Educators should ensure that ICT tools enhance children's communication, enable them to understand new ICT tools, and integrate ICT into children's play (NAEYC, 2012). More specifically, the tools should be used with children in preschool education;

- Children should experience the developmentally appropriate ICT tools individually.
- Children should have the opportunity to search for answers on a website using a real mouse and keyboard.
- Take photos and videos of children during activities such as drama and watch them later with the children.
- Children's progress can be recorded via audio and/or video to document their development (NAEYC, 2012).

However, these benefits can only be realised if educators have positive attitudes towards the use of ICT, have access to the technology and are able to use it appropriately.

There are many challenges to the inclusion of ICT tools in preschool settings. These barriers include unfavourable attitudes of educators, inadequate training on purposeful technology use with young children, limited access to devices, software, and the internet, uncertainty about standards, rapid technology development trends, and a shortage of time to successfully integrate technology into classroom activities (Blackwell et al., 2014; Bingimlas, 2009).

The integration of ICT into education is closely tied to educators' decision-making as leaders of educational implementation (Neumann et al., 2018). Educators need to be well-informed about the potential of various ICT types and adept at deciding when, how, why, and what technology is most beneficial for classroom use (Ihmeideh & Al-Maadadi, 2018). Lack of knowledge about ICT integration can lead to inappropriate usage, resulting in inactive roles for children and inadequate guidance for their responses (Sargent, 2017). Consequently, this situation may elicit negative emotions in children and limit their learning opportunities (Park, 2015). The concern over inappropriate usage may not only jeopardizes the educational benefits of ICT but also poses the risk of educators avoiding its use altogether.

Finally, attitudes towards ICT have been examined in the education context to explain educators' ICT implementation in education. According to the existence literature, attitudes towards ICT are impacted by educator-level factors, like age (Lawrence & Tar, 2018; Schomakers et al., 2018) and years of teaching experience (Ayub

et al., 2015), which is usually associated with age (Siyam, 2019) and professional knowledge on the ICT integration. For instance, Huang et al. (2019) argued that novice and young educators think they can follow technological development and are comfortable using technology hence they successfully integrate technology into education. However, according to the same author, senior educators believe they lack technical knowledge, they do not have the confidence to apply technology in the education environment. Clearly, educators required training in technology innovations, and they need to learn how they use them in education and their individual development (Baturay et al., 2017). Notably, educators' experience with digital technology is one of the influencers on their attitudes towards ICT (Lawrence & Tar, 2018).

2.3 Using ICT in preschool education in portugal

In Portugal, early childhood education is split into two groups: children up to three years old and those older than three years old. Children under three years old are not part of the formal education system, but instead are cared for by the Ministry of Labour, Solidarity and Social Security (MTSSS). Typically, private non-profit organizations or other private institutions recognized by the MTSSS provide services for these children. Between three and six years old, children can enrol in the formal education system, with the Ministry of Education responsible for providing education in this age range. There are both private and public institutions providing pre-primary education for these children. However, preschool education is not mandatory in Portugal, though the majority of children aged between 3 and 6 years (93.3%) attended preschool in the 2020–2021 academic year (DGEEC, 2023).

The OCEP (Orientações Curriculares para a Educação Pré-Escolar), which is a legal document created by the Ministry of Education in 2016, provides guidance for the design and management of preschool education. According to the curriculum, children are subjects and agents of the learning process, which means that children play an active role in their learning journey and that learning takes place in their social context. The learning areas are highlighted in OCEP, three content areas that educators should focus on: personal and social education, expression and communication, and the world of knowledge. These content areas provide a framework for educators to teach children. Technology is a part of the world of knowledge section of the Portuguese preschool education curriculum framework. The pedagogical and curricular framework for preschool education encourages the integration of ICT in the education settings and children's play, as stated by Figueiredo and Alves (2021). This curriculum framework serves as a standard reference for all educators at this stage without restricting them in their daily activities.

The COVID-19 pandemic has led to significant changes in Portugal as in the other European countries and has recognized the increased importance of utilizing ICT in education (European Commission, 2020). By the aim of qualified educators with digital skills some studies have been conducted to define the current situation in the country. According to the European Commission study, the profile of educators in Portugal reveals that 12% of educators need to enhance their ICT skills for effective implementation in education. Furthermore, 49% of primary school educators have received training in pedagogical ICT usage, and a total of 72% of educators have

undergone training in the last five years (European Commission, 2020). However, these figures lag significantly behind those of other European countries, emphasizing the need to increase the supply of ICT skills training for educators.

Additionally, improvements in digital infrastructure and equipment are essential for Portuguese schools (Vieira & Pedro, 2023). Furthermore, the Portuguese Ministry of Education conducted a study, the results shown that educators with 5 to 15 years of teaching experience demonstrated an improvement in their digital skills. In contrast, educators with more extended years of experience exhibited a reduced level of digital competencies (Lucas & Bem-haja, 2021). Additionally, as a current study reported that preschool educators usually employ the ICT tools to communicate with their peers and parents also administrative and pedagogical tasks (Preciosa et al., 2023) but the utilization of ICT has the potential to enhance to children's learning in preschool education as well.

Within this framework, this study aims to present the attitudes of preschool educators towards the use of ICT according to the aforementioned implications at the country level and their predictors such as age, professional experience and professional training.In addition to the teachers' self-reports, the study also provides observational results on how ICT is integrated into the daily educational routine, as the use of ICT tools alone is not enough to empower children's learning.

Aligned with the study's objectives, the research endeavors to address the following questions:

1. What are the attitudes of preschool educators in the North of Portugal towards ICT in their educational practices?
2. To what extent is there a relationship between the age, years of experience of preschool educators and their attitudes towards incorporating ICT in their teaching methodologies?
3. Is there a significant difference between attending professional training and preschool educators' attitudes towards incorporating ICT in their teaching methodologies?
4. How do preschool educators in the North of Portugal practically implement ICT in their educational approaches?

3 Material and method

The methodology of the study is described in this section. The study design, participants, data collection tools, and data analysis are described below.

3.1 Study design

The study was designed as a mixed-method study. Tashakkori and Creswell (2007) defined mixed-method research as "research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry"

(p. 4). Additionally, the mixed method research provides an opportunity to have a more complete understanding of research questions. The current study was designed based on the sequential design. The sequential design means that at least two parts chronologically follow the other part (Teddlie & Tashakkori, 2009). To illustrate, the quantitative part runs first, and then the qualitative part follows it, or vice versa. In the current study, the procedure was started with data collected from preschool educators in the North of Portugal by means of a questionnaire, and then classroom observation was implemented to explain the situation in depth.

4 Survey method

4.1 Participants and procedure

The study was conducted in the Municipality of Porto, located in the North of Portugal. 58 preschool educators responded to the survey. All of the participants were female, and their ages ranged from 23 to 27 to 53+. The educators are cumulated between the age range 48–52 and 53+years old. 81% of the educators have a bachelor's degree, 17% a master's degree and 1% a doctorate degree. All participating educators use ICT in their professional lives (see Table 1). Convenience sampling was used to select participants. An online questionnaire was generated as a data col-

Table 1 Preschool educators' demographics ($N=58$)

Measure	n	%
Age		
23–27	1	1.7
28–32	3	5.2
33–37	0	0
38–42	4	7.0
43–47	3	5.2
48–52	11	19.0
53+	36	62
Educational Background		
Bachelor's	47	81.0
Master's	10	17.2
Doctorate	1	1.7
Years of teaching experience		
1–5	2	3.4
6–10	3	5.1
11–15	1	1.7
16–20	3	5.1
21–25	8	13.8
26–30	7	12.1
31–35	16	27.6
36–40	16	27.6
41+	2	3.4

lection tool and this questionnaire was shared with preschool educators who work in the northern part of Portugal through digital devices.

4.2 Instrument

4.2.1 Attitudes towards ICT questionnaire

The questionnaire on preschool educators' attitudes towards ICT consists of three parts. The first section asks about educators' demographic information, the second section questions about their use of ICT in educational settings, and the last section asks about their attitudes. The last part includes three core attitudes towards ICT namely, general attitudes towards ICT, attitudes towards educational use, and perceived ease of ICT use. These three core parts were gathered by Scherer et al. (2018).

There are 11 items on the 5-Likert-scale statements. Participants can rate their level of agreement on a scale of 1 to 5, with 1 representing "strongly disagree" and 5 representing "strongly agree." The scale is formed by three subscales. *General attitudes towards ICT* (GATT) include five items about general interest, pleasure, and usefulness. *Attitudes towards educational use of ICT* (EDATT) measure the perceived usefulness of ICT for teaching and learning. Finally, *ease of use* (EASE) comprises three items measuring general perceptions about how easy it is to use ICT in the general context. In their study, Scherer et al. Cronbach's alpha values for the following scales were found: GATT=0.85; EDATT=0.83 and EASE=0.89. In the current study Cronbach's alpha values calculated as following: GATT=0.87; EDATT=0.87 and EASE=0.95.

4.3 Observation method

After collecting quantitative data, one researcher from the study team, conducted classroom observations to provide in-depth insights into the use of ICT in education. For this purpose, two non-profit preschool institutions were selected for observation. These schools are in the city centre of the municipality of Porto, Portugal. One of the schools has four classrooms and the other has six classrooms. Observations were conducted in classes of 3-4-5-year-olds, with an average of 20 children enrolled in each class. The observation processes were planned with the school principals. They determined which classes would be observed and which days would be observed according to their daily schedules. The observations were scheduled once a week for four hours. The observations started at 8:00 am and lasted until before lunch break (12:00 pm). A total of five observations were conducted over two months (March and April).

Direct observation is used to count or measure certain behaviours (Lewis et al., 2014). Observations were made of the educators during a specific period from morning to afternoon) and ICT integration was recorded. As part of the observation, the researcher participated in the class and activity with the children without interfering with or intervening in the learning process.

The educators introduced the observer to the children as a guest who wanted to play with them and stay in their classroom until lunch break. Since the focus was not

on the children, the observer played and interacted with the children. Each school has fairly large spaces for classrooms. In the classroom children have books, different types of toys, an art centre with a sink, common areas and a gymnastics room. However, none of the classrooms have technological infrastructure such as laptop, desktop computers, tablet projectors, speakers, etc. for regular use. Solely one of the schools also has a computer lab which is accessible to preschool children as well.

The observed classrooms were coded as A, B, C, D, E.

4.4 Data analysis

The quantitative part of the study data was analysed using the SPSS 22.0 package. In the first step, missing data and normality were checked. According to the descriptive analysis, the data are normally distributed and there are no outliers in the data set, so 58 sets of observation data were subjected to correlational analysis. Age, years of teaching experience and attitudes towards ICT were analysed with correlational statistics. Professional training in digital technology was analysed by t-test. The qualitative data was collected as field notes during each observation. These notes were typed in laptop and then analysed through coding these data. Afterwards, the data was analysed through qualitative thematic content analysis. Thematic content analysis refers to the process of interpreting and making sense of qualitative data sources in a broader sense. Thematic content analysis analyses data based on categories or topics to interpret the qualitative data (Patton, 2002). The analysis process has been started with the first reading of the open-ended answers gathered through the survey and also the field notes. While the first reading, some notes had been attached to the document to define the codes. Then, during the second reading, the actual coding and categories have been decided in a systematic way.

5 Results

The results of the data analysis are presented in this section.

5.1 Quantitative data analysis

The following section presents the outcomes of quantitative data analysis derived from preschool educators' responses through a questionnaire. The data were analyzed using SPSS V22.

To respond the first research question "What are the attitudes of preschool educators in the North of Portugal towards ICT in their educational practices?" mean score of the overall scale was calculated. Additionally, the mean of subscales was calculated too. As shown in Table 2, preschool educators' attitudes towards ICT were positive with an overall mean score of 4.2 and a standard deviation of 0.64. Additionally, the attitudes dimensions found positive with an overall mean and standard deviation respectively GATT $M=4.4$ and $SD=0.43$; EDATT $M=4.3$ and $SD=0.75$; EASE $M=3.8$ and $SD=0.90$.

Table 2 Distribution of mean scores on the attitudes towards ICT scale

	N	Mean	SD
Attitude towards ICT	58	4.2	0.64
GATT	58	4.4	0.43
EDAT	58	4.3	0.75
EASE	58	3.8	0.90

Table 3 Pearson product moment correlation matrix of age and attitudes towards ICT

Variable	GATT	EDATT	EASE	ATT	Age
GATT	1.00				
EDATT	0.709**	1.00			
EASE	0.431**	0.388**	1.00		
ATT	0.900**	0.828**	0.725**	1.00	0.00
Age	0.105	−0.026	−0.120	0.00	1.00

Correlation is significant at the 0.01 level (2-tailed)

5.2 Age and attitudes towards ICT correlation

A correlation test was run to show the correlation between preschool educators' age and their attitudes towards ICT and to answer research question "To what extent is there a relationship between the age, years of experience of preschool educators and their attitudes towards incorporating ICT in their teaching methodologies?". Pearson Product Moment correlation was employed to describe the relationship between the preschool educators' attitudes towards ICT and its dimensions GATT, EDATT and EASE as dependent variables and age as an independent variable. The correlation matrix shows that there is not a significant correlation between age and attitudes towards ICT ($r=0.00$, $p<0.01$) and its dimensions GATT ($r=0.105$, $p<0.01$); EDATT ($r=-0.26$, $p<0.01$); EASE ($r=-0.120$, $p<0.01$) (see Table 3).

The current study found that age is not a significant factor for attitudes towards ICT as well as general attitudes (GATT), attitudes towards educational use of ICT (EDATT) and perceived ease of use ICT (EASE).

5.3 Years of teaching experience and attitudes towards ICT

To present the correlation between preschool educators' years of teaching experience and attitudes towards ICT and its dimensions, a correlation test was run. The result of the Pearson correlation (Table 4) shows the relationship between years of teaching experience (exp.) and attitudes towards ICT. The dimensions of ATT were also examined. Preliminary analyses were performed to ensure no violation of the assumption of normality and linearity. According to the analysis, there is no correlation between the years of teaching experience and attitudes towards ICT ($r=0.07$, $n=58$, $p<0.05$) and years of teaching experience (exp.) and attitude dimensions GATT ($r=0.112$, $p<0.01$); EDATT ($r=0.16$, $p<0.01$); EASE ($r=-0.145$ $p<0.01$).

Table 4 Pearson product moment correlation matrix of years of teaching experience (Exp.) and attitudes towards ICT

Variable	GATT	EDATT	EASE	ATT	Exp.
GATT	1.00				
EDATT	0.709**	1.00			
EASE	0.431**	0.388**	1.00		
ATT	0.900**	0.828**	0.725**	1.00	0.00
Exp.	0.112	0.016	−0.145	0.07	1.00

Table 5 Attending professional course and attitudes towards ICT

	N	M	SD	t	p
Attitudes towards ICT					
Attending	30	45.96	7.13	0.504	0.62
Not attending	25	46.92	6.8		
GATT					
Attending	30	22.04	3.31	−0.064	0.96
Not attending	25	22.1	3.57		
EDATT					
Attending	30	13.68	1.97	2.33	0.23
Not attending	25	12.3	2.33		
EASE					
Attending	30	11.2	3.18	−0.49	
Not attending	25	11.5	2.32		0.62

5.4 Professional training and attitudes towards ICT

To compare the mean score of attending professional training in ICT to answer the third research question "Is there a significant difference between attending professional training and preschool educators' attitudes towards incorporating ICT in their teaching methodologies?", an independent sample t-test was conducted. According to the statistical analysis, there was no statistically significant difference between attending a professional training in ICT ($M=45.96$, $SD=7.13$) and not attending professional training ($M=46.92$, $SD=6.8$) and attitudes towards ICT (t (53)$=0.504$, $p=0.62$) (see Table 5). Additionally, there were no found significant difference between attending a professional training ($M=22.04$, $SD=3.31$) and not attending professional training ($M=46.92$, $SD=6.8$) and GATT (t (53) $=$.-06, $p=0.96$); no statistically significant found between attending a professional training in ICT ($M=13.68$, $SD=1.97$) and not attending professional training ($M=12.13$, $SD=2.33$) and EDATT (t (53)$=0.233$, $p=0.23$); there is no statistically significant difference between attending a professional training ($M=11.2$, $SD=3.18$) and not attending professional training ($M=11.5$, $SD=3.18$) and EASE (t (53) $=$.-49, $p=0.62$).

5.5 Qualitative data analysis

In order to answer the fourth research question, which is "How do preschool educators in the North of Portugal practically implement ICT in their educational approaches?",

qualitative data was gathered through open-ended questions in a questionnaire and observation. The data was analyzed based on thematic analysis, which revealed several themes. The results can be seen in Table 6.

Some observational anecdotes describing how teachers use ICT tools in the classroom are given below.

5.6 ICT as educational material

Class D was in English class. The subject was emotions. They began playing with monsters of different colors and emotions. The educator hung the monsters around the class. Children were asked individually, "Can you show me the angry monster?", and "What is the color of the happy monster?" etc. They continued the activity until every child performed the same activity. Afterward, they moved on to another activity. On the floor, they sat in a circle. The educator put an English song on her computer. When the song plays, the children tried to see the screen of the teacher's laptop, but the educator did not show the screen as she said them to concentrate on the lyrics. When the children listened to the song once, they started singing it with the educator. They consolidated what they learnt with the song. In this example, the educator used a laptop as an educational tool to facilitate carrying out educational activity.

5.7 ICT for creating portfolio

The researcher observed that in class A, the main educator was completing some documents with her laptop. The educator explained that she records children's performance in some activities. A child's file was brought to the researcher so that she could see what kind of activities the child participated in and what record she had about the child's development. For instance, they had a field trip to a veterinarian, after they came back to school, the educator asked individually each child what they learned as a new word today and she recorded their answers on their portfolio. A regular portfolio is part of the school culture, and using a computer simplifies the process and ICT makes it easier to do paper-based work. An example of a page from a portfolio is shown in Fig. 1. The activity paper was written using ICT and printed by the educator for inclusion in the portfolio. The educator completed the document based on her

Table 6 Preschool educators' purpose of ICT usage in education

Purpose	Frequency
Communication with parents	7
Material to enrich activity	17
Research	11
Children's engagement	13
Professional network	4
Record keeping	3
Individual learning	3
Pedagogical	7
Assessment	1
Engage children's digital competences	4

Fig. 1 Portfolio sample created by ICT
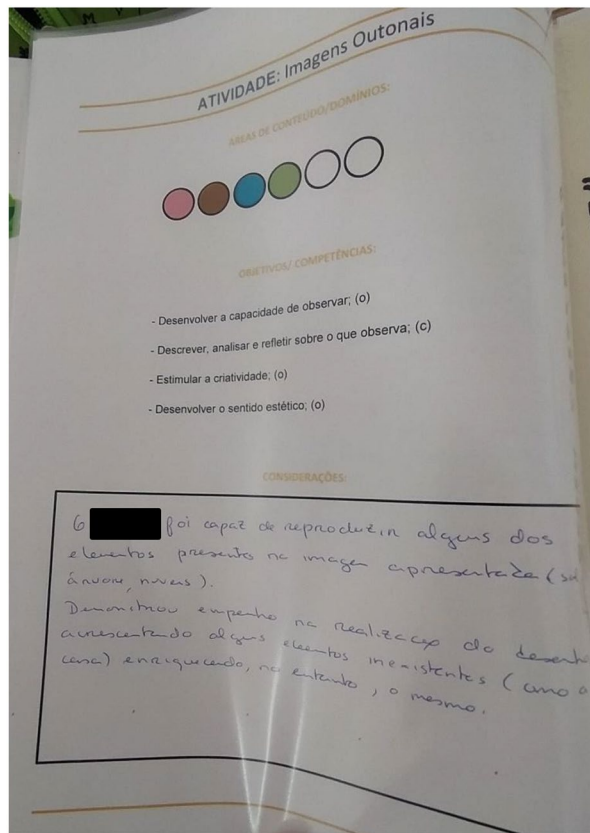
observations and recorded her notes in her own handwriting. The case presented in class A shows that educators utilize ICT tools to create portfolios that track children's development throughout the year. In addition, ICT tools make it easier for them to organize evidence of children's progress.

5.8 ICT as a communication tool

The educator in class A welcomed children to circle time. However, she realized that one of the children was missing. She stood up and checked her phone, then turned to the children and said, "Your friend's parents didn't contact me through our school system. I don't know what happened to him. I'll have to call his parents. If you don't come to school, please remind your parents to inform me through the app, OK? Then she left the class to call his parents. When she returned to the classroom, she told the children about their friends. She then explained to the researcher that they were using a communication application at school. Each class has their own room in the application. All communication (general or private), including sharing of photos, is enabled through the application for parents who enrol in the system. They do not use Whatsapp or other social media. She added that "I like this application. You can store information about children in the program and do not use Whatsapp for pictures of

children or parent conversations. It separates work and private life." The case demonstrates how ICT tools are being used to actively communicate with parents. These devices are also making it easier to inform parents about classroom activities, involve them in the education process and make them feel like a part of the classroom.

5.9 ICT for documentation

Most classes and hallways were filled with children's photos. Based on the observation, educators use ICT as a documentation method. "Children engage in every kind of activity, and this activity (shown in Fig. 2) was about shadows. Observing their shadows at different times of the day was a fun activity for children. We photographed them to recall what they experienced at that time and what they remember about shadows." As the principal declared during the introduction of the school. According to the principal explanation, the photos are used to relaunch an activity and refresh children's memory about the subject. In the case presented, ICT tools can be used to document and remember what children have learned in the past. This is also a good opportunity for children to create valuable learning moments by refreshing their memories.

5.10 ICT as a research tool

A total of two computers were in class E. During free time, some children played with these computers. The educator helped them while showing how to control the cursor, how to click and talk about keyboards etc. Sometimes, children use computers as dramatic play material. The educator explained why the computer in their classroom is different from other classes. She said that their last project was about TV, while they are improving their project, children require to conduct some research about technology and TV, therefore educator requested a computer from school principal. Ultimately, they borrowed these two computers. When they finish the project, these computers will be returned back to the computer lab. ICT tools provide immediate

Fig. 2 Photos from shadow activity
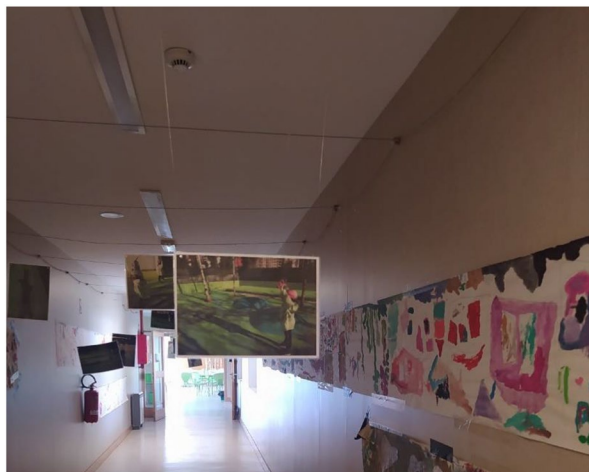
access to knowledge on the internet. Integrating ICT as a research tool in education allows students to ask questions and obtain answers from web browsers. This is a beneficial practice for living in a digital society.

6 Discussion

The objective of this study was to investigate the attitudes of preschool educators in the North of Portugal and explore the potential impact of factors namely age, years of teaching experience, attending professional course on these attitudes. Additionally, the study aims to explore the implementation ICT base activities in the classroom was identified to show the reflection of attitudes on the real classroom environment.

What are the attitudes of preschool educators in the North of Portugal towards ICT in their educational practices? To explore the attitudes of pre-school teachers towards the use of ICT in education and to answer the research question "What are the attitudes of preschool educators in the North of Portugal towards ICT in their educational practices?" the study findings indicated that the preschool educators in the North of Portugal held positive attitudes towards ICT, which is consistent with previous literature (Brito et al., 2021). These findings reaffirmed the general positivity among preschool educators regarding the use of ICT in educational settings, recognizing its numerous advantages. As well as the preschool educators adopted diverse approaches in utilizing ICT within their educational environments.

To what extent is there a relationship between the age, years of experience of preschool educators and their attitudes towards incorporating ICT in their teaching methodologies? Regarding the relationship between age and attitudes towards ICT in relation to the second research question, the study found no significant correlation among preschool educators. Although age has been considered a significant factor in some prior studies (Arrosagaray et al., 2019; Semerci & Aydın 2018; Teeroovengadum et al., 2017), it did not emerge as a decisive factor in this study. The study also did not find a significant correlation between years of teaching experience and attitudes towards ICT among preschool educators. This aspect remains under debate in the existing literature, with conflicting views from previous studies. Some researchers argued that novice educators are more comfortable with technology and rely on it in their activities (Huang et al., 2019), while others suggested that attitudes towards ICT improve with higher levels of teaching experience due to enhanced problem-solving capabilities (González-Sanmamed et al., 2017). However, this study results, both quantitative and qualitative, aligned with the perspective that years of teaching experience might not be a decisive factor in shaping attitudes towards ICT among preschool educators. Further research could provide additional insights and contribute to a better understanding of this relationship. In short, attitudes towards the use of ICT in education are positive across all age groups.

Is there a significant difference between attending professional training and preschool educators' attitudes towards incorporating ICT in their teaching methodolo-

gies? Surprisingly, professional training in ICT was not found to be a significant factor in shaping attitudes towards ICT among preschool educators. Typically, attending professional training in ICT is expected to positively impact educators' attitudes by fostering appropriate integration of technology in the classroom (Hernández et al., 2018). The current result could be explained that the content of the professional training might not satisfy the educators to change their attitudes, or the level of the training would not be appropriate for the educators participating. As Dong (2018b) argued that an effective professional training in ICT should provide knowledge on their specific needs and not solely focus on providing technical knowledge. Moreover, continuous support and guidance after the training are essential to ensure that the positive impact is sustained over time (Uslu & Bumen, 2012; Romero-Tena et al., 2020). Uslu and Bumen's (2012) study indicates that educators, motivated to integrate ICT into education after six weeks of professional development, faced challenges sustaining this motivation due to a lack of guidance and support post-training. Romero-Tena et al. (2020) emphasizes the significance of not only providing training opportunities but also ensuring adequate frequency, duration, and support afterward to sustain the effectiveness of the training.

How do preschool educators in the North of Portugal practically implement ICT in their educational approaches? In relation to the third research question, teachers' use of ICT was explored. Educators participating in the study reported that the primary use of ICT in education is to provide materials that support educational activities, in line with findings in previous research (Öngören, 2022; Sundqvist, 2021). The study also notes that children were engaged in information searches on desktop computers, even though there is limited individual access due to the inadequacy of classroom computers. Despite the potential role of educators in supporting ICT activities, challenges remain, such as limited computer availability and the need for assistance with search queries (Plowman & Stephen, 2005). Furthermore, the study highlights the widespread use of ICT for research, consistent with the literature on educators seeking information during science activities (Walan & Enochsson, 2022). This is in line with the broader benefits of internet searches that help explain phenomena for children and increase educators' content knowledge (Furman et al., 2019; Mishra & Koehler, 2006).

ICT plays an important role in facilitating communication with parents; educators often use photos and videos to showcase children's development and daily activities (Romero-Tena et al., 2020). The study highlights the effectiveness of direct communication apps that allow real-time sharing of information, photos and videos, as well as engagement and tracking of important updates (Lindeman et al., 2021). This approach has significantly reduced reliance on paper-based communication, aligning with environmentally friendly practices. In addition, ICT is being used for record keeping and tracking children's progress, integrated into documentation and digital portfolios to effectively track and consolidate learning experiences (Masoumi, 2015; Knauf, 2020).

The study reveals progress in preschool educators' use of ICT and shows a shift from previous roles such as documentary screener, babysitter or play tool to a more

instructive tool for children (McPake et al., 2012; Ljung-Djärf, 2008; Lindahl & Folkesson, 2012). Despite some improvements, the current situation shows that ICT tools are not being used to facilitate children's construction of knowledge through manipulation of materials, social interaction and taking responsibility for their own learning. In addition, these applications show that children are dependent on teachers when using ICT.

The results of the study also show that in most cases, educators are the main users of ICT and children play a passive role in the classrooms observed. Children are still dependent on educators for ICT use. The real implication that observed classrooms, therefore, may not in line with NAEYC's effective implementation of ICT in preschool settings. The current situation shows that educators and parents are the main actors in the use of ICT in preschool education, rather than children. The situation may arise where educators are unaware of their pedagogical role in children's ICT skills and, and as Dong (2018a) emphasised, they may need for support in developing both ICT knowledge and pedagogical understanding.

7 Implication

While the study highlights the positive attitudes of preschool teachers in the North of Portugal towards ICT integration, the implementation of ICT in preschool education may not be sufficient to construct preschoolers' knowledge. To promote more constructivist and effective way of ICT incorporation into preschool education, preschool educators would be well equipped not only with technological tools but also with pedagogical strategies that maximize the benefits of ICT in preschool education.

In order to use ICT tools to enhance learning, the technological infrastructure would have to be adequate and educators could be equipped with knowledge on how to be facilitators of ICT tools rather than main users. It can be suggested that professional training in ICT is crucial. In this sense, policy makers and school leaders should prioritise in their investment considerations not only the provision of hardware, but also the development of specific training programmes to enhance the skills of educators to integrate ICT effectively into the educational environment.

7.1 Limitations

It is essential to acknowledge several limitations of this study. First of all, there is a limitation in the quantitative part of the study, where the number of participants was relatively small, consisting of 58 participants. Even though the findings provide valuable insights, the small sample size might be a limitation to generalize the result. Future research with large sample size and more diverse sample might improve the robustness and external validity of the findings. Secondly, the qualitative data were collected from non-profit preschools, which may limit the generalizability of the findings to other types of preschools. Additionally, while questions were posed during classroom observations to gain insight into educators' application of ICT, formal interviews were not conducted as part of the study. Directly querying educators about their age and years of teaching experience might have provided more precise data.

Finally, each classroom was observed only once, and further investigations could benefit from more extended observation periods and follow-up interviews to gain deeper insights into ICT implementation and pedagogical practices among preschool educators.

This study primarily focused on preschool educators' attitudes towards ICT and investigated both their predictors and real-life ICT applications. However, further investigation is necessary. For example, it would be beneficial to examine whether the content and methods of professional training enable educators to practice ICT, and how this hands-on experience impacts their attitudes. Additionally, a comparison could be made between the attitudes of educators who use ICT as a pedagogical tool in the classroom and those who do not use ICT in education.

Data availability No data or models were used or generated in this study.

Declarations

Competing interests The authors report there are no competing interests to declare.

References

Amante, L. (2007). As TIC na escola e no jardim-de-infância: Motivos E factores para a sua integração. *Sísifo Revista De Ciências Da Educação*, *3*, 51–64. http://sisifo.fpce.ul.pt.

Arrosagaray, M. M., González-Peiteado, Pino-Juste, M., & Rodríguez-López, B. (2019). A comparative study of Spanish adult students' attitudes to ICT in classroom, blended and distance language learning modes. *Computers & Education*, *134*, 31–40. https://doi.org/10.1016/j.compedu.2019.01.016.

Ayub, A. F. M., Bakar, K. A., & Ismail, R. (2015). Factors predicting educators' attitudes towards the use of ICT in teaching and learning. In I.Mohame, L. T. How, A. Chin, Y. Mui, W. K. Bin (Eds.) AIP Conference Proceedings October, 030010, https://doi.org/10.1063/1.4932473.

Baturay, M. H., Gökçearslan, Ş., & Ke, F. (2017). The relationship among pre-service teachers' computer competence, attitude towards computer-assisted education, and intention of technology acceptance. *International Journal of Technology Enhanced Learning*, *9*(1), 1–13. https://doi.org/10.1504/IJTEL.2017.10003119.

Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, S. A. (2023). A review of using digital game-based learning for preschoolers. *Journal of Computers in Education*, *10*(4), 603–636. https://doi.org/10.1007/s40692-022-00240-0.

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics Science and Technology Education*, *5*(3), 235–245.

Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2014). Factors influencing digital technology use in early childhood education. *Computers & Education*, *77*, 82–90. https://doi.org/10.1016/j.compedu.2014.04.013.

Brito, R., Dias, P., Barqueira, A., & Silva, J. (2021). *A Utilização De Tecnologias Digitais Por Educadores De Infância E Crianças que Frequentam a Educação Pré-escolar, em Portugal*. Edição ISEC Lisboa - Escola de Educação e Desenvolvimento Humano.

Bruning, R. H., Schraw, G. J., Norby, M. M., & Ronning, R. R. (2004). *Cognitive psychology and instruction* (4th ed.). Merrill/Prentice Hall.

Dawson, K., Cavanaugh, C., & Ritzhaupt, A. D. (2008). Florida's EETT leveraging laptops initiative and its impact on teaching practices. *Journal of Research on Technology in Education*, *41*(2), 143–159.

Direção-Geral de Estatísticas da Educação e Ciência (DGEEC) (2023). Educação em Números - Portugal 2023. https://pessoas2030.gov.pt/wp- content/uploads/sites/19/2023/08/EducacaoEmNumeros_2023.pdfcontent/uploads/sites/19/2023/08/EducacaoEmNumeros_2023.pdf.

Dong, C. (2018a). Preschool educators' perceptions and pedagogical practices: Young children's use of ICT. *Early Child Development and Care*, *188*(6), 635–650. https://doi.org/10.1080/03004430.2016.122629.

Dong, C. (2018b). Young children nowadays are very smart in ICT' – preschool educators' perceptions of ICT use. *International Journal of Early Years Education*, 1–14. https://doi.org/10.1080/09669760.2018.1506318.

Dore, R. A., & Dynia, J. M. (2020). Technology and media use in preschool classrooms: Prevalence, purposes, and contexts. *Frontiers in Education*, *5*, 600305. https://doi.org/10.3389/feduc.2020.600305.

Enochsson, A. B., & Ribaeus, K. (2020). Everybody has to get a chance to learn: Democratic aspects of digitalisation in preschool. *Early Childhood Education Journal*, *49*, 1087–1098. https://doi.org/10.1007/s10643-020-01117-6.

Er, M., & Eram, F. (2013). Instructional technology as a tool in creating constructivist classrooms. *Procedia - Social and Behavioral Sciences*, *93*, 1441–1445. https://doi.org/10.1016/J.SBSPRO.2013.10.060.

European Commission (2020). *Digital education action plan 2021–2027: Resetting education and training for the digital age*. https://education.ec.europa.eu/focus-topics/digital-education/action-plan.

Fernández-Cruz, F. J., & Fernández-Díaz, M. J. (2016). Los docentes de la generación z y sus competencias digitales. *Generation'Z Educators and Their Digital Skills*, *46*, 97–105. https://doi.org/10.3916/C46-2016-10.

Figueiredo, M., & Alves, V. (2021). Children and technology: preoccupations, practices and participation in Early Childhood Education. *In ICERI2021 Proceedings* (pp. 4176–4183). IATED.

Furman, M., De Angelis, S., Prost, D., E., & Taylor, I. (2019). Tablets as an educational tool for enhancing preschool science. *International Journal of Early Years Education*, *27*(1), 6–19. https://doi.org/10.1080/09669760.2018.1439368.

Gilakjani, A. P., Lai-Mei, L., & Ismail, H. N. (2013). Teachers' use of technology and constructivism. *International Journal of Modern Education and Computer Science*, *5*(4), 49. https://doi.org/10.5815/ijmecs.2013.04.07.

González-Sanmamed, M., Sangrà, A., & Muñoz-Carril, P. C. (2017). We can, we know how. But do we want to? Teaching attitudes towards ICT based on the level of technology integration in schools. *Technology Pedagogy and Education*, *26*(5), 633–647. https://doi.org/10.1080/1475939X.2017.1313775.

Harel, I., & Papert, S. (1991). *Constructionism*. Ablex Publishing.

Hernández, R. M., Cumpa, O., R., & Quiñones Rodríguez, S. (2018). New ways of learning: Teacher training in the use of ICTs. *Journal of Educational Psychology-Propositos y Representaciones*, *6*(2), 687–701. https://doi.org/10.20511/pyr2018.v6n2.248.

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, *55*, 223–252. https://doi.org/10.1007/s11423-006-9022-5.

Huang, F., Teo, T., & Zhou, M. (2019). Factors affecting Chinese English as a foreign language educators' technology acceptance: A qualitative study. *Journal of Educational Computing Research*, *57*(1), 83–105. https://doi.org/10.1177/0735633117746168.

Ihmeideh, F., & Al-Maadadi, F. (2018). Towards improving kindergarten teachers' practices regarding the integration of ICT into early years settings. *The Asia-Pacific Education Researcher*, *27*(1), 65–78. https://doi.org/10.1007/s40299-017-0366-x.

Isik, A., D (2018). Use of technology in constructivist approach. *Educational Research Review*, *13*, 704–711. https://doi.org/10.5897/ERR2018.3609.

Jha, A. (2017). ICT Pedagogy in higher education: A constructivist approach. *Journal of Training and Development*, *3*, 64–70. https://doi.org/10.3126/jtd.v3i0.18232.

Johnston, K., Hadley, F., & Waniganayake, M. (2020). Practitioner inquiry as a professional learning strategy to support technology integration in early learning centres: Building understanding through Rogoff's planes of analysis. *Prof Dev Educ*, *46*, 49–64. https://doi.org/10.1080/19415257.2019.1647871.

Konok, V., Liszkai-Peres, K., Bunford, N., Ferdinandy, B., Jurányi, Z., Ujfalussy, D. J., & Miklósi, Á. (2021). Mobile use induces local attentional precedence and is associated with limited socio-cognitive skills in preschoolers. *Computers in Human Behavior*, *120*, 106758. https://doi.org/10.1016/j.chb.2021.106758.

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence educators' adoption and integration of ict in teaching/learning process. *Educational Media International*, *55*(1), 79–105. https://doi.org/10.1080/09523987.2018.1439712.

Learning and Teaching Scotland. (2003). *Early learning, forward thinking: The policy framework for ict in early years*. Dundee.

Lewis, T. J., Scott, T. M., Wehby, J. H., & Wills, H. P. (2014). Direct observation of educator and student behavior in school settings: Trends, issues and future directions. *Behavioral Disorders*, *39*(4), 190–200. https://doi.org/10.1177/019874291303900404.

Lindahl, M. G., & Folkesson, A. (2012). ICT in Preschool: Friend or foe? The significance of norms in a changing practice. *International Journal of Early Years Education*, *20*(4), 422–436. https://doi.org/10.1080/09669760.2012.743876.

Lindeman, S., Svensson, M., & Enochsson, A. B. (2021). Digitalisation in early childhood education: A domestication theoretical perspective on teachers' experiences. *Educ Inf Technol*, *26*, 4879–4903. https://doi.org/10.1007/s10639-021-10501-7.

Ljung-Djärf, A. (2008). To play or not to play – that is the question: Computer use within three Swedish preschools. *Early Education & Development*, *19*(2), 330–339. https://doi.org/10.1080/10409280801964069.

Lucas, M., & Bem-haja, P. (2021). Estudo sobre o nível de competências digitais dos docentes do ensino básico e secundário dos agrupamentos de escolas e das escolas não agrupadas da rede pública de Portugal continental. *Aveiro: Ministério da Educação–Direção-Geral da Educação*. https://www.dge.mec.pt/sites/default/files/Noticias_documentos/estudo_sobre_o_nivel_de_competencias_digitais_dos_docentes_do_ensino_basico_e_secundario_dos_agrupamentos_de_escolas_e_das_escolas_nao_agrupadas_da_rede_publica_de_portugal_continental.pdf.

Masoumi, D. (2015). Preschool educators' use of ICTs: Towards a typology of practice. *Contemporary Issues in Early Childhood*, *16*(1), 5–17. https://doi.org/10.1177/1463949114566753.

McPake, J., Plowman, L., & Stephen, C. (2012). Pre-school children creating and communicating with digital technologies in the home. *British Journal of Educational Technology*, *44*(3), 421–431. https://doi.org/10.1111/j.1467-8535.2012.01323.x.

Mertala, P. (2019). Digital technologies in early childhood education – a frame analysis of preservice teachers' perceptions. *Early Child Dev Care*, *189*, 1228–1241. https://doi.org/10.1080/03004430.2017.1372756.

Ministério da Educação (2016). *Orientações curriculares para a educação pré-Escolar*. https://www.dge.mec.pt/ocepe/sites/default/files/Orientacoes_Curriculares.pdf.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in educator knowledge. *Educators College Record*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x.

NAEYC and Fred Rogers Center (2012). *A Joint position statement: Technology and interactive media as tools in early childhood programs serving children from birth through age 8* https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/position-statements/ps_technology.pdf.

Nanjappa, A., & Grant, M. M. (2003). Constructing on constructivism: The role of technology. *Electronic Journal for the Integration of Technology in Education*, *2*(1), 38–56.

National Association for the Education of Young Children. (2022). *Developmentally appropriate practice in early childhood programs* (4th ed.). NAEYC.

Neumann, M. M. (2018). Using tablets and apps to enhance emergent literacy skills in young children. *Early Childhood Research Quarterly*, *42*, 239–246. https://doi.org/10.1016/j.ecresq.2017.10.006.

Ofcom (2023, March 29). *Children and parents: media use and attitudes report 2023* https://www.ofcom.org.uk/__data/assets/pdf_file/0027/255852/childrens-media-use-and-attitudes-report-2023.pdf.

Öngören, S. (2022). Educators' use of ICT in the preschool period: A mixed research method. *Education and Information Technologies*, 1–22. https://doi.org/10.1007/s10639-022-11066-9.

Palaiologou, I. (2016). Educators' dispositions towards the role of digital devices in play-based pedagogy in early childhood education. *Early Years*, *36*(3), 305–321. https://doi.org/10.1080/09575146.2016.1174816.

Papert, S. (1999). *Ghost in the machine: Seymour Papert on how computers fundamentally change the way kids learn*. https://dailypapert.com/ghost-in-the-machine-seymour-papert-on-how-computers-fundamentally-change-the-way-kids-learn/.

Park, E. (2015). *A case study exploring TPACK framework within the context of early childhood education* [Dissertation, University of Hawai]. http://hdl.handle.net/10125/51006.

Patton, M. Q. (2002). *Qualitative research & evaluation methods: Integrating theory and practice* (3rd ed.). Sage.

Plowman, L., & Stephen, C. (2005). Children, play and computers in pre-school education. *British Journal of Educational Technology*, *36*(2), 145–157. https://doi.org/10.1111/j.1467-8535.2005.00449.x.

Preciosa, F., Angélica, M., Carla, F., Paulo, M., & Carla, V. (2023). Digital platforms and technologies in preschool education in Portugal: Perceptions of preschool teachers. *Asia-Pacific Journal of Research in Early Childhood Education*, *17*(3). https://doi.org/10.17206/apjrece.2023.17.3.73.

Rahiem, M. D. (2021). Storytelling in early childhood education: Time to go digital. *International Journal of Child Care and Education Policy*, *15*(4). https://doi.org/10.1186/s40723-021-00081-x.

Rideout, V., & Robb, M. (2020). The commonsense census: Media use by kids age zero to eight. Common Sense Media. https://www.commonsensemedia.org/sites/default/files/research/report/2020_zero_to_eight_census_final_web.pdf SaldañaSaldaña, J. (2015). The coding manual for qualitative researchers. Sage.

Romero-Tena, R., López-Lozano, L., & Gutiérrez, M. (2020). Types of use of technologies by Spanish early childhood teachers. *European Journal of Educational Research*, *9*, 511–522. https://doi.org/10.12973/eu-jer.9.2.511.

Sargent, A. R. (2017). *Urban preschool teachers' instructional technology integration perceptions and practices* [Dissertation, Hampton University]. https://www.proquest.com/dissertations-theses/urban-preschool-teachers-instructional-technology/docview/1900177790/se-2?accountid=13014.

Scherer, R., Tondeur, J., Siddiq, F., & Baran, E. (2018). The importance of attitudes toward technology for pre-service educators' technological, pedagogical, and content knowledge: Comparing structural equation modeling approaches. *Computers in Human Behavior*, *80*, 67–80. https://doi.org/10.1016/j.chb.2017.11.003.

Schomakers, E. M., Offermann-van Heek, J., & Ziefle, M. (2018). *Attitudes towards aging and the acceptance of ICT for aging in place*. In International Conference on human aspects of it for the aged population. Springer, Cham., July, 149–169.

Schunk, D. H. (2012). *Learning theories an educational perspective* (6th ed.). Pearson Education, Inc.

Semerci, A., & Aydin, M. K. (2018). Examining high school educators' attitudes towards ICT use in education. *International Journal of Progressive Education*, *14*(2), 93–105. https://eric.ed.gov/?id=EJ1177301.

Siyam, N. (2019). Factors impacting special education educators' acceptance and actual use of technology. *Education and Information Technologies*, *24*(3), 2035–2057. https://doi.org/10.1007/s10639-018-09859-y.

Sundqvist, P. (2021). Characterizations of preschool technology education: Analyses of seven individual preschool educators' and childcare attendants' descriptions of their teaching. *International Journal of Technology and Design Education*, *32*, 2003–2018. https://doi.org/10.1007/s10798-021-09678-2.

Tashakkori, A., & Creswell, J. W. (2007). The new era of mixed methods. *Journal of Mixed Methods Research*, *1*(1), 3–7. https://doi.org/10.1177/2345678906293042.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Sage.

Teeroovengadum, V., Heeraman, N., & Jugurnath, B. (2017). Examining the antecedents of ICT adoption in education using an extended technology acceptance model (TAM). *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, *13*(3), 4–23. https://www.learntechlib.org/p/182155/.

Unesco (2023). *Global education monitoring report, 2023: technology in education: a tool on whose terms?* https://doi.org/10.54676/UZQV8501. https://unesdoc.unesco.org/ark:/48223/pf0000385723.

Uslu, O., & Bumen, N. T. (2012). Effects of the professional development program on Turkish teachers: Technology integration along with attitude towards ICT in education. *Turkish Online Journal of Educational Technology-TOJET*, *11*(3), 115–127.

Vieira, C. R., & Pedro, N. (2023). Weaknesses of ICT integration in the initial teacher education curriculum. *Computers and Education Open*, *5*, 100150.

Walan, S., & Enochsson, A. B. (2022). Affordances and obstacles when integrating digital tools into science teaching in preschools. *Research in Science & Technological Education*, 1–20. https://doi.org/10.1080/02635143.2022.2116423.

Xie, K., Vongkulluksn, V. W., Justice, L. M., & Logan, J. A. (2019). Technology acceptance in context: Preschool teachers' integration of a technology-based early language and literacy curriculum. *Journal of Early Childhood Teacher Education*, *40*(3), 275–295. https://doi.org/10.1080/10901027.2019.1572678.