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Digital Technology in Kindergarten: Kindergarten Teachers' Practices and Their Effects on Children

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ABSTRACT

As digital technology (DT) is increasingly used in all areas, its use in kindergartens has become inevitable. However, there is limited information on how DT can be used in kindergartens and what the effects of its use are. Therefore, this study investigated use of DT in kindergartens and its impact on children through practices and experiences. The study's theoretical background is constructivism, which views DT as a helpful tool in enabling learning. This study, which was conducted with a single case design of qualitative research, used document analysis, interview, and observation techniques. The data were obtained by observing 66 activities for 17 hours and 53 minutes, interviewing seven educators, and examining curriculum/lesson plans in four kindergartens of an elementary school in a Midwestern state of the United States, where 135 children received education. Thematic content analysis identified six themes and 19 categories. The results revealed a wide range of the use of DT in kindergartens; the resources used in planning, assessment, and implementation; the adaptations that determine its use; and its effects on children. This study invites early childhood educators to reflect on how they can implement and embed DT in kindergartens and evaluate and improve their current practices.

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Children's learning; digital technology; early childhood educators; kindergarten; teaching practices

Digital technology (DT) is a set of tools and applications for the comprehensive development of communication, collaboration, production, teaching, and learning processes in early childhood education (Gunčaga et al., 2020). The appropriateness of DT in the educational environment is related to how it is used in activities, and the teacher has a very crucial role in DT use (e.g., Bourbour & Masoumi, 2017; Ertmer et al., 2012; Masoumi, 2015; Plowman & Stephen, 2013; Tondeur et al., 2017; Vidal-Hall et al., 2020). In addition, constructivism theory, with its deep understanding of the effectiveness of learning through concrete and social interaction, also emphasizes the effectiveness of using DT in learning and the importance for teachers to focus not on traditional teaching but rather on the art of learning that enables the construction of knowledge (Kretchmar, 2015). Teachers' decisions about DT use in classroom routines and activities affect children's learning with technology (Arnott, 2016). Although teachers' use of DT in early childhood education has increased (Hooker, 2017; Pyle & DeLuca, 2017), there are many challenges in integrating DT appropriately into learning environments (Kewalramani & Havu-Nuutinen, 2019). Some teachers, whose core beliefs and thinking are based on the value of teaching through play (Bourbour & Masoumi, 2017), may not be sufficiently knowledgeable about pedagogical approaches to DT use (Fenty & Anderson, 2014). More knowledge is required about the factors that influence teachers' beliefs and practices to bring about a shift in thinking to develop strategies on the potential and appropriateness of DT for play-based curricula in early childhood education (Johnston et al., 2018). Studies on DT use have identified that teachers need to be supported by more research to understand the learning opportunities for

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children (e.g., Aubrey & Dahl, 2014; Belo et al., 2016; Masoumi, 2021; Sulistyaningtyas et al., 2023; Vidal-Hall et al., 2020). Further empirical studies that identify how DT tools are integrated into classroom practice and the effects (Otterborn et al., 2018) will support teachers in using DT in a play-based curriculum (Hooker, 2017; Pyle & DeLuca, 2017). The limitation of research on DT use in early childhood education has revealed the need for research and constituted the most significant rationale for conducting the present study. By examining the use of DT in kindergarten educational settings with three different data sources (observation, interview, and document analysis), this study provides support to teachers in overcoming implementation challenges and expanding implementation strategies. The findings also have important implications for school administrators and policymakers who are responsible for the provision and dissemination of DT. In this respect, the study aims to make a scientific contribution to the efficient use of DT in early childhood education.

DT in early childhood education

DT involves tools such as computers, tablets, interactive screens, cameras, programming equipment, and digital content resources used with children, such as online or downloadable applications or software (Undheim, 2022). In today's world, where digital literacy and keeping up with current technology have become important (N. Yelland, 2011), and given the importance of supporting children with play activities (Bourbour, 2020), DT has become an indispensable part of the educational process and has been associated with the pursuit of excellence in education and the drive to learn. Digital competence, emphasized as a key competence for 21st-century skills (OECD, 2016), is seen as a new way of collaboration and communication in the recently emerging digital environment (Undheim & Ploog, 2024). The digitalization of schools has made an extraordinary digital leap in children's daily lives (Iivari et al., 2020); through DT use, children are provided with better opportunities to increase their active participation in activities that are essential for developing key 21st-century skills (Hsin et al., 2014; Miller, 2018; N. Yelland, 2011). Additionally, Gardner's theory of multiple intelligences supports using DT in educational settings. For example, Bryner (2003), in an experimental study examining how students learn by producing products in technology-rich centers established according to the theory of multiple intelligences, created centers for each intelligence area in the classroom and left the use of the centers to the children's choice. As a result of the study, it was determined that the learning rate was much higher in technology-rich centers, and it was emphasized that children should be allowed to choose to learn in the way they want. The intelligences that a technology activates are determined by the context in which the technology is used for teaching. Considering how different technologies are matched with each intelligence enables the successful use of DT in the classroom. While DT supports the integration of multiple intelligences in the classroom, multiple intelligences are strong supporters of the integration of DT into education (McKenzie, 2005).

Some early childhood education organizations state that DT in early childhood education will be permanent (NAEYC and Fred Rogers Center, 2012) and emphasize the importance of using DT with the teacher and child together to support existing educational goals without being an isolated activity (NAEYC, 2013). Activities can include opportunities to watch photos, videos, and audio recordings together or to search for information on websites together, using tools that children can experience individually (NAEYC & Fred Rogers Center, 2012). As stated in early childhood education policy documents, DT, seen as a potential, should be used for the benefit of children (Mantilla & Edwards, 2019). Using DT-supported learning tools, such as mobile devices, smart boards, tablets, laptops, simulations, dynamic visualizations, and virtual laboratories, has changed education in schools and institutions (Haleem et al., 2022). Previous studies have reported the effects of using DT on children, increasing motivation and engagement (e.g., Bay & Hartman, 2025; Istenic Starčič et al., 2016; Lim & Wardrip, 2024). The importance of using DT is further enhanced by the fact that with DT, children gain new knowledge, experiences, and attitudes every day (Gunčaga et al., 2020).

Research on the use of DT in early childhood education has made visible its benefits and advantages for children (e.g., Bay & Hartman, 2025; Istenic Starčič et al., 2016; Kermani &

Aldemir, 2015; Lim & Wardrip, 2024; Mertala, 2019; Otterborn et al., 2018). Findings show that use of DT in early childhood education can provide unique learning opportunities for children, such as literacy (Kucirkova, 2019), exploration, problem-solving (Edwards & Bird, 2017), and acquisition of DT usage skills (Bay & Hartman, 2025), and can pave the way for positive effects. Li et al. (2024) stated that the importance of DT in early childhood education is that it has the capacity to revolutionize and offers unprecedented opportunities in educational practices.

Research has shown that DT can improve children's language skills (Alkhawaldeh et al., 2017; Blackwell et al., 2014; Chen et al., 2018; Dore et al., 2019; Kaynar et al., 2020; Miller, 2018; Penuel et al., 2012); mathematics skills (Alkhawaldeh et al., 2017; McCarthy et al., 2018; Schacter et al., 2016; Yang & Gunn, 2020), abstract thinking and inquiry skills (Miller, 2018; Portelance et al., 2016), and positive effects on social-emotional skills and digital literacy levels (Anggraeni & Listiana, 2023; Undheim, 2022). Roseberry et al. (2014) examined the effect of social media use on children's language development and found that children learned verbs more easily with video chat applications. Neumann and Neumann (2014) examined the impact of touchscreen tablets on children's literacy skills and found that using touchscreen tablets improved early literacy skills such as letters and phonics.

Outhwaite et al. (2017) examined the effect of tablet use on the development of early math skills and found that children achieved powerful learning gains in the development of early math skills due to the features of tablets, such as repetition, interaction, and quick feedback. Magnusson (2023) examined how children use digital technologies and non-digital materials to create and make visible their visual and aesthetic aspects and found that children's activities with digital technology and non-digital artifacts stimulate, expand, and transform their understanding and use of literacy and mathematics.

Masoumi et al. (2024) examined children's actions in a context where an interactive whiteboard (IWB) was used and found that children demonstrated behaviors such as solving a problem, using language in meaningful contexts, and contributing to their learning and development. Similar studies point to new ways in which DT can offer possibilities for children's learning (e.g., Hatzigianni et al., 2018; Kewalramani et al., 2020; R. Liu et al., 2023; N. J. Yelland, 2018). The results of the research show that the inclusion of DT as a component of education is an important factor in children's full potential for learning and development (McManis & Gunnewig, 2012).

However, some studies focus on how new technologies can be used to support children in different settings (Arnott et al., 2019; Marsh et al., 2005, 2018), studies mostly concentrate on how digital technologies contribute to children's learning rather than teachers' teaching (see Arnott et al., 2019; Gillen & Kucirkova, 2018; Marsh et al., 2005, 2018; Masoumi, 2015). Rather than in-depth studies on how DT is used in early childhood education, studies have focused on access to digital devices and frequency of use (Fenty & Anderson, 2014).

The increasing introduction of DT into educational settings has changed the way teachers communicate with, select, and structure educational resources and, in particular, their teaching practices. For example, by using smart boards as a DT tool, teachers have been able to store their resources as they wish, use them repeatedly, and make changes easily (Bourbour, 2020). The rapid development of DT has created an innovative set of opportunities and challenges in the learning and development process, placing new demands on teachers' and children's knowledge and skills (Kearney et al., 2018). Although DT has the potential to enrich early childhood education, its actual impact on education is related to how it is used. There are concerns that DT will replace rather than enhance and augment existing teaching practices (Lynch & Redpath, 2014), and barriers to the effective use of DT in the educational setting include lack of comfort, technical support, and training (Blackwell et al., 2014; Groff & Mouza, 2008; Nikolopoulou & Gialamas, 2015). Teachers who are expected to use DT meaningfully in their learning activities and achieve the goals set by the curriculum urgently need suggestions and examples on its use (Neumann & Neumann, 2014; Strawhacker et al., 2017; N. Yelland & Masters, 2007). In the early years, when critical stages of development occur, it is especially crucial to make DT developmentally appropriate and to choose DT tools carefully. Therefore, a closer look should be taken at how DT is used in classrooms and children's interactions with it (Fantozzi, 2022).

In order to overcome all the obstacles encountered in DT use and to meet the needs of teachers, there is a need for in-depth research on implementation examples. This study focuses on meeting this need through observation, interviews, and document analysis of DT use in kindergartens in terms of its purpose, scope, and content. The findings of the study, which reveal examples of the use of DT in the educational environment, its areas, types, and effects on children, will not only expand the existing literature in the field of early childhood education but also guide teachers, administrators, and policymakers on the use of DT in the educational environment.

Early childhood teachers have a crucial role in incorporating DT into the educational process (Masoumi, 2015; Plowman & Stephen, 2013). What makes DT meaningful for children is not the DT itself but the teachers' practices (Morgan et al., 2016). By observing children's experiences, teachers can determine their engagement, competence, and satisfaction levels in DT (Hatzigianni, 2017). Redecker (2017) explained teachers' DT knowledge and skills in terms of using it to increase children's active participation, personification, and inclusion; to improve assessment; to enable communication, professional development, and collaboration; to find and create resources; to help children be creative in communication, knowledge, content creation, and problem-solving; and to be organizers and managers of DT in the educational process. Meier's (2002) "Power of Their Ideas" study emphasized that teachers should believe in the need to embed the new into the old. Teachers' views on the application of different learning styles and the use of information technology as a new tool to help children develop critical thinking and problem-solving skills also emphasize the use of DT (Marias, 1999). For children to benefit from DT use, teachers need to have all this knowledge and skills (Fenty & Anderson, 2014; Hughes, 2005; Undheim, 2022).

Moreover, the knowledge and beliefs of teachers who need to successfully integrate developmentally appropriate DT and tools for children into the curriculum (NAEYC & Fred Rogers Centre, 2012) influence how DT is used and embedded in practice (e.g., Bourbour & Masoumi, 2017; Edwards et al., 2020; Enochsson & Ribeaus, 2020; Vidal-Hall et al., 2020). Teachers' attitudes determine what the rules regarding the use of DT will be and to what extent they will be used (Enochsson & Ribeaus, 2020). Therefore, teachers' practical decisions regarding DT use affect the learning process (Arnott, 2016). Thus, teachers should select appropriate DT to support children's development, observe children, and use DT with content suitable for children's development (Buckleitner, 2011).

Although significant progress has been made in DT use in terms of planning, teaching, and communication (Wilson et al., 2024), studies have shown that teachers have limited use of DT (Pervolaraki et al., 2017), have difficulties using DT due to their limited knowledge (Edwards & Bird, 2017), and need support (Wilson et al., 2024) and further training in developing their understanding of DT and enabling children's independent use and mobility (Dong & Newman, 2016; Lindeman et al., 2021; Magen-Nagar & Firstater, 2019). Teachers should be helped to use DT appropriately in early childhood education settings and to achieve competence in preparing quality activities (Lindeman et al., 2021).

Unfortunately, the paucity of research focusing on DT use in educational practice and children's interactions with DT (Undheim, 2021) leads to a lack of knowledge and learning about its implementation, jeopardizing the contribution of teachers who have a critical role in the use of DT (Hatzigianni, 2017). The current study contributes to the knowledge support needed by early childhood teachers by revealing the areas, types, and sources of DT use.

Early childhood teachers and DT

Theoretical background

The constructivist learning theory developed by Seymour Papert was the theoretical basis of this study. Inspired by the constructivist theory in which mental models are created to understand the world through individual learning (Alesandrini & Larson, 2002), this theory emphasizes that

learning takes place with actual artifacts or objects (a poem, a robot, a sand castle, or a computer program) with a different perspective that values the concrete (Kretchmar, 2015). Effective learning takes place when individuals are active in using concrete objects in the real world (Cakir, 2008). Moreover, in this theory, the ability of concrete materials to be shared and discussed with others reveals the social nature of learning. Therefore, the focus is on tools to construct learning, and computers, Logo programming language, or LEGO building blocks can play a crucial role in structuring learning. In this construct, technology applications present themselves as one of these tools (Kretchmar, 2015).

Papert questions to what extent technology shapes people's thinking and communication and explains the effectiveness of technology use through his observations. In experiential learning, the teacher is a mediator to help children understand and a facilitator who coaches them to reach their goals (Alesandrini & Larson, 2002). In a classroom observation, a teacher asked children to do a task in an activity where the teacher used a computer, and the children did more than what they were told, organized themselves through group work, and created different products by enjoying themselves without the need for motivation from the teacher (Semenov, 2017). Similarly, Kafai and Harel (1991) considered instructional software design projects a learning method. As a result of the study, it was seen that children collaborated and could share their thoughts freely.

When Papert was developing the theory, learning was addressed with computer and Logo program material examples; now it has evolved toward digital learning with digital tools used by children (Levin & Tsybulsky, 2017). Today's technological developments also overlap with Papert's theory, and constructivism is the theoretical perspective on which this study is based. The use of DT in the learning process in early childhood education has the potential to revolutionize traditional practices. Including DT in the learning process in educational settings facilitates children's learning and increases children's participation in active learning (e.g., Bay & Hartman, 2025). Therefore, DT is used in early childhood education as a concrete tool for children to construct knowledge that should be recognized.

The current study

Most of the existing studies have focused on teachers' beliefs or the skills developed by certain practices without examining the variety and ways in which teachers use DT in the context of their experiences and practices in the educational setting. However, it is crucial for teachers to see the big picture of how DT can be used in kindergarten in order to integrate it into the educational environment. This study is unique in revealing how DT is used in kindergartens through teachers' views, practices, and documents; how it is identified as appropriate for use; what DT resources are used in planning, assessment, and implementation; as well as what effects the use of DT can have on children. Moreover, given the rapid changes in technology, it is extremely important to identify current examples of DT use in kindergartens. Therefore, this study addresses four exploratory aims:

RQ1. What is the use (purpose, context, characteristic) of DT by early childhood educators in kindergartens?

RQ2. What are the determinants (adaptations) of DT use by early childhood educators in kindergartens?

RQ3. What are the resources (curricula, practices, tools) that early childhood educators use in planning, evaluating, and practicing DT in kindergartens?

RQ4. What are the effects of early childhood educators' DT use on kindergarten children?

Methods

In this study, qualitative research was conducted to gain an in-depth understanding of teachers' DT use in kindergartens across a broad range of practices, understandings, materials, and influences. In qualitative research, a case study is particularly suitable for examining teachers' beliefs and practices in educational settings (Olafson et al., 2014). The study was conducted according to the case study as a qualitative research approach that provides a holistic perspective on various phenomena in the natural environment (Creswell, 2015). This study was guided by questions and a single-case design (Yıldırım & Şimşek, 2016; Yin, 2014) that involved examining holistic situations in a single school in depth, a triangulation of document analysis, and interview and observation techniques (Creswell, 2015). The research focuses on DT use as a learning tool in the context of kindergartens through teachers' perspectives, practices, and classroom observations, and the findings provide an important report that can shed light on decisions to be made about the place of DT in kindergarten in terms of curriculum design and pedagogical practices.

The data presented in this article are drawn from a broader study conducted as a TUBITAK (Scientific and Technical Research Council of Turkey) project on "The use of DT in early childhood education."

Participants

Researchers purposely selected schools and participants with kindergartens to reach inductive conclusions about a phenomenon using qualitative and systematic procedures (Creswell, 2015). In this exploratory study, to reach valuable and meaningful findings for other practitioners, purposive sampling was used to identify the schools with kindergartens, and some criteria were set:

- Non-profit
- Locally licensed
- More willing to incorporate digital technology into children's learning experiences.

The criteria-based elementary school in a Midwest State of the United States is a public district school. In the study, observations were made in four kindergartens of the primary school, where 135 children in the 5-year age group received education. All observed classrooms had iPads and headphones, desktop computers, laptops, document cameras, projectors and screens, and sound systems for each child, while three classrooms also had BenQ smart boards.

Interviews were conducted with seven volunteer educators working in the same school as the teachers of the observed classes. Six of the educators had the role of kindergarten teachers in the 5-year-old age group, and one participant had the role of school administrator. The participants manage their changing roles in the curriculum to achieve children's learning goals through DT. Table 1 shows the demographic characteristics of the participants.

Table 1. Teachers' demographic information.

Name	Age	ETC	ZA/ZS	Education Level	Teaching experience in ECE	Class size
Ann	42	1	1	MD	10	23
Dolly	43	1	1	MD	12	21
Kasey	45	1	1	MD	18	24
Misty	51	1	1	MD	28	22
Lily	42	1	-	MD	15	23
Shay	45	1	-	BD	8	22
Holly	52	1	1	MD	29	-

ETC = elementary teaching certificate; ZA/ZS = first early childhood endorsement; BD = Bachelor's degree; MD = Master's degree; PD = Doctoral degree; ECE = Early childhood education.

The ages of the participants, all of whom were female, ranged from 42 to 52 years. One (14.3%) of the participants had a bachelor's degree, 6 (85.7%) had a master's degree, and their experience in early childhood education ranged from 8 to 29 years. All participants have an Elementary Teaching Certificate, and 5 (71.4%) have ZA/ZS endorsement.

Data collection

This study's data were triangulated (Yin, 2014). Data triangulation, which increases the reliability of qualitative research, is using multiple data sources to help understand a phenomenon (Lauri, 2011). In the study, data were obtained from three different data collection methods:

- Non-participant observation records of daily classroom-based activities (e.g., DT used by the teacher in the activity, children's participation in activities using DT)
- Semi-structured interviews
- Documents (e.g., curriculum, lesson plans, daily training flow).

Observation

To define and understand the scope of practice for DT use in kindergartens, four kindergartens with 135 children were observed by the first author. All observations were conducted at the teachers' convenience and according to the timetable set by them. The observations were conducted in the natural environment without any intervention (Mertens, 2023) in four kindergartens by taking video recordings and photographs and using the observation guide prepared by the researchers. The researcher also took notes to help with video coding. Observations in the classroom were conducted using DT tools, focusing on the use of DT with regard to teachers' and children's behaviors. The observation data provided a deep insight into the age group of the children, the educational environment, the teaching content, the choice of materials and methods, and how DT can be used. Table 2 provides information about the observation process.

After obtaining approval from the teachers and parents, the first researcher observed 66 large- and small-group activities over one month. Sixty-six activities, each lasting approximately 16 minutes, were videotaped, for a total of 17 hours and 53 minutes (1,053 minutes). Teachers performed each activity by the same curriculum they used. In the activity observations, the number of activities that included DT ($n = 45$, 68.2%) and the duration of DT used in the activities (min. = 537, 51%) indicate the inclusion of DT in the educational environment. As seen in Table 2, the rates of DT use observed in the classrooms confirm the criterion of being more willing to incorporate DT into children's learning experiences.

Interview

The interview method, one of the basic mechanisms of data generation in qualitative research (Creswell, 2015), is to reveal people's feelings and thoughts that cannot be realized through observation through questions (Patton, 2015). In this study, semi-structured interviews were used to examine individuals' perspectives and elicit detailed responses from them (Patton, 2015), and seven educators

Table 2. Rate and duration of digital technology use in the observed activities.

Classes	Observed Activities ($n = 66$)				Observation time (min. = 1052)			
	Digital technology used ($n = 45$, 68.2%)		Digital technology not used ($n = 21$, 31.8%)		Digital technology used (min. = 537, 51%)		Digital technology not used (min. = 515, 49%)	
	n	%	n	%	min.	%	min.	%
C1	5	41.7	7	58.3	88	41.9	122	58.1
C2	20	76.9	6	23.1	193	52.2	177	47.8
C3	13	76.5	4	23.5	202	65.2	108	34.8
C4	7	63.6	4	36.4	54	33.3	108	66.7

were interviewed. The interview form consisted of questions developed by reviewing previous studies (Bay, 2022; Marsh et al., 2005; Thorpe et al., 2015). The developed questions were presented to two field experts, and the interview form was finalized. The interview form consisted of closed-ended questions about demographic information and open-ended questions about their experiences and opinions on the use of DT:

- What do you think about integrating digital technology into educational activities?
- How do you plan the use of digital technology in the process of planning your educational activities? (You can give a specific example of how you use digital technology in an activity plan.)
- How can you ensure that the use of digital technology is developmentally appropriate for your children?
- How do you adjust your use of digital technology based on child performance or feedback?
- Which digital technologies do you use in the process of evaluating children at the end of your educational activities?
- Which digital tools do you use when implementing your educational activities in your classrooms (e.g., digital cameras, video cameras, webcams, art software, programmable toys, smart boards)?
- Which mobile applications do you use in the classroom to increase children's participation (e.g., digital cameras, digital video cameras, scanners, programmable toys such as bee bots, smart boards, old overhead projectors, role-play toys such as defunct mobile phones or laptops or keyboards, computers/laptops and tablet computers like iPads, sound recorders and listening devices, walkie talkies, webcams, metal detectors, internet cassette recorders, photocopiers, art programs such as MS Paint or Paint 3D, digital movie maker, telephones, literacy and language software such as MS Word for the development of ICT capability, spreadsheets such as MS Excel for numeracy learning and development)?
- What do you think about the impact of using digital technology in educational activities for children (participation, motivation, focus, problem solving, design, construction, creation, invention, programming, etc.)?

After obtaining the approval of the participants with the interview protocol, the demographic information form consisting of closed-ended questions was sent to the participants via e-mail, and they were asked to fill it out and resend it. Before the interview with open-ended questions, participants were informed about the purpose of the study, and verbal consent was obtained for video recording. The interviews were recorded on Zoom. Each interview lasted approximately 25–35 minutes. Interviews were transcribed using a transcription service.

Document

Finally, eight documents were collected from the teachers, including ELA reading and math syllabi, lesson plans, curriculum standard benchmarks, daily instructional flow, and explanations. The documents were used to complement the observation and interview data and to reveal the use of DT in the activities.

Data analysis

The data obtained in the study were organized in three ways: observation records, interview transcripts, and training plans. The video recordings obtained during the observation process were watched repeatedly by the researchers, and after reading the observation notes, each observed activity was described to gain a deeper understanding, focusing on teacher and child behaviors and the extent to which DT was used. The documents were analyzed for the inclusion of DT, and the daily plans were compared with the observed activities to identify the activities in which DT was used. The document review helped to clarify and complete the

analysis. Finally, the records obtained from the interviews were transcribed and read repeatedly.

After these arrangements formed the basis of the analysis, the thematic content analysis method was used to identify, analyze, and report the themes in the data (Braun & Clarke, 2006; Mayring, 2000). In thematic content analysis, which is defined as analyzing and interpreting data based on categories (Glesne, 2012; Patton, 2015), similar data are brought together within the framework of certain categories and themes and interpreted by organizing them in a way that the reader can understand (Yıldırım & Şimşek, 2016). Accordingly, the transcripts were read and divided into sections according to the research questions, and themes and categories were identified and named (Braun & Clarke, 2006; Creswell, 2015). In this process, the themes were checked and discussed by the researchers, each category and theme was examined to reach a consensus, and, finally, the themes and categories were supported with quotations. Participants were given the code names Ann, Dolly, Kasey, Misty, Lily, Shay, and Holly. The observations and interview transcripts were then compared as a form of data triangulation. Nineteen categories were generated from the data, and six themes emerged from the categories.

The reliability of the data analysis was ensured through triangulation using multiple data sources (observations, interviews, and documents), rigor in coding (following the guidelines), long-term observation in the research area, and direct quotations in their original form (Creswell, 2015).

Findings

As a result of the observations, interviews, and document analysis, it was determined that the educators used DT tools and practices under six different themes and 19 categories within the scope of the daily education program. The themes and categories are given in Table 3.

DT use in educational settings

Digital technology (DT) is regarded as an important tool in achieving the predetermined goals of education. Its use not only facilitates the educator's work but also provides indispensable support in ensuring children's development and learning at the desired level. The enriched educational environments enabled by DT have been reflected in teachers' views and practices.

Under the theme of DT usage in educational settings, three distinct categories were identified: supporting teaching, context, and balanced use. The *supporting teaching* category highlights the purpose of using DT, with teachers who actively use DT during the teaching process viewing it as a supportive tool. Lily stated, "With the learning games on their iPads, I help my children improve their learning. These games progress alongside what we learn in class," expressing how she supports children's learning process with DT. In addition to learning games, teachers also use DT for reviewing, understanding, and remembering learned information.

> So we try to do whatever we're working on. I try to do something small. Something. Like a game or an activity, they can do afterward. It helps them learn and understand the material and also keeps them interested in the lesson. (Ann)

As Ann stated, DT also supports children in showing how much they have learned.

> I often use technology as a way to engage them with information and materials. So I do a lot of activities that we do. Like a game on technology or something where we learned the concept and now we apply it, or as a way to introduce a concept. To engage them in a fun, different way. (Dolly)

DT is also seen to provide fun and engaging learning for children in the teaching process. Holly explained how the DT use should be viewed in supporting teaching:

Table 3. Themes and categories.

Themes	Number of Categories	Categories	For example
The use of digital technology in educational settings	3	Supporting teaching	To help learning, to provide repetition and reinforcement, to increase interest in learning
		Context	Joint or individual use
		Balanced use	Complementing existing activities, balance between the use of real material and technology
Adaptation of DT for children	4	Through professional development	Receiving trainings, weekly class level meetings, expert support
		Through the use of teaching strategies	Preparing digital content suitable for children, role modeling and guiding children, starting from the lowest level
		Through the selection of digital applications	Using structured applications, using few applications, using applications determined by the school, using applications suitable for the age group, using applications where they can make changes in visuals and solve problems
		Through assessing children's performance and feedback	Their interest, body language, silence, focus
Resources used in planning the utilization of digital technology	2	Use of digital application resources	Seesaw, Paint Cat Studio, Jam Board, Google Suit
		Use of curriculum resources	Bridges program, ELA program
Digital technology resources used in the assessment of children	4	Seesaw assessment system	Video recording, document recording, sharing and messaging with parent app
		Through technology devices	Tablet/lPad
		Through standardized tests	Measurement and Data Mdk2, Diagnostic Reading Assessment DRA
		Through documenting and storing data	Google spreadsheet, Google cloud
Digital technology resources in the educational environment	2	Digital technology tools	BenQ, lpad, projector, computer, document camera, Apple TV, sound system, Chromebook
		Digital technology apps	ABC mause, PBS kids, Seesaw, epic, Splasch Math, MeL, Josh, Teach Your Monster
The effects of digital technology use on children	4	Social interaction	Conversation, group work, meeting different people
		Motivation	Exciting, increasing participation
		Development of digital technology skills	Knowledgeable, skillful and comfortable to use the tools
		Addiction when not used in a balanced way	Emotion control problems, irritability, adjustment problems

> Technology should be used in a way that enhances learning, not just for fun . . . . So to me, it's about the goals and purpose of a lesson and how you can thoughtfully integrate it to make it more meaningful and allow those standards to shine through.

It was observed that teachers frequently used smart boards, computers, tablets, document cameras, and screens in the classrooms to support teaching, both for transferring information and for practice applications that required repetition and recall of information. For instance, in a language activity where the teacher repeated sounds on the board, children practiced writing words that the teacher said on the smart board. In another activity, after the teacher gave examples, children performed additional activities on the number line on the smart board. (See Figure 1.)

Another category that emerged was the context of DT use. It was observed that DT was sometimes used individually by children and sometimes used jointly by the whole class. While the use of the document camera screen or the smart board screen included the participation of the entire class, the work done on the iPad represented individual use. It also should be noted that there were as many iPads as there were children in the classroom and that these iPads, which were kept in a charging cabinet, were taken and used by the children. During small-group activity time, children take their



Figure 1. Digital technology use in educational settings.

iPads with the teacher's guidance and do their activities with individual applications. The applications and programs used by the children on the iPads are determined by the school management and teachers through a joint decision. Shay noted this use: "I was giving them some digital activities like on the iPads so that they could go and do them independently on their own." Misty noted the whole-class use: "I can do a study that they follow along with me on the screen." The content of the activities determines the way DT is used.

> Small activities that they can do online, games that are related to what we are working on. Let's say we are working on a reading assignment, and after we do that they do a small activity on their iPad. (Ann)

> I use it for movement breaks in my classroom. I use it sometimes for songs. I use it. For reading, there is an option in our curriculum where we can put the books on the projector, and the whole class can see and follow. I use it for that in the classroom. Sometimes the children use iPads. They use different applications. (Kasey)

As can be seen in the statements, while DT is used by the whole class in large-group activities, children also make individual use of iPads in small-group activities to repeat the information learned through educational games. In large-group activities, in activities carried out with the participation of children using smart boards, document projectors, projectors, and desktop computers, teachers ask children questions about the information they will learn, show examples, and expect children to show them on DT tools. In small-group activities, it was observed that sometimes all children were asked to work individually on the iPad, and sometimes they were divided into groups, and one of the groups used the iPad individually. (See Figure 2.)



Figure 2. Context in digital technology use (jointly or individually).

The last category that was identified under this theme was balanced use. As Kasey put it, "Kids need face-to-face learning. And you know, digital technology can be a good thing. It just needs to be used in balance." What is meant by balance is that activities with real materials and activities using DT complement each other.

> I think it's a balancing act because I think kids have a lot of technology at home that they don't need. Really. Sometimes, it's for the best, but that's why they know so much about technology, and they're excited to use it. So I think it's important to have a balance between good activities where they can use their hands and use technology because for them, a lot of technology is hands-on, and that's where they're most engaged when they're learning. (Shay)

> My philosophy on technology and educational activities is that they should be in addition to what they're already getting, that they shouldn't replace other activities, but they should be complementary to them. (Dolly)

Shay particularly emphasized the exciting effect of DT on children, that children may want to use it more and that the teacher should provide a balanced use in this case. Indeed, it was observed that children's interest increased during DT use in the activities and that they were particularly keen on using the iPad individually. Teachers who were aware of this situation were observed to use DT in some activities or to carry out activities where they combined DT and real materials to provide balance. For example, in one activity, the teacher explained a math problem by projecting it on the document camera screen, and a screen was opened on the smart board for the children to solve the problem. While three children solved the questions on the smart board with the teacher's guidance, the other children in the class wrote the solution to the problem on their blackboards with pencils. In addition, when the observed activities were compared in terms of the time DT was used and not used, it was seen that there was almost a half-and-half sharing and that they were complementary.

Adaptation of DT for children

Another theme that emerged when determining the DT to be used in the educational environment was to adapt it according to the developmental levels of children. Using a digital application without any adaptation can hinder children's learning rather than supporting it. For this reason, DT applications that children can understand and achieve are compatible with the determined goals of education and support the current education. Teachers note that they make adaptations in four different categories: through professional development, through use of teaching strategies, through selection of digital applications, and through assessing children's performance and feedback.

Teachers' professional development emerged as a category in determining and using appropriate DT for children and making developmental adaptations. A deeper understanding of early childhood educators' knowledge, skills, and practices enables them to interact with and provide richer educational experiences for children. Therefore, the professional development of early childhood educators is critical to the quality of experiences offered to children (Sheridan et al., 2009). Below are the opinions of some teachers about their professional development.

> I think planning at the grade level and making teachers' voices heard is very critical. We have professional learning communities in our building that some people call PLCs every week. We call it grade-level planning. On Mondays, this grade level meets in the elementary school, and on Tuesdays, this grade level meets. If there's a big change or a question, my coaches are the literacy coaches. And Matthew, they're there or the principals are there and if there's something big, they'll come in and help explain things. (Holly)

> I think it's just because I've been working with kids for a long time. I mean, I have my own kids. I know it's developmentally appropriate. I've taken the coursework and training to do that. (Ann)

As Holly and Ann stated, receiving training, discussing with colleagues, and receiving expert support are ways to provide professional development in DT use.

Developmental adaptation through the use of teaching strategies is another emerging category. It is known that teachers have many experiences as a result of their professional experiences. The increasing use of digital tools also allows teachers to increase their experience and develop strategies.

> I bring it down to their level, so a lot of the stuff you buy is not developmentally appropriate, but I create a lot of the stuff that I use in the classroom. I think I just make sure that they can do it, and then because I created it, if it doesn't work, I can always adjust it or make it work at their level. (Ann)

> So it's very directive, not open-ended. That's how I follow it. They never just give me the tablets and say go play. It's always very structured (predetermined gamified applications for children), and I ask them to go do XY or Z on the tablet and show them how to do it. (Dolly)

Teachers' statements revealed strategies to adapt digital content and guide children. In addition to these strategies, starting from the lowest level and being a role model are among the other mentioned strategies. Observations also showed that teachers were present among the children, informed them about which application they would work on, and monitored their activities. For instance, when an activity to collect the spots of butterflies could not be done on the smart board due to a problem in the application, the teacher directed the children to get their iPads and the children started to use the same application on their iPads. The teacher had initially planned to conduct this activity with the whole class on the smart board, but she had to direct the children to work individually. While the children were doing the activity on the iPad, the teacher checked on each child individually and gave them directions. After the teacher's instructions, the children continued to individually collect the speckles easily on the app and progressed at their own pace.

In the category of selecting digital applications for the pre-determination of the DT to be included in the education process, teachers also use some strategies. The selection of applications suitable for the age and developmental level of the children seems to be quite important. Lily talks about choosing the appropriate age level: "The applications that Josh (student) uses are suitable for their age group. That's why I'm sure of it. Whatever application I use is an application suitable for his developmental age group." Lily confirms that its practices are appropriate for children's developmental level by reviewing and agreeing upon them with the school administration and kindergarten teachers at the beginning of the school year.

> They're doing seesaw activities. I can present them more easily or like our curriculum for shared reading. I can put the pieces in the right level digital reading pieces for the products. So when they go online to read their books, they have a reading group with the right level books. So it's like my own. like my own cycle at this time. When we do similar things digitally, all the kids are good at what they're doing. (Kasey)

> I knew that my kids were much more willing to participate when they could use something digital and get it, move things around, and solve problems. But their problem solving pays off, especially some of the things that they have to separate, okay, does that start? No, that's not right. Okay, the fallacy of going back and repeating. Try again. You know, in our smart lab at school, the teacher stuff? Okay, let me try that. Oh, that's not working. Okay, I'll try that now when you get back. (Shay)

We see that Kasey mentions that she directs children to participate in activities in groups that are suitable for their levels, in addition to determining activities that are easy for them to do, while Shay states that she tries to choose applications that children can make changes to and solve problems with. Apart from these strategies, it was observed that teachers use structured, school-determined applications and try to make appropriate choices for children by keeping the applications limited.

Finally, it was determined that teachers make developmental adaptations by considering children's performance and feedback. Many clues, such as children's interests, body language, and focus, help the teacher understand the developmental appropriateness of the activity.

> If something seems too difficult for them, then we won't do it. We won't do it again, or we'll have to learn more together before the kids can do it. If they seem frustrated doing certain things, then I know we need to spend more time on that, maybe not. They're not developmentally ready for it. (Lily)

> I really look at their interest level and their interest and how engaged they are with technology. And again, as I said, kids are very talkative at this age. And they'll tell me with their body language or their words whether it's fun or not. And when they're engaged here, it's either a low noise, a productive noise, or they're completely silent. And those are my indicators' you know they're really interested in this activity. When there's no behaviors that come up here, you know they're joking around. And then I'll adjust accordingly and say, okay, we're done writing. (Dolly)

It is also seen that teachers are good observers of the developmental adaptations they will make regarding DT in the classroom. The most important indicator that everything is going well is silence. As Shay explained, "When I give them something to do with digital technology on the iPad, I can tell that the room will go completely silent."

Resources used in planning DT use

Planning the use of DT for activities (Math MTSS, writing, read aloud, shared reading, ELA MTSS, math, science/social studies), which are determined according to 15-minute time slots in the daily education flow, except for rest and meal times, is considered very important for teachers since the curriculum is suitable for digital use and all digital tools are available in classrooms. Teachers refer to two different resources determined as categories while making these plans.

In planning the use of DT, many digital applications are used by teachers. At the forefront of these applications is the Seesaw application, which has storage and sharing capabilities.

> It's called Seesaw, and the kids go in. It's like a portfolio journal, but you can create tests in there. You can create games in there. Things that they can manipulate. I have those products and only those products. Like if we're reading a book and it's something that they can read at their grade level, I distribute it and turn it into a digital book. So the kids can read it when they're kids. Once they do that, they can send it to their families, and their families can see that amount. (Ann)

As Ann also pointed out, many digital products created with the Seesaw application can easily be used both on the smart boards in the classroom and on the children's iPads. In addition to the Seesaw application, other applications also assist teachers in planning their DT activities.

> I used to use a Jam Board a lot to help the kids. Manipulating parts and that kind of stuff and Seesaw. I find Seesaw activities, and most of the time. I use that, too. I use a lot of learning sites. Paint Cat Studio is one of the biggest sites I use for review. (Dolly)

As Dolly mentioned, although not all of the teachers mentioned all of them under this category, it was seen that they used many applications (ABC mouse, Paint Cat Studio, Jam Board, Google Suit, Chromebook, Flipgrid, epic, MeL, Splash Math, PBS Kids, GoGuardian, Teach your Monster).

Another resource used in planning is curriculum resources. These resources, jointly determined by the school, are shared with all teachers at the beginning of the year and used. As seen in the teachers' statements and the documents examined, Bridges and ELA Programs are used. Holly described one of the selected resources as follows:

> We chose the Bridges math program after looking at some research, and actually if you know the math foundations that are big in the state of Michigan, all the examples there are taken from the Bridges math program. I don't believe in programs, I believe in people, but we use the Bridges resource, and it's kind of a tripartite structure. There is a whole set of lessons, a number corner, and learning stations.

As for how resources in the curriculum are used to plan DT, Lily said,

> Some of our curriculum has a digital component. For example, for math, we have some stories that we can show digitally. Sometimes, we have activities that we can do digitally. If there is such a thing in our curriculum, I try to use the digital component as much as I can.

As it is understood from the statement, it seems that one of the most important tools enabling the use of DT in the educational environment is the curriculum. If the curriculum includes DT content or is digitally available, the teacher may be encouraged to use it. This school, which was more enthusiastic

about using DT, was also more careful about making appropriate choices for use in the digital environment when determining the curriculum. Teachers were also observed to use digital tools frequently in their classrooms in line with their curriculum, suggesting that curriculum is an effective way of guiding teachers to use DT.

DT resources used in the assessment of children

Four different categories were identified under the theme of DT resources used in assessing children: the Seesaw assessment system, technology devices, standardized tests, and documenting and storing data.

A DT application that teachers frequently use for assessment is the Seesaw assessment system. Seesaw is an application with comprehensive content that children and teachers can record and share with families.

> They can record in it, they can take videos. When you talk about assessment, when you have student artifacts in a portfolio, digital portfolio, and as soon as the child has helped a little bit, guess who gets a message and can look at it. So there's a parent app, so as soon as it's installed, parents, whether they have e-mail or not, a lot of parents prefer text messages, so that's when it comes out and how cute is it? Here is a little girl singing, singing her alphabet, or writing this or that, reading something, reading, learning to read, and sharing that moment with the parents. To me, when you talk about assessment, if you are doing sounds or anything, that really creates an opportunity to see it live, and then you have the learning log of all this and it follows. That's why we pay for a professional license. (Holly.)

As Holly mentioned, the Seesaw assessment system, which creates a digital portfolio based on children's records, makes the child active, especially with the teacher and the family. This portfolio, which can be created through the application, has a feature that can be continued until the last grade of high school and can be easily transferred to other grades.

Teachers also use standardized tests in the evaluation process. Misty described the standardized test she uses: "I don't assess them except for MDK 2 (Measurement and Data), which is a standardized test." In addition to the MD2 assessment, the Diagnostic Reading Assessment (DRA) assessment is also used.

> One of the assessments we do digitally is the DRA reading test. So, children actually have books. But when I record their assessments, I have a digital book on my iPad where I can mark whether they missed any words, whether they read correctly. I score it on an iPad and then on most of ours. Our tests, our assessments are done on paper, but then we transfer them digitally to our computers, so all the children's assessments are also online digitally. (Lily)

The assessments mentioned by the teachers were those that were jointly decided by the school and used by all teachers. Both assessments are added to the portfolios digitally and shared with parents.

In addition to Seesaw, some digital applications are used for documenting and storing the data obtained in the assessment. In the category of documenting and storing data, Kasey said,

> I know the curriculum, our coaches created like Google spreadsheets to help us document the data we collected. But that's my point of view. The kids don't use these things to help organize. For us, it's more like looking back and reviewing the data and seeing their growth.

In addition to Google spreadsheets, Google Cloud is also used for storage and sharing. "We can all see where each child is at any point in time in the local assessment based on these Google Cloud templates; it's all protected and tracked in some way," Holly said. As Holly's statement shows, not only the school's assessments but also the district's assessments are done from here.

Technology tools play an important role in using both Seesaw and standardized tests, as well as other digital applications. The last category identified in the theme of DT use in assessment is technology tools. Dolly describes how assessment is done: "Tablets and technology are used to assess their learning."

> The only thing the kids really use is that we have iPads that we've been working on this week. We have state tests, and it's all done on the iPads. They have to click and swipe and do all that for me now. We do a reading test, and I put all the information in it online through the program. That's how the company came about. I mean, I use it, but children primarily use tablets and iPads for themselves. (Shay)

As Shay points out, iPads enable children to actively participate in the assessment process by practicing and recording. However, the DT tools used in the educational environment are not limited to iPads. The tools and practices involved in using DT were identified as another theme.

DT resources in the educational environment

For the use of DT to be possible, in addition to the resources used in planning and assessment, DT resources need to be available in the environment. In the observed classrooms, tools such as smart boards, computers, document cameras, and many other applications were used. All DT resources used were identified under two categories: DT tools and DT apps.

In the DT tools category, teachers reported using BenQ, iPad, projector, computer, document camera, Apple TV, sound system, and Chromebook. Misty described the DT tools she used:

> My computer, projector, overhead projector. That's all the technology for me, and then of course we have iPads. I have an Apple TV. I don't use it very often. I don't use the sound system. I speak loud enough. So yeah, I just use my computer and the projector.

Shay said:

> Smart boards, tablets. I try to think about what else we are using now. I have a document camera that I show to the children. I can put my papers on there, and they can see them. So they can see what I'm doing.

The active use of these tools was also monitored during the observations. As Misty mentioned, each teacher used a lapel microphone and sound system, and there were also microphones for the children to use in large-group activities. BenQ, as a smart board, document camera, and desktop computer screens, were connected, and an application opened on one could easily be shown on the other. (See Figure 3.)

It was also identified that Seesaw and other apps were used. In addition to the DT applications mentioned under the theme of planning DT, ABC Mouse, PBS Kids, Seesaw, Epic, Splash Math, MeL, Josh, and Teach Your Monster applications were also used under this category.

> They really like to use ABC mouse, and they use PBS Kids, and they use Seesaw. (Lily)

> I also use Seesaw. We are a seesaw school. Another big one that I use as Teacher Monster is something that the kids use independently in their free time of the day. I also use epic. The kids use it independently five times a day,

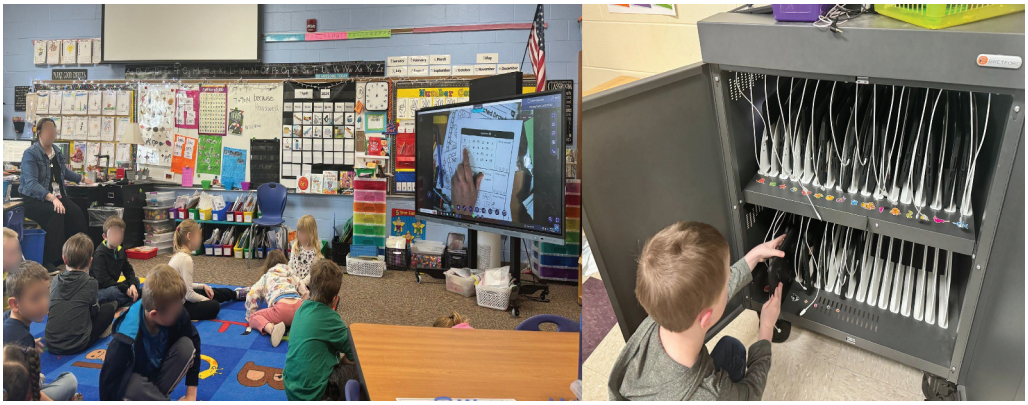


Figure 3. Sample digital technology tools.

> and I also use it to open books that we read in class. I use mel.org. It's MeL's website. I use the smart board as a way to direct students to something specific, a website like Splash Math, or just a fun website without an app that I want them to go and explore. (Dolly)

As seen in the statements, teachers make use of different DT applications in the educational environment to support children's learning. During the classroom observations, it was observed that these applications mentioned by the teachers were also available on children's iPads and that children frequently used these applications with the guidance of the teachers.

Effects of DT use on children

DT use has different life spans in children. These effects are classified under four categories: social interaction, motivation, development of DT use skills, and dependency when not used in balance.

The social interaction that occurs with the communication established in children during DT use was emphasized by the providers. As Ann expressed, "They need to solve many problems or not take them together to make sure they do it correctly. That's why. I think it's the most effective interaction." The conversations and children working together during DT use were seen as important in the emergence of social interaction. In the classroom observations, it was seen that children's DT operations created a lot of social interaction both in large-group activities and in small-group activities on iPads. (See Figure 4.)

> . . . .to develop social skills where they can talk to other kids and do group work or collaboration together . . . . I think it's good to introduce them to technology so they're ready. (Lily)

> We can now do field trips at the kindergarten level. We can have virtual people, or we can have a VAT expert from the Mammoth Cave in Tennessee that we couldn't interview before. So some of our teachers have taken advantage of those experiences where talking to an expert, a NASA expert, would have been very costly and unaffordable. With technology, it's completely possible, or you can have guest readers and writers . . . . You couldn't do that before, and now I think it connects us and deepens us, . . . so our kids are connecting with other cultures and people and expanding their thinking. (Holly)

In addition to interacting with their peers in the educational environment with the use of DT, children also engage in social interaction by communicating with people outside the school and through virtual connections, as Holly stated.

Another category identified is the motivational effect of DT use on children. In the observations, it was seen that children participated in the activities with enthusiasm and interest and were very excited, especially during individual tablet use times. Dolly expressed the motivational effect of DT as,



Figure 4. Social interaction using digital technology.

"Focusing on them is a great source of motivation. It is a great motivation and a great participation." We can understand why DT is a source of motivation from Ann and Shay's explanations.

> We have a phonics program that we're in. We just change the sounds. And there's nothing really fun that they can do with it. But if they can record themselves and share it with their parents at home, that's huge for them because they can go home and tell their parents. Yes, I was making sounds with my fingers. But if they can show their parents something, that's huge. Then they go back to the classroom, and they want to record their friends. They want to send it. At home with their parents. I think that probably excites them because then they can share. (Ann)

> I think it's a lot more because there's things that they can really like, manipulate, move, and do. It's just the hands-on part. It's like having a smart board, and they can come in and point to the words and read the book. It excites them more. It's more than having a paper book in front of them or me holding a paper book and looking at it. (Shay)

As seen in the teachers' statements, the most important factor underlying DT being a crucial source of motivation for children is that they can use it individually. In this respect, it is seen that the use of DT in the educational environment is a use that centers on children and thus excites them and increases motivation. In addition, it was observed that teachers frequently use upbeat songs during activity transitions to provide and raise the power of DT to ensure and increase motivation for children. These transition activities, in which children participate with great enthusiasm and interest, are also effective in creating an enjoyable learning environment. (See Figure 5.)

Another striking element in teachers' statements in this category was about children's ability to use digital technology. Children can write, drag, scroll, and mark with their fingers on the smart board, as well as demonstrate the same skills by opening the application on a tablet, recording activities and videos, and sharing via the application. Kasey expressed her digital skill development as "I think all my students are talented and probably know how to use the iPad better than I do." Shay noted, "They know how to interact as a group. They know how to do this job." As teachers stated in the observations, it was seen that children can use DT expertly without any problems. (See Figure 6.)

Finally, the category of addiction effect on children when DT is not used in a balanced manner was determined. The statements of teachers that it is necessary to be balanced all the time and that they try to use it in a balanced manner are an indication that they are aware of the possibility of addiction.

> It's not used very often in a balanced way (at home), and I've noticed this in these kids. It's like an addiction for them. They like it a lot, but then I feel like they get frustrated easily. (Kasey)

> Kids can't regulate themselves when they're done. If I have to turn off the technology I've had students in the past who can't accept that. That causes me problems again. I swear. Their ability to regulate their own emotions. They rely on that. When the technology that's supposed to entertain them is taken away from them, they can't seem to adapt. (Misty)

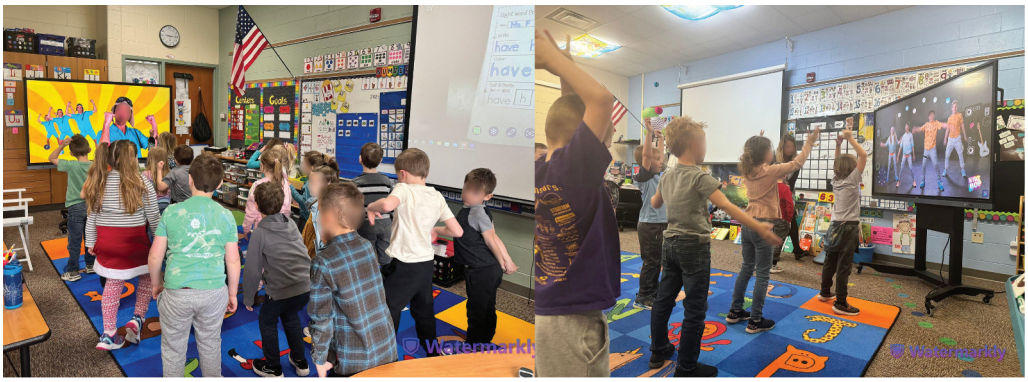


Figure 5. Use of digital technology in activity transitions.

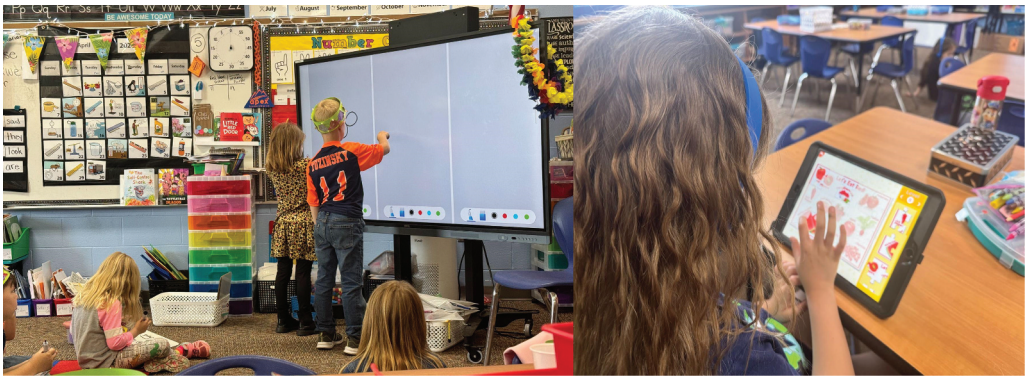


Figure 6. Children's digital technology usage skills.

It has been observed that when the use of DT is restricted, children may not be able to regulate their emotions, such as anger and lack of acceptance. It is thought that this negative effect of DT is also related to children's use of DT in the home environment, as understood from Shay's statement, "I think it's a struggle for balance. Because I think children have too much technology at home that they don't need." It is possible to understand that teachers are aware of what needs to be done to protect children from this negative effect from Kasey's statement, "I try to use it in a balanced way, so they're not completely on a screen all day, but at the same time I like to use them." Indeed, it was observed that the teachers provided a balance in terms of the time allocated and the content of instruction in the activities they carried out using real objects and DT and that some of the negative behaviors that teachers had observed in children in the past were absent, and that children were in harmony with the teachers' guidance.

Discussion

The purpose of this study was to describe, examine, and characterize the nature, scope, and context of early childhood educators' use of DT in kindergarten educational settings. Overall, the findings show that DT is used frequently in kindergartens and that teachers use DT in multiple contexts and for different purposes, such as implementation, planning, and assessment. It is also seen that DT has different effects on children. As stated in the constructivism theory, DT, which is considered as a concrete object and acts as an auxiliary tool in learning, is seen to be a facilitator that motivates children and builds learning. We discuss our findings and their implications for practice below.

The use of DT in kindergartens in early childhood education

The use of DT in educational settings supports children's learning process (Sulistyaningtyas et al., 2023), expands their knowledge (Slutsky et al., 2021), improves their academic skills (Kaynar et al., 2020), and provides experience and diversity in their learning (Yang & Gunn, 2020). In this study, it was concluded that DT was used to support teaching in kindergartens. The findings coincide with the findings of previous research that DT is used by teachers to support teaching (Bay & Hartman, 2025; Dorouka et al., 2020; Fantozzi et al., 2018; Hatzigianni et al., 2023; Kucirkova, 2014; Lindeman et al., 2021; Lynch & Redpath, 2014; Ottenbreit-Leftwich et al., 2010). It is seen that the use of DT in early childhood education supports a fun learning environment through many applications, such as story-telling and educational games (Li et al., 2024). Thus, DT can be seen as a kind of power to support children's learning.

Teachers also experiment with different ways of using the power of DT in teaching. Individual and collective use of DT elicited the context category. The findings revealed that teachers used more than

one DT tool simultaneously in large-group activities with the participation of the whole class and tried to support children's learning by repeating, recalling, explaining, and demonstrating information. By using DT, teachers achieve educational goals in this way while encouraging children to reason comprehensively and broadly (Redecker, 2017). The study also showed that children's individual use of the iPad as a context also ensured that the information learned was permanent. Although teachers may be reluctant to allow children to use iPads independently, independent use offers many opportunities to support instruction (Wilson et al., 2024). Therefore, it is recommended that in early childhood education, in addition to shared use of DT, independent use of DT tools with children's choices and active participation should be integrated into the educational environment (Petersen, 2015).

Moreover, this study found that teachers were particularly attentive to using DT in a balanced way, tried to balance between activities with and without DT and the duration of their use, and considered the use of DT as a tool to support learning for children. An indication of how attentive the teachers are to the use of DT is shown by the amount of time they allocate to DT use and the proportion of activities they do with and without the use of DT (see Table 2). In Bay (2022), Bay and Hartman (2025), and Hatzigianni (2018), early childhood teachers emphasized the balanced use of DT. DT is a valuable teaching tool for children who are fast learners by nature (Schriever, 2018). DT, which has become a means of entertainment for children (Plowman & McPake, 2012), should be balanced in daily routines by teachers (NAEYC, 2013). DT should be used not only for playing but also as another branch of learning in meaningful, purposeful, and intentional ways (Hatzigianni et al., 2018). Applications with colorful graphics, animations, moving pictures, and videos support children's behaviors, such as creativity, curiosity, exploration, and independence, while making learning more fun and permanent (Inci & Kandır, 2017). Therefore, using DT should be seen as a part of children's play (Vidal-Hall et al., 2020).

Determinants (adaptations) of DT used by early childhood educators in kindergartens

Another issue concerns determining the DT to be used. It is crucial that DT is appropriate for children's developmental and age characteristics and that the right applications are selected for teaching (Hu et al., 2021; McManis & Gunnewig, 2012; NAEYC & Fred Rogers Center, 2012), and both of these issues are determinants of DT use in the educational environment. It is seen that adaptation is made in determining the DT that is suitable for children to be used in kindergarten or the ones that are made suitable. Considering that some practices are confusing, contradictory, and have no educational value, teachers need to determine the pedagogical appropriateness of DT so that practices with real educational value (Papadakis, 2021) can be used in the educational environment (see Nagel, 2021; Papadakis, 2021; Redecker, 2017). There are different ways to ensure the appropriateness of DT for children regarding content and usage features. Papadakis (2021) stated that teachers should consider the dimensions of usability, efficiency, parental control, and reliability, considering their own teaching goals.

In this study, teachers identify DT to cover all these dimensions by supporting their professional development, using some teaching strategies such as modeling or starting from a low level, trying to choose the right app to meet children's needs, and evaluating children's performance and feedback during their use of DT. Especially in this regard, children's interests and curiosity serve as a guide for teachers (Hatzigianni, 2017). In a sense, apps that children are interested in are more likely to work better in achieving the desired goal and may be appropriate for children. The use of proper DT benefits children by providing enriched and more diverse learning opportunities (Hu et al., 2021). In addition, well-chosen DT allows for collaboration and communication between children (Fantozzi et al., 2018). In order for DT use to be effective, it is necessary to provide DT that is appropriate for children's development and compatible with their current abilities and needs and to evaluate DT carefully. Efficient and appropriate use of DT for children is crucial if it is to be a tool that supports learning (Lim & Wardrip, 2024).

Resources used by early childhood educators in planning, evaluating, and implementing DT in kindergartens

It was found that teachers use a wide range of tools, programs, and applications as DT resources in the educational environment, including the use of DT in planning the educational process, as classroom materials, and in assessing children. They use many tools, such as BenQ (smart board), iPads, projector, computer, document camera, and sound system, as well as applications, such as Seesaw, Jam Board, ABC mouse, Epic, PBS kids and technology, supported Bridges, Mdk2, DRA, and ELA curriculum.

When digital tools are evaluated, the use of the smart board, which creates environments that support collaboration and meaningful learning (Ward et al., 2016) and facilitates the use of different teaching styles (Bourbour, 2020; Gillen & Kucirkova, 2018), and the increasingly widespread use of tablets/iPads (see Dore & Dynia, 2020; Kucirkova, 2014; Lindeman et al., 2021), which increase motivation to participate in pedagogical activities directed by teachers, are seen as the most important facilitators in the teaching process. It is also seen that tablets/iPads are very effective in developing children's literacy skills and enabling them to learn information (Neumann & Neumann, 2014), developing creative and innovative thinking, and achieving goals in teaching (Couse & Chen, 2010). In this study, the fact that each child in the kindergartens had an iPad and used the iPad individually in the activities with the guidance of the teacher and that the smart boards, projectors, and document reflectors were used by the whole class and even at the same time with the guidance of the teacher shows that the potential benefits of digital tools were effectively revealed.

In addition to digital tools, using digital applications is also important in kindergartens. Teachers use iPad applications, electronic portfolios (e-portfolios), digital pictures, and videos to assess and document children's learning according to the goals of these programs, as well as some curricula suitable for use with DT (Danniels et al., 2020). In addition, digital platforms such as Seesaw are used to document children's learning, facilitate sharing with parents (Beaumont-Bates, 2017; Dwyer et al., 2019; Stratigos & Fenech, 2021; White et al., 2021), and provide opportunities for children to express their knowledge and ideas (Johns et al., 2017). Through the use of digital tools and applications, teachers contribute to systematically monitoring children's learning, creating permanent records of children (Hooker, 2015; Lyons & Tredwell, 2015), and developing children's self-evaluation and metacognitive thinking skills (Danniels et al., 2020).

However, the expected positive impact of ever-changing and evolving DT resources on children's learning can only be realized through teachers' professional development (Birden, 2022). With increased knowledge and understanding of using DT resources, teachers can better explain the technical aspects of DT by creating learning environments where DT becomes natural for children (Öqvist & Högström, 2018). The examples of using DT resources presented in the findings will expand teachers' knowledge.

The effects of early childhood educators' DT use on kindergarten children

There is a dynamic interaction between children and DT, which they can turn into play tools for active learning (Fleer, 2018; Kewalramani et al., 2020; Undheim, 2022). While using DT, children develop social behaviors such as discussion with teachers and peers, communication (L. Lee, 2015), cooperation, respect for others, and turn-taking (Lindeman et al., 2021). In this study, it was determined that children established social interaction through practices such as communicating with each other, group work, and collaborative use while using DT. Similarly, in Kucirkova (2014) and Bourbour (2020), it was determined that children using DT showed collaborative behavior. However, it is worth re-emphasizing that DT should be chosen carefully to encourage collaboration, communication, and creativity in children and to avoid passive learning (Fantozzi et al., 2018). Teachers responsible for selecting DT use their professional knowledge and skills. Bountri (2021) found that children who use DT support their emotional and social skills, while teachers need more training to use technology

devices. Therefore, it should be considered that to support children's developmental skills with DT, teachers also need to improve their own skills in using DT (Bountri, 2021).

From this study, another important effect of DT on children is that it increases their motivation in the learning process. Teachers use DT to increase children's motivation and interest, as well as to increase retention and engagement in learning (Y. Lee & Vail, 2005). DT is a way to create a fun environment in an educational setting, to motivate and hold attention for longer periods (Kaynar et al., 2020). Children are more focused on DT, and using it excites them. Computers, tablets, multimedia presentations, and educational games increase the excitement even more (Istenic Starčič et al., 2016). Similarly, previous studies have found that DT use increases children's motivation (Adolf et al., 2022; Bay & Hartman, 2025; Enochsson & Ribeaus, 2020; Istenic Starčič et al., 2016; Kaynar et al., 2020; Lim & Wardrip, 2024; Walan & Enochsson, 2024). In this respect, DT has a remarkable power over children, and teachers can easily use this power.

Among the changes that DT brings about in children's learning behaviors is a change in their experiences using DT (Bourbour, 2020). Educational environments where DT is used also enable children to develop their DT usage skills (Bountri, 2021; R. Liu et al., 2023). While using digital tools, children can demonstrate many skills, such as opening, using, and changing applications. Children using DT tools develop their hand-eye coordination and digital vocabulary and learn how to use digital tools and the Internet. This development and learning makes it necessary to integrate DT into teaching practices to prepare children to participate in this society as societies transform into digital societies (Lindeman et al., 2021).

Balanced use, which the teachers emphasized in using DT and stated that they were careful about, also impacts children. While four of the teachers emphasized the importance of using DT in a balanced way, two of these teachers expressed the view that if DT is not used in a balanced way with traditional activities, it causes addiction in children. Even though only two teachers expressed concern about dependency, this is a significant issue that needs to be addressed. This situation, which causes children to react angrily when they stop using DT and show a desire to use DT more, can lead to DT addiction in children in the future. For this reason, it is crucial to provide children with a balanced learning process that includes various alternative activities, such as outdoor play, social interactions, and creative pursuits, and to provide children with healthy DT use habits by being role models in DT use (Semiz, 2024). Thus, the study showed that negative situations that may cause addiction can be easily prevented thanks to teachers' careful and balanced use.

As a result, this study, which explored the use, determinants, sources, and effects of DT in a kindergarten education environment, went beyond previous research. Rather than presenting the ideal practice, the study's findings provide a basis for thinking about how educators can reflect examples of successful practices into the learning process. In this way, it will support educators to review their current practices and develop their approaches to implementing DT.

Limitations of the study and future direction

This study, which comprehensively demonstrates DT use in kindergartens with practical examples, contributes to educators' better understanding of DT use in educational settings and the importance of being more demanding in accessing resources to support children's learning. However, the study also has its limitations. The findings based on qualitative data with limited participants as a case study need to be extended and generalized by further research to explore learning experiences and practices with DT in different contexts and to understand how DT enhances learning. Unfortunately, research on the use of DT in early childhood education is scarce (Edwards & Bird, 2017; Lindeman et al., 2021; Vidal-Hall et al., 2020). Future studies could:

- Examine early childhood children's perspectives on DT use and their attitudes toward new technologies in the educational environment

- Plan longitudinal studies to follow the approaches used to support teaching with DT and the effectiveness of these approaches, and develop a DT pedagogical integration model
- Investigate the effects of the pedagogical design of applications, software, and programs used in educational settings and considered appropriate for children in their use routines and in supporting instructional goals.

Moreover, under current policy guidelines and the conditions provided, how to prepare children for digitalized societies is a crucial issue (see Lindeman et al., 2021; Mertala, 2019). This importance is highlighted in Donaldson's (2015) report on "Successful Futures," which advocates for development of a digital competency framework in curricula. Donaldson (2015) also stated in his report that current curricula do not provide current science and technology developments, that current curriculum policies need to be improved to include digital competencies, and that strategies and tools need to be developed to support development of informed digital citizens who critically evaluate their place in the digital world (Donaldson, 2020). Therefore, more studies should be conducted to inspire the development of policymakers' and school administrators' understanding of DT use. Moreover, the process of constructing knowledge with the motivation provided by concrete materials in constructivism theory has become visible with the examples of the application of DT as a tool in the classroom.

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Data availability statement

The study data is stored in a password-protected database on a password-protected computer. When the researchers are contacted, they can access the data.

Credit authorship contribution statement

Dondu Neslihan Bay: Conceptualization, Methodology, Data collection, Data analysis, Writing – original draft.
Douglas K. Hartman: Conceptualization, Methodology, Review and Editing.

Ethical approval

The guidelines on research ethics of the second researcher's university were carefully reviewed, and ethical approval was obtained from the Institutional Review Board (IRB) with the reference number STUDY00009529. Informed consent was

obtained from the school administration where the study was conducted, the teachers participating, and the parents of the children in the observed classes. The consent forms included explanations about the purpose of the study, that participants could withdraw from the study at any time, that participants would be given pseudonyms in the research report, and that personal information of children would not be used.

In addition, to support contextual analysis, photographs of classroom environments were collected, and images of children and teachers were blurred to preserve anonymity. The study records were stored on encrypted and password-protected drives accessible only to the researchers.

Classroom observations were conducted in the natural environment without intervention. Children present in the classroom during data collection were not direct participants. All protocols were designed to ensure the welfare and privacy of teachers and children involved in the research setting.

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