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**PEER INTERACTIONS AROUND DIGITAL  
TECHNOLOGIES IN EARLY CHILDHOOD  
EDUCATION**

A Systematic Literature Review

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# ABSTRACT

Meryem Tugba Yetimakman: Peer Interactions Around Digital Technologies in Early Childhood Education: A Systematic Literature Review

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Speedy advancements in information and communication technologies have placed digital technologies in every aspect of our lives and digital devices are now widely used everywhere. Children are exposed to technology from babyhood daily in their homes. Technology has transformed children's education and school experiences as well; students are now engaged with technologies daily for their schoolwork. While technology is already widely integrated and used with older children, integration of technology in early childhood education settings is a recent development. The main concern in integrating digital technologies as part of early childhood is its possible negative effects on children's development, for example, hindering children's development of social skills. Digital technologies are still considered as more suitable for solitary use because of some of their features such as having a small screen, allowing one user to control the device at a time, their association with video watching and game playing that limit the possibilities for collaboration and cooperation. This study systematically reviews articles that investigated children's social interactions during digital play in early childhood education and care context. We aimed to identify empirical evidence that points out if the use of digital technologies hinders or enhance peer interactions. This review found that digital play indeed offers children a social environment and possibilities to interact and develop social skills with peers. During digital play children help, share, lead, plan, organize, negotiate, celebrate, investigate, build confidence, creativity and positivity. Results also show that technology availability and use is still very infrequent in early childhood settings limited to few devices. This study intends to provide research-based information to parents and professionals working in early childhood education by presenting overview of the existing literature, identifying what behaviours children display and features of interactions promoted during digital play. We also aim to provide researchers interested in this field a base knowledge by bringing studies in the field together. Finally, the review points out gaps and gives recommendations for future research.

Keywords: social interactions, peer interactions, digital technologies, digital play, early childhood education

The originality of this thesis has been checked using the Turnitin Originality Check service.

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# 1 INTRODUCTION

Digitalization in education refers to the changes in the structure of education made possible by technology, it is an ongoing process and new fields of digitalization are constantly emerging, these emerging technologies provide new opportunities to bring people together (Vogt & Hollenstein, 2021). Digitalization has especially gained speed in the last decade and nowadays we see and use technology in many educational institutions from preschool to universities (Zizikova, Nikolaev & Levchenko, 2023). In today's developed world engaging with a technology is the new reality, even children are exposed to the technology from the day they are born and it transforms their childhood experiences from the experiences of older generations.

Technology now plays a significant role in children's education and in developed countries it is very common to see technological tools in educational institutions (Zizikova, Nikolaev & Levchenko, 2023). While technology education is generally embraced with older children, integration of technology in early childhood education has been a slow and difficult process (Hatzigianni et al., 2018). Many professionals in the field are skeptical about children's play with digital technologies where children are engaged with devices with a screen and various software. Their reasoning for this skepticism is that digital play and devices can hinder children's skills, especially social skills, and health at this significant stage of life for development (Hatzigianni et al., 2018). Technology increases the risk of obesity and other injuries due to increased sedentary lifestyle and sitting positions, damage eye sight, increase aggression, damage bonds with adults and peers and put them at risk of encountering harmful content (Cordes & Miller, 2000).

According to van Laar et al., (2017) rapid advancements in technologies made it significantly important that individuals acquire skills called "21<sup>st</sup> century skills" to participate in technologically complex societies. These skills are *'collaboration, communication, digital literacy, citizenship, problem solving,*

*critical thinking, creativity and productivity'* (p. 577). Vogt and Hollenstein (2021) state that in the future new technological trends will come up and children should be given the opportunities to acquire these crucial skills as early as they can. In early childhood children acquire these skills during play. Play is the primary context where children interact with their peers around them and develop social skills, since digital technologies are still perceived as more suited for individual play and not promoting social interactions, digital play is not considered as part of children's play. According to (Hatzigianni et al., 2018) while there is much research with hopeful results about children's learning with technologies, the concept of playing with technology is under researched and not very well understood.

This work makes valuable contribution to the literature by reviewing the studies that investigate young children's social interactions while they play with digital technologies with their peers in early childhood education settings that were published between the years 2013 and 2022. This study aims to provide an overview of the state of the literature and answer the questions: Do digital technologies promote children's social interactions if they do what types of interactions they promote? Additionally, this study provides information on what kind of hardware and software technology is available to children in kindergarten settings. This review intends to provide a base information for researchers interested in this area, point the gaps in the literature and establish that more studies should be conducted to better understand the technologies' contribution to children's social development.

## 2 DIGITAL TECHNOLOGIES IN ECEC

Digital technology used in education settings such as schools and kindergartens is referred to as educational technology, however, there is no exact definition to identify the scope of educational technology (Undheim, 2022). Jack and Higgings (2019) claim that every definition can change according to the individual who defines it. According to some researchers a narrow definition of digital technologies include computers and screens and a broader definition additionally includes technology that can offer imaginative and creative play opportunities such as not working devices (Undheim, 2022; Jack & Higgins, 2019). Digital technologies include both hardware and software technologies to facilitate learning. Undheim (2022) provided a translated definition of digital technologies from Olsen Fjørtoft (2019);

*“Digital tools refer to various types of computers and tablets, interactive screens, cameras, equipment for programming, and other types of digital production. Digital resources refer to the digital content used together with the children, both online content and apps or software to be installed” (page. 472).*

Edwards, (2013)’s definition of digital technologies is;

*“Digital technologies’ include multiple desktop and mobile technologies as well as digital toys and internet enabled technologies that operate as platforms for young children’s consumption of digital media and associated popular culture” (page. 202).*

and finally, Mantilla and Edwards, (2019, p. 183) define digital technology as;

*“Digital technology uses microprocessors to process information in digital form. Digitized information can be stored, reused and communicated by adults and children for multiple purposes (e.g. entertainment, social interaction and sharing knowledge)”*

The modern world has witnessed significant advancements in information and communication technologies and these developments affect the social life and attitudes of modern generation. Developments in technology, especially advancements of touchscreen devices has changed the dynamic of children’s everyday lives, their solitary and social play (Lawrence, 2018). Children interact with technology daily in their home environment. According to Rideout (2017) 98% of children in the USA live in a house that has at least one type of mobile device. According to their report while only 41% of families had a smart phone in the home in 2011, it moved up to 95% in 2017. Similarly, while only 8% of households had a tablet at home in 2011, it significantly increased to 78% in 2017, and finally in 2017 42% percent of children had their own tablet while less than 1% of children had personal tablets in 2011. According to The Common-Sense Census 2020 report in the USA children from birth to age 8 used on average 2 and half hours of screen media per day (Rideout & Robb, 2020). According to Mantilla and Edwards (2019), one third of Australian pre-schoolers have access to mobile devices and spend on average 26 hours per week.

However, despite this increase in technology availability and engagement at home, it is not the case in early education settings due to various reasons and concerns of different parties about children’s sociality and development (Lawrence, 2018). Lawrence (2018) claims that concerns about children’s engagement with digital technology could partially be due to the lack of literature and knowledge about it. Although technology has been in our lives for several decades, research regarding young children (0-8 years) and their technology use is significantly limited comparing to studies conducted with older children. Also little attention has been given to how children engage, instead research has prioritized quantitative measures of habits and technology use rather than qualitative investigations of children’s interactions around technological devices (Chaudron et al., 2015). Today’s children will be adults in the future who will most probably need to collaboratively work with different technologies, maybe



technologies not even known to us yet (Wohlwend, 2015). Therefore, it is important to understand the contributions and drawbacks of technology to children's learning and development. In order to establish that more studies should be conducted about the use of technology in early education from different aspects (Edwards, 2013).

According to Jack and Higgins (2019) technology used in early childhood education includes various devices such as; cameras, I-pads, recording devices, programmable toys, metal detectors, phones. However, one issue despite the variety of resources is how infrequently they are used in daily activities. According to them technology in early education is used intermittently and generally consists of learning operating skills, some play skills such as taking turns and basic literacy and numeracy skills. They also mention two contradictory claims from researchers that some researchers claim educational technology in early childhood education settings are used during whole class practices and drills, while other researchers suggest that it is mainly used during free play and interpreted as just computers.

## *2.1 Digital technologies in social educational context*

Children develop and make sense of the world around them through play and it is situated in the historical era which it occurs. Communities continuously evolve and change carrying their current knowledge and technology further, consequently presenting different developmental contexts of play for children. In this digital age children's traditional and digital play experiences are becoming interrelated and closer everyday (Undheim, 2022). Newly developed technologies present the opportunity to transform the nature of play through variety of available resources and how they are used during children's play (Sulaymani et al., 2018) However, despite years of research, rapid advancements in technology and the evident need for children to develop new skills to participate in increasingly digitally complex environments, children's play is still understood more traditionally and technology education is still not fully considered as part of children's play (Edwards, 2013).

Recently, technology is being included in the whole early years curriculums and used in various ways in ECEC (Jack & Higgins, 2019). In Finnish National Core Curriculum for ECEC, digital competence is included in seven transversal competence areas and significant importance is placed on it, given the reasoning that digitalisation is part of the society, and children need to be digitally competent enough to participate and communicate in the society and learning. ECEC centers are given the task of supporting children's understanding of digitalisation in collaboration with home. Digital technology is encouraged to be used in various ways daily and possibilities are encouraged to be explored with children;

*“The role of digitalisation in everyday life is explored and observed with the children. Digital tools, applications and environments are used in documentation, play, interaction, games, exploration, physical activity and artistic experience and production. Possibilities for practising, experimenting and personally and collaboratively producing content with the help of digital tools promote creative thinking, teamwork skills and multiliteracy in children. The personnel guide children in versatile, responsible, and safe use of digital environments.” (National core Curriculum for early childhood education and care p. 24).*

Some of the key goals of technology education are; developing confidence, perseverance, resilience, curiosity, cooperation and reflection (Jack & Higgins, 2019). They suggest ways children can use the technology in ECEC in order to reach these goals such as; home/school projects, searching the internet for information, using Youtube for songs, open-ended language and number activities with computers and I-pads, whole class or group role play, free play with programmable toys, drawing pictures and printing with computers, taking photos with I-pads, recording messages, listening and reading stories, programming, supporting children with special needs for calming, enlarging books and pictures for visually impaired children.

According to Wohlwend (2015) children's digital play may seem crowded and noisy that educators may intend to direct to more orderly play however, a lot of collaboration and shared learning occur behind that crowd and noise while

providing children with bodily engagement where they learn through touching, swiping, dragging, enlarging and shrinking objects, being exposed to various feedback from devices that activate their senses such as images, audios, animations. Well-designed digital technology can reinforce collaborative learning and interactions by encouraging turn taking and children asking and offering verbal and non-verbal help (Lieberman, Bates & So, 2009). When Lim, (2012) asked one of the children about which was more fun playing on the computer by themselves or with their peers, the child answered that playing with their friends was more enjoyable.

Davidson et al., (2016) claim that the absence of adults is one defining feature of technology use in ECEC and in general free play with digital technology is emphasized by teachers, however, children need richer technological experiences in order to benefit the most from technology and teachers are responsible to provide it through purposeful interactions. They suggest that using technology with adults or more experienced peers presents more positive effects for children. However, although in ECEC teachers and staff are generally in charge of determining the possibilities and limitations of integrating technology and establish rules of how and when to use the digital technologies (Undheim, 2022) children are not as guided or monitored as they are during traditional activities (Jack & Higgins, 2019).

Peer support is as highly important as teacher support (Kulju & Mäkinen, 2021). In their research they found that children used various strategies to complete the game tasks with their friends and children seemed to understand the idea of supporting their classmates, therefore, concluded that students interact and learn from each other during digital games. Danby, Evaldsson, Melander, and Aarsand, (2018) stated that digital game playing is actually a “*social enterprise*” where collaboration and interactions are necessary, children were found to be highly active and engaged with their peers during digital collaborative and cooperative play (Karno & Hatcher, 2020). Similarly to traditional play digital competence is built by interacting and learning together with peers and according to research more digitally competent children play a significant role in the learning of more novice children and collectively children accomplish more goals (Lim 2012 ). According to her children who are generally quiet and keep to themselves during a regular day of learning can be highly

competent in technology area and become more social and accessible to the peers, they can act as a problem solver.

## *2.2 Affordances and drawbacks of digital technologies and digital play in ECEC*

Although young children are involved in digital activities from babyhood there are a number of concerns educators and parents have about technology use in the early years and how it effects young children. According to Arnott (2016) affordances of toys for children has been studied by various perspectives and according to general understanding while some play tools such as games, and dramatic play tools enhance interactions and cooperation some toys inhibit interactions and are more suited to solitary play. Recently, questions have been raised about the affordances of digital tools in this respect and the most common belief seems to be that digital tools are more suited to individual play due to their size, portability and association with video watching and game playing activities (Sakr, 2019) and the single user feature makes technology harder to incorporate in collaborative activities.

Survey results of Zabatiero et al., (2018) showed that adults hold mixed views about the place of technology in early childhood. Adults accept the significance of technology in the 21<sup>st</sup> century and for future and importance of being skilled technology users, however they disagree that technological skills gained in early childhood education will support children in the future. Most educators are highly involved with technology in their personal lives; however, they can be reluctant to use technology with children and some do not consider children's engagement with digital media educationally valuable (Lawrence, 2018). Many of the concerns stem from the image of children engaging with technology individually which differs from the general early education goals of early childhood (Arnott, 2013). Fast-paced nature of digital activities (Sakr, 2019) and negative effects on children's physical, social and emotional, intellectual and moral development (Zabatiero et al., 2018) constitute the root of these concerns. Only engaging with a device limits movements and bodily engagement which is essential for children's learning. Cordes and Miller (2000)

mention that children at young age learn literacy through physical engagement such as drawing and creating the letters with their hands and bodies and claim that pressing a key instead of direct engagement can actually hinder children's learning how to read and write.

Cordes and Miller (2000) mention the risks of computers to children's physical (p. 25), social and emotional (p. 33), intellectual (p. 38), and moral development (p. 45). Some physical negative impacts associated with technology use in early childhood are increased sedentary lifestyle, obesity and other physical injuries (Karno & Hatcher, 2019; Cordes & Miller, 2000). Limited movements and sitting positions while using digital devices can put great stress on children's young bodies and negatively affect their physical health such as their hands, arms and neck (Cordes & Miller, 2000, p. 25). Children's bodies and muscles are more prone to injuries than older children and adults. Children involuntarily come close to the screen as much as possible in order to eliminate the distractions in their peripheral vision and maintain focus, this puts strain on the eyes, inhibits eye health and visual development (Cordes & Miller, 2000, p. 28; Zabatiero et al., 2018). Other common concerns mentioned by these authors are underdeveloped motor and sensory skills, sleep quality and heightened aggression (Plowman & Stephen, 2005).

Digital devices are perceived as harmful to children's social, emotional and intellectual development due to generally being associated with individual use while children need true human interactions to practice and master these skills (Cordes & Miller, 2000). Some adults view technology as the reason for children's less interest and low skills in traditional play and books (Plowman and McPake, 2013). Cordes and Miller, (2000). state that technology isolates and disengages children from their community, weakens bonds with teachers, decreases self-motivation, increases the chance of children coming in contact with harmful digital content, hinders imagination, creativity, concentration, patience and leads to learning and language difficulties.

Although some features of digital devices and games may not allow further discussion by simply moving to the next task when the previous one is completed, wide range of games and the touch screen feature of the i-Pad enhances the peer scaffolding and these digital technologies are still open for improvement (Kulju & Mäkinen, 2021). Therefore, it is essential to study how young children

engage with technologies to learn and gain knowledge on their interactions with others during digital activities (Danby, Evaldsson, Melander, & Aarsand, 2018) in order to prepare them for future.

Some digital tools are perceived as easier to use than others with children. Especially handheld touch screen devices are among the most preferred devices to integrate technology in ECEC. In a research when ECEC teachers were asked what kind of technology they would like to have if there were no limits to accessing the technology, most teachers mentioned I-pads as desirable devices in early childhood education, where those who did not have wanted them and those who had some wanted more (Jack & Higgins, 2019). Other technology that was mentioned by teachers were cameras, different softwares and interfaces such as touch screens tables and voice-activated devices. Teachers also mentioned having these technologies in their own setting rather than going somewhere else and borrowing devices and their desire to have an expert to support them in technology use.

Advantages of mobile and handheld devices such as, a single I-pad or mobile phone containing various apps that enable children to work on different skills are their portability, easy to use nature, ability to reach various sources of information. Digital technologies such as I-pads allow children to document their ideas and perspectives efficiently without constraining them to their limited abilities due to their age such as most of them not being able to read and write., by using the apps they can document and express their thoughts freely (George et al., 2018). According to Palmér, (2015) digital devices can provide unique visuals and audios, they offer easier manipulation of objects and provide instant feedback, possibility to save their work and continue or reflect on it later. Customization enables personalizing the apps and games according to children's own development and quick access to programs and applications on different levels. Different kinds of features and programs make it possible for children and teachers to take different roles and further promote interactions (Palmér, 2015). The technology education helps support the communication and language and develop understanding of the world (Jack & Higgins, 2019).

The review reported in this paper deals specifically with digital technology. Following the translated definition of digital technology provided by Undheim (2022), digital technology is defined in this review as digital devices (e.g.

computers, tablets, interactive boards) and the digital resources (e.g. applications, websites, games) viewed, played, read or created by children on these devices.

### 3 SOCIAL INTERACTIONS AND DIGITAL TECHNOLOGIES IN ECEC

Humans' social development starts at the beginning of life, babies interact with close adults through their senses, such as touch and making eye contact with them. Children are attracted to others from early age and are eager for interactions, the more they interact the more different ways of interacting they learn. First crucial steps are taken in this first year in regards to children's sociability and as a result of direct interaction with others, children develop emotional skills and social understanding consequently building social competence (Syrjämäki et al., 2017). After the first-year children start engaging in conversation like scenarios and interact more (Lindon, 2011), children expand their network out of their family and develop social and emotional skills by interacting and building relations with others such as friends, teachers, and other people outside of their home environment (Wang et al., 2021). Children interact with their peers in various ways which depend on the setting, the individual child that is interacting, the peer that the child is interacting with and the nature of the interaction (Fabes, Martin, & Hanish, 2009).

In early childhood play environments form the primary context for peer interactions. Coplan and Arbeau, (2009), highlight three themes about the contribution of play to peer interactions. Firstly, the adaptive function of play presents children with opportunities to interact and practice real life skills they will need in adulthood without the unwanted consequences of mistakes. Secondly, during pretend play children explore and replay situations that arouse intense emotions, and through play children learn to regulate emotions, reduce anxiety and master the emotion regulation skills. Finally, exploring various representations of situations and possibilities encourage children to think out of the box and try new things which promotes cognitive flexibility and creativity. Wohlwend, (2015) describes play as an ongoing collaborative activity where



children engage with their bodies and play materials. During play children construct stories, take on different roles, negotiate, disagree and offer different ideas. According to Dunn and Herwig (1992) the link between play and diverse thinking is stronger when the experience is shared with peers (as mentioned in Coplan & Arbeau, 2009), further emphasizing the importance of interactions with peers during play.

Positively interacting with peers is essential for children's learning and these interactions are regularly occurring opportunities during play for children to support and develop their own skills as well as their peers' (Bulotsky-Shearer et al., 2012). Play activities present children with opportunities to advance in all development areas such as, cognitive, linguistic and social skills necessary to maintain reciprocal play (Coplan & Arbeau, 2009), children express their own perspectives, nurture their creativity and thinking (Luckenbill et al., 2019, p. 16). During play children are engaged in a shared project, they collaboratively create and change play situations (Cederborg, 2020). Getting exposed to other's ideas, opinions and feedback encourage children to develop more empathy, conflict-resolution and cooperative learning skills.

### *3.1 The Importance of Sociability*

Kim, (2023) defines sociability as *"preferring to be with others rather than being alone"*. Oksman et al., (2019) defines it as *"preferring someone else's company instead of loneliness"*. In a broad definition sociability is tendency to seek interaction with others and join the social life. Even in first years of life through innate skills infants seek interactions from adults which increase their chance of survival and learning experiences (Flanagan, 1999 p. 9). According to Oksman et al., (2019) sociability is the result of various inner social needs such as depending on others' approval, feeling the need to emotionally attach to others, feeling the need to be surrounded by a big social circle.

In early childhood, educational settings carry significant value in children's social and emotional development and socialization (Phillips et al., 2022), as they engage with adults and their peers in different situations. Early education and care environment and the pedagogically planned unique opportunities they provide play significant role in developing sociability (Oksman et al., 2019).

Syrjämäki et al., (2017) found that high quality early education pedagogy positively impacts peer relationships. Interactions between the adult and child and among peers is essential for developing and learning. In Finnish National Core Curriculum for Early Education, recognizing the importance of play for children and promoting play opportunities for children is mentioned as a principle of operational culture, interactions and collaboration among children and adults are emphasized and children are encouraged to act as part of a group and build positive peer relationships (p. 28).

Through interacting and socializing with peers, children develop various social and emotional skills as well as academic skills (Bulotsky-Shearer et al., 2012). Positive peer interactions promote skills related to successful learning, such as attention, motivation and persistence (Cohen & Mendez, 2009). In a year-long study they found that stable peer relationships contributed to positive social behaviour changes in children, in their research 27% of children were found exhibiting behaviour problems in the beginning of the year while this number decreased to 22% at the end of the year. They also state that poor interactions with peers are associated with poor social and learning behaviours as a result of children preferring less aggressive and disrupting peers to play with.

Early environmental factors related to sociability effect children's personality and social life in adulthood (Oksman et al., 2019). Early positive peer play experiences and socializations contribute to not only children's early development, but also social and school outcomes later in life as they grow and enter formal schooling (Bulotsky-Shearer et al., 2012; Coolahan et al., 2000). Children who attend a centre-based daycare or family daycare get the chance to practice their social skills more than children who are cared at home and become more socially competent. Oksman et al., (2019) found that children who attend centre-based daycares, and family daycares were associated with higher adulthood sociability than children who were cared at home. Children who are more socially competent have better cooperation and self-control skills (Şenol, 2021) and children who possess well developed social and emotional skills build better relationships with their peers and teachers and are more likely to be liked and accepted by their friends resulting in these children showing more prosocial behaviours such as listening and helping (Wang et al., 2021). Similarly, children

with lower emotional control experience lower peer acceptance resulting in more aggressive, disruptive and problematic behaviour.

### *3.2 Digital Technologies and Social Interactions*

Digital technologies could be absent in many early learning settings due to concerns about devices replacing interactions and other benefitting activities for children and consequently inhibiting children's learning through interactions (George et al., 2018). Digital technologies are perceived as more suited to individual activities and hindering children's social and emotional development by many professionals and parents. Therefore, it is essential to study how young children engage with technologies in order to learn and gain knowledge on how they interact with others during digital activities (Danby, Ewaldsson, Melander, & Aarsand, 2018).

Different digital technologies offer distinct opportunities for collaboration and interactions according to their various features. As bigger, shareable and interactive displays, such as multi-touch tables, offer greater opportunities, smaller devices such as iPads while allowing multiple children to work together may not offer easy collaboration to as many children as the bigger devices. I-pads' affordances of lying flat or tilted conveniently, portability, wide viewing angle and built-in keyboard facilitates children's work and interactions (Disney & Geng, 2021). According to them touch screen provides sensory satisfaction for young children and it enables the enjoyment they experience in the moment.

Research shows that technologies possess the ability to encourage social interactions among children with the proper guidance (Valkonen et al., 2020). They emphasize that digital devices do not automatically promote social interactions, they provide opportunities for shared meaning making which supports the idea of integrating technology developmentally appropriately with a purposeful pedagogy. Palmér, (2015) states that the design of the digital tool, the teacher and the educational context are critical components on the way to reach success in technology education. She states that tools cannot be expected to naturally produce intended results, desirable results come from its appropriate integration and use.

Therefore, it is necessary to consider developmentally appropriate ways of technology use in kindergarten settings in order to benefit the most from it. Developmentally appropriate use of technology is to integrate technology in the overall learning of the kindergarten curriculum (Lim, 2012). Lim (2015) found that even if the children work individually on different devices if they work about the same topic, which is the ongoing classroom theme, they tend to talk a lot and interact more with their friends which facilitates meaningful knowledge construction. When technology is used to expand the knowledge about ongoing classroom activities, students share common joy and are more likely to interact and collaborate while using digital devices. She also found that although children are provided access to limited programs in the devices, they found new features and functions of the existing programs and taught their friends and children built new knowledge through their interactions. When the technology is integrated in ongoing classroom activities not only the children who actively use the technology get engaged but sometimes other children can come over, watch and interact with their friends. Valkonen et al., (2020) found that children were enthusiastic and eager to use new technologies and displayed high motivation to participate and cooperate during the digital activity and they state that these tools have an effect on learning and development when children use it, emphasizing the importance of making these devices a part of everyday meaning making.

Lim (2015) found 4 factors that support social interactions during digital activities which are “*connection with classroom theme, user-friendly software design, working pairs and open-ended software program*”. and three factors that hinder children’s social interactions which are “*teacher interruption, closed software design apps, environmental limitations*”. Palmér, (2015) lists three factors that effect the success of digital technology use; the design of the tool, the teacher and the educational context. Some features to consider when choosing applications in order to foster more interactions are ease of navigation, multi player features, multimodel (supporting different features such as allowing children to import photos, videos, audios, supporting design, action etc.), open-ended app design (Wohlwend, 2015).

Using digital technology involves different kinds of interactions, between devices and children, between teacher and children and between peers (Palmér, 2015). This review particularly focuses on peer interactions. Studies that focus

on interactions between children and adults and children with devices are not included in this work.

# 4 METHODS

## 4.1 *Research Design and Research Questions*

To investigate the state of existing literature in the controversial topic of children's peer interactions around digital technologies in early childhood education settings this study has employed systematic literature review as research design and aims to answer the following questions;

1. Do digital technologies enhance or hinder peer social interactions in ECEC?
2. What features of social interactions do technologies enhance in ECEC context?
3. What kind of technology is available in Early Childhood Education settings?

It is a fundamental part of any research to relate new studies to existing knowledge and expand it. With vast amount of existing literature and new knowledge production every day, it becomes difficult to keep up with the state of literature in any field (Snyder, 2019). Systematic literature reviews are imperative to academic research due to extensive insights they provide about existing knowledge and gaps, therefore, allowing researchers to reach up to date information, relate their studies to available literature and expand it. (Xiao & Watson, 2019). Snyder (2019) describes systematic literature reviews as “*a research method and process for identifying and critically appraising relevant research, as well as for collecting and analyzing data from said research*” (p.334).

## *4.2 Data Gathering, Inclusion Criteria and Quality Appraisals*

The literature on the use of technology in ECEC was meticulously examined by using the search string created by the author. Search terms were developed deriving from the research questions and preliminary research of the literature. The following search string was used during the database search “social interactions” OR “group dynamics” OR “peer interactions” OR “collaborative learning” AND “technology” OR “new technologies” OR “digital technologies” OR “mobile digital technologies” OR “digital play” OR “computer-supported collaborative learning” OR “technology integration” AND “early childhood education” OR “preschool” OR “young children” OR “early learning” OR “kindergarten classrooms”. To identify most related studies extensive database search was conducted by the author in six databases: Education Collection (ProQuest), Education Database (ProQuest), Social Science Premium Collection (ProQuest), Education Research Complete (EBSCO), Scopus (Elsevier), ERIC (ProQuest). The databases were accessed through the Tampere University library database to secure access to all the articles. Database search was conducted between 20 - 30 September 2022. Search results were limited to peer reviewed articles that were published in English. The period included in the review was limited between years 2013 and 2022. (see Table 1 for inclusion and exclusion criteria).

A valuable systematic literature review should present transparent and accurate information about why and how the review was done (Page et al., 2021). To establish the transparency and value of the current review PRISMA (2020) guidelines were used. The PRISMA (2020) statement is an updated version of PRISMA 2009 statement, the checklist consists of 7 sections and 27 items and can be used for mixed methods systematic reviews (Page et al., 2021).

The first search results provided 14675 results. Search results were exported and gathered in Zotero application. 2077 doubles and 1 ineligible study were removed in Zotero and the results were exported to Excel.

**TABLE 1.** Inclusion and exclusion criteria

Criterion	Included	Excluded
Education level and setting	Early Childhood Education (age 0-6) settings	Primary Secondary High school University Home
Participants	Typically developing children aged 0-6.	Children with complex/special needs
Interactions	Peer Interactions	Teacher-child interactions Child-device interactions Parent-child interactions
Context of Play	Digital Play	Traditional play Story telling
Technology	Digital Technologies I-pads Computers	Robotics Engineering Any other daily available technologies in TECEC settings

Initial title and abstract screening were conducted in Excel by filtering with keywords in the search string. This screening classified 355 studies as potentially related to the review. The author personally screened the titles and abstracts of remaining 355 studies by using the title and abstract screening tool developed in the initial stages of the research based on the guidelines and example from (Polanin et al., 2019) (see Appendix 1). This stage classified 36 articles as related to this review. Finally, a full text screening was conducted by the author for the remaining 36 studies in order to identify the studies that were included in the review. The author reviewed the references of the articles and found 4 more potential studies. Additionally, 6 more potentially related studies were found and included in the screening. After screening all the studies, 12 articles were selected to be included in the review. Excluded articles had topics very close to the aims of this review however, did not provide enough insight to be included. They investigated topics such as children's interactions with teachers or parents during digital play, storytelling, technologies contributions to learning literacy and mathematics, robotics. Some of them were excluded due



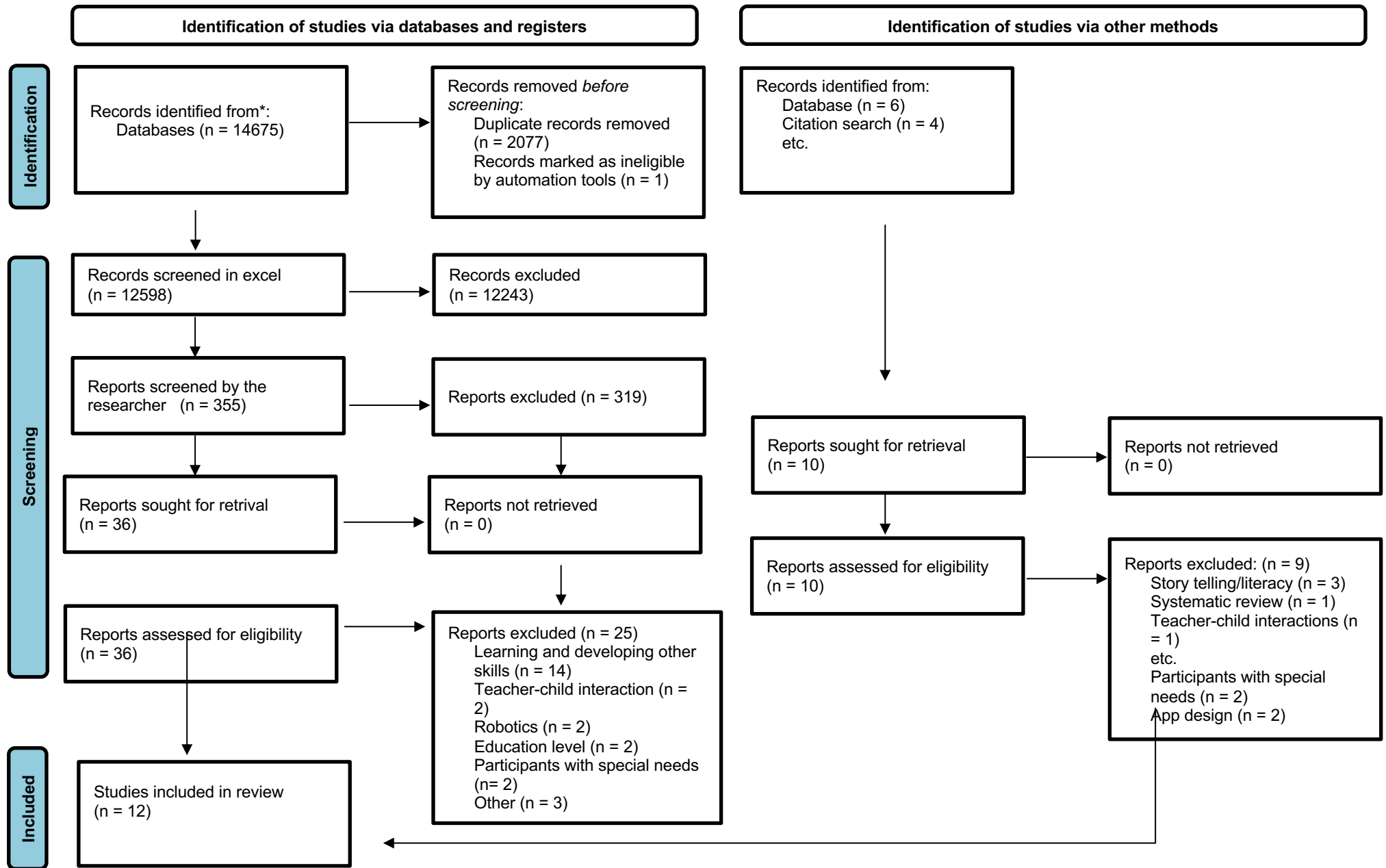
to participants and settings not matching with the inclusion criteria. For example, studies conducted with children with special needs were excluded. Figure 1 shows the study selection process according to PRISMA 2020 (Page et al., 2021) flow diagram for new systematic reviews which included searches of databases, registers and other sources.

A systematic selection criterion is used during the review process to minimize bias, reach reliable data and conclusions (Snyder, 2019). To identify the most relevant studies to answer the research questions inclusion and exclusion criterion were established (see Table 1). In the current review studies were included if they were conducted in early childhood education settings such as stand-alone schools, preschool classrooms in primary schools or on university campuses with typically developing children as participants. Studies conducted with children aged 0-6 in other settings such as home and students with special/complex needs were excluded. Among these, studies that investigate children's peer social interactions when playing with digital technologies with screen or touch technologies such as I-pads, interactive tabletops, and computers were included. Studies that investigate other types of interactions such as teacher-child, parent-child and child-device interactions with other technologies such as robotics, any other daily available technologies were excluded.

There were four exceptional articles (1,2, 5 and 7) that were included although they investigated interactions in different settings and with other technologies together with digital technologies. Articles 1 and 2 were published by the same author and investigated children's peer interactions around various technologies such as, metal detector, digital cameras, microwave, laptop, computer. Since these studies observed children around digital technologies as well alongside other devices, they were included in the review. Study 5 investigated children's interactions across different settings (home, kindergarten and after-school program). Only findings in the kindergarten setting are included in the review. See Table 1 for inclusion and exclusion criteria. Finally study 7 was conducted in a primary school in year 1 classroom. Although this study was conducted in a primary education class it was included in the review due to age-appropriate participants and primary education starting age varies across the world.

According to Hong et al., (2018) systematic reviews that combine qualitative, quantitative and mixed-method studies are called “systematic mixed studies reviews”, and they are becoming increasingly popular in the academic research due to extensive knowledge and richer understanding they provide.

**FIGURE 1.** Study selection flow chart according to PRISMA 2020 (Page et al., 2021)



However, with extensive knowledge they provide comes the challenge of ensuring the quality of each study and findings which is difficult for authors as they would need to learn different tools to appraise the quality of studies with different designs. This review includes 7 qualitative, 3 quantitative and 2 mixed-methods studies. Due to heterogeneous nature of this review Mixed Methods Appraisal Tool (MMAT) Hong et al., (2018) was considered an appropriate tool and was utilized to appraise each study included. MMAT was developed for appraising the quality of systematic mixed method studies reviews. It allows authors to critically appraise qualitative, quantitative and mixed methods studies. MMAT consists of two screening questions and nineteen items for assessing the quality of studies in five different categories. 1. qualitative studies (4 items), 2. quantitative randomized controlled trials (4 items), 3. quantitative nonrandomized studies (4 items), 4. quantitative descriptive studies (4 items), and 5. mixed methods studies (3 items) (Hong et al., 2018). After deciding which studies will be included in the review author appraised each study by using the MMAT Hong et al., (2018) checklist. Table 2 displays the MMAT Hong et al., (2018) checklist.

### *4.3 Data Extraction and Synthesis*

Data extraction was conducted only by the author for all the studies. Table 3 displays the information extracted from the studies. The data was extracted and sorted into the following categories; “study author and year, title, location, study design, setting, data collection methods, technological tools and technology use (children’s access to technology during the study), behaviours and actions”. Studies are listed in alphabetical order; studies will be referred to with the order number in Table 3 in the next chapter when synthesizing the results.

Findings were sorted into seventeen features of interactions digital play enhances, to answer research questions 1 and 2. In the next chapter we present a list of hardware and software technologies (see Table 7) to answer research question 3 and find out what technology is mostly available to children in ECEC. The findings will be synthesized narratively in the next chapter.

**TABLE 2.** Mixed Method Appraisal Tool Hong et. Al, 2018

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	S1. Are there clear research questions?				
	S2. Do the collected data allow to address the research questions?				
	<i>Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.</i>				
1. Qualitative	1.1. Is the qualitative approach appropriate to answer the research question?				
	1.2. Are the qualitative data collection methods adequate to address the research question?				
	1.3. Are the findings adequately derived from the data?				
	1.4. Is the interpretation of results sufficiently substantiated by data?				
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?				
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed?				
	2.2. Are the groups comparable at baseline?				
	2.3. Are there complete outcome data?				
	2.4. Are outcome assessors blinded to the intervention provided?				
	2.5. Did the participants adhere to the assigned intervention?				
3. Quantitative non-randomized	3.1. Are the participants representative of the target population?				
	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?				
	3.3. Are there complete outcome data?				
	3.4. Are the confounders accounted for in the design and analysis?				
	3.5. During the study period, is the intervention administered (or exposure occurred) as intended?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question?				
	4.2. Is the sample representative of the target population?				

	4.3. Are the measurements appropriate?				
	4.4. Is the risk of nonresponse bias low?				
	4.5. Is the statistical analysis appropriate to answer the research question?				
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?				
	5.2. Are the different components of the study effectively integrated to answer the research question?				
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?				
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?				
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?				

# 5 RESULTS

The results of the study selection process showed that there are actually many studies about technology integration in early childhood education, however, most of them focus on different aspects of technology such as technology and literacy (Aarsand & Sørensen, 2023), technology to enhance mathematics learning (Disney et al., 2019) other subject learning outcomes (Martín et al., 2019), teacher-child interaction (Davidson et al., 2016), and storytelling (Skantz Åberg et al., 2014). Results of this review shows that although there is lots of debate about technology hindering children's social interactions unfortunately there is still not enough research about children's social interactions around digital technologies.

Among 12 articles, 11 studies (all studies except for study 7) focus on features of interactions and analyze what kind of interactions and behaviors children engage to during digital play. In this chapter the researcher will synthesize the results and answer the research questions. While giving general information and answering results the articles included in the review will be referred with their numbers according to the list of studies in Table 3.

## 5.1 *Descriptive findings*

In this study, 12 articles were found relative to answering research questions. Among twelve articles 2 were conducted in Scotland, 2 in England, 1 in USA, 1 in Canada, 1 in New Zealand, 1 in Chile, 1 in Australia, 1 study was conducted across Australia, Sweden and Norway and place was not mentioned in two of the studies. This result shows that the concern with children's digital play is present in many different places. There were 7 qualitative, 3 quantitative and 2 mixed methods design studies. In total there were 23 settings, 19 of them were stand-alone early education centers, 2 were preschools on university campuses, and 2 were early education classes in primary school.

**TABLE 3.** Summary of included studies

No	Study	Title	Location	Study Design	Setting	Participants	Data Collection	Technological tools	Technology use
1	Arnott, 2016	An ecological exploration of young children's digital play: framing children's social experiences with technologies in early childhood	Scotland	Qualitative	Two preschools	90 preschool children aged 3-5	Systematic observations, Cluster mapping (noting down each child's location, activity and social interaction on a classroom map), Researcher-led games Interviews with practitioners.	Computer Interactive Whiteboard Leappad Laptop Alphabet Board Electronic bus Electronic road Fire Truck landline Telephone Microwave Mobile Telephone shopping Till Hair straighteners Washing Machine Digital Cameras Metal Detector Fairy Lights Calculator Exercise Equipment CD Player Musical Keyboard Tape recorder Duplo Techs Tool Box	Children were observed around readily available technology in each setting.
2	Arnott, 2013	Are we allowed to blink? Young children's leadership and ownership while mediating interactions around technologies.	Scotland	Qualitative	Two preschools	90 preschool children aged 3-5	Systematic observations, Cluster mapping (noting down each child's location, activity and social interaction on a classroom map), Researcher-led games Interviews with practitioners.	Computer Interactive whiteboard Leappad Laptop Alphabet board Electronic bus Electronic road Fire truck Landline telephone Microwave Mobile telephone Shopping till Hair straighteners Washing machine Digital cameras Metal detector Fairy lights Calculator Exercise equipment CD player Musical keyboard Tape recorder Duplo techs Tool box	Children were observed around readily available technology in each setting.
3	Barros Blanco et al., 2022	How do preschoolers interact with peers? Characterising child and group behaviour in games with tangible interfaces in school	not mentioned	Quantitative	1 pre-primary school	81 children aged 3-4 years old	Video recordings Log files of each session collected by the software	Hardware: an interactive table, Nikvision table top device  Software: Nikvision Software, an augmented collaborative game developed by the researchers	Children were assigned in groups of three by the teacher and observed during sessions. Before playing the game children played with colorful chips on a model on the floor similar to the game.



4	Charissi & Rinta, 2014	Children's musical and social behaviours in the context of music-making activities supported by digital tools: Examples from a pilot study in the United Kingdom	West London, England	Qualitative	primary school	4 children aged 6-6.5	Field notes Video recording of the subset Audio recordings observations	Hardware - computer Software: two music programs for children (Sibelius Groovy Shapes and JamMo)	Study was conducted in the schools computer lab and children had access to the technology for 4 sessions over 4 week period as part of their music lesson timetable.
5	Danby et al., 2018	Situated Collaboration and Problem Solving in Young Children's Digital Gameplay	Australia	Qualitative	home	6 children and their families	video recordings	Hardware - tablet Software - Minecraft	Not mentioned
			Norway		3 preschools	preschool children aged 3-5 years old. Number of children is not mentioned.		Hardware - tablet Software - tablet games	
			Sweden		an afterschool program	children aged 8 years old. Number of children is not mentioned.		Hardware - computer Software - popular network site for children called Mornio	
6	Disney & Geng, 2022	Investigating Young Children's Social Interactions During Digital Play	Australia	Mixed Methods	3 childcare centers	80 3-4 years old children	Semi-structured observation	Hardware - iPads Software - mathematical apps	Children had free access to readily available iPads in the center. Play was monitored by the center staff
7	Falloon & Khoo, 2014	Exploring young students' talk in iPad-supported collaborative learning environments	New Zealand	Quantitative	primary school	19 children aged 5. The study was included due to appropriate age of the participating children,	Display capture tool called "Display Recorder". While children are using the apps the tool records in the background of the screen of the I-pad with audios of children's talk and creates a video.	Hardware - I-pad Software - 3 apps chosen by the teacher.	Children were using I-pads prior to the research as part of their learning. During the research 10 I-pad 3s were supplied by the university for the research. Students worked in teacher-assigned pairs.
8	Gómez et al., 2013	Co-located single display collaborative learning for early childhood education.	Chile Metropolitan Region	Quantitative	Intervention group - 5 schools with two kindergarten classrooms each Control group - 4 other schools total of 5 classrooms	Intervention group - 268 children aged 5-6 years old and 10 teachers Control group - 172 children aged between 5-6 and 9 teachers	Pre and post tests Observation with a rubric	Hardware - computer and mouse for each child Software - Single display groupware application (Role Game, Exchange and Sort)	Study was conducted in the computer lab of the school children had access to the technology twice a week over a 4 month period.

9	Karno & Hatcher, 2020	Building Computer-Supported Collaborative Learning Environments in Early Childhood Classrooms	New England	Qualitative	Preschool class in a lab school	18 children aged between 2,5 to 5	Videos and transcripts Teacher feedback surveys Observation notes	Hardware - Engage-2 multi-touch table  Software : four of Kaplan Early Learning Company's apps (Math Bubbles, Group Bubbles, Puz-zles and Insect Creator)	Table was provided by researchers and was available to the children during morning center-time and during late afternoon individual choice-time. Children self-selected table play and there was no attempt to balance or direct participation by age or gender.
10	Lawrence, 2018	Preschool Children and iPads: Observations of Social Interactions during Digital Play	not mentioned	Qualitative	1 early childhood education center located in a university	20 children aged 5	Observational field notes Semi-structured interviews with educators	Hardware - iPad  Software - Five closed-design apps focusing on literacy, numeracy, and shape/size recognition iWriteWords (Giggle Lab, 2013), Word Wagon HD (Duck, Duck, Moose, 2014b), Park Math HD (Duck, Duck, Moose, 2014a), Bugs and Numbers (Little Bit Studio, 2012), and Monkey Preschool Lunchbox (Thup Games, 2014)  One an open-design coloring/painting app Doodle Buddy (Pinger, 2012)	At specific times during the day assigned pairs of children had the opportunity to play with a shared iPad in a classroom activity center for a 15-min session. Participation was voluntary.
11	Ralph, 2018	Media and Technology in Preschool Classrooms: Manifesting Prosocial Sharing Behaviours When Using iPads	Canada	Mixed Methods	1 community ECEC center	3 children aged 4 and 1 teacher	Video observations Semi-structured interviews with the teacher and students children's artifacts from the activities	Hardware - iPad  Software - Chatterpix Kid app	Technology and media is not integrated in the classroom. Children use the iPad in different scenarios created by the researcher.
12	Scollan & Farini, 2020	In, out and through Digital Worlds: Hybrid-Transitions as a Space for Children's Agency	Boston, U.S.A.	Qualitative	1 pre-kindergarten	8 children aged 3-4 years old	Participant observation	Hardware - computer  Software - communication skills software	Children were observed during 30 minutes sessions in the early afternoon for over two weeks.

Participants across the studies are children between the ages 2,5–6,5. Four studies include teachers as participants (3,5,9,10), and one study (5) includes families as participants as well. However, in study 5 only the data acquired from preschool was analyzed, results concerning the families were not considered. Two studies (1,2) interviewed practitioners as well however, did not mention the number of practitioners. Study 11 did not mention the number of participants. Collectively from 11 studies there were 763 children and 26 teacher participants.

Among the 12 studies, the most common process of data collection was observations and was used by 8 studies (1,2,4,6,8,9,10,12) followed by video recordings, used by 5 studies (3,4,5,9,11). Other methods used to collect data were; cluster mapping (1,2), researcher-led games (1,2), interviews (1,2,10,11) and survey (9) with practitioners and children, field notes (4,10), audio recordings (4), pre and posttest (5), two of the studies used software to collect data, study 6 used log files collected by the software as data and study 7 used a display capture tool named “Display Recorder” that created a video of tablet screen with audios of children’s talk.

Computers and tablets were the most common hardware technological tools children were engaged during studies with ten studies employing these devices. Two studies used an interactive table (3) and multi-touch table (9). Two of the studies (1,2) included other tools alongside computers and tablets such as interactive whiteboard, laptop, calculators, metal detectors, electronic road, landline telephone, digital camera, microwave (see Table 6 for complete list of daily technologies used in studies and see Table 7 for division of hardware and software digital technologies). Almost all the studies used different software, games and applications with these devices. Two studies (1,2) did not mention which software was used.

## *5.2 Research question 1: Do digital technologies enhance or hinder peer social interactions in ECE?*

Contrary to common belief that digital activities are more suited to solitary play and hinder children’s interactions, social and emotional development (Cordes & Miller, 2000), all 12 studies found that digital play offered children a social

environment and opportunities for interactions. According to study 10 technology (an I-pad in this study) seemed to invite interactions and children continuously engaged with each other in different ways, one educator noted that it provided children with a different field of play. Children attempted to establish interactions with their peers in several ways such as solving technical problems, guiding those who have difficulties playing the game, thanking and celebrating accomplishments. They displayed prosocial and antisocial behaviors. Children engaged in various types of play during digital play. The most common type of play was cooperative play, where children need to work and complete a task together (3). Children adopted different roles such as the helper, leader and engaged in different interactions through these roles, participants frequently exhibited helping behaviors and scaffolded their peers' learning with technology, invited others to join them in their play, offered feedback or just generally became a member of the cluster (2) (see Table 4 for the complete list of behaviors and actions children exhibited during digital play). Similar to these findings, study 6 found that children aged 3-4 interact with their peers and display prosocial behaviors such as taking turns, explaining something to their partner, build solutions and adopt different roles.

Study 7 used Mercer's (1994) talk type framework to understand the nature of children's talk and interactions while using an I-pad. They found that children mostly engaged in cumulative consensus talk where they worked on developing mutual understanding of ideas and working towards agreeing on what to do. Followed by cumulative agreement talk where children support and agree with their friends without criticizing and objecting. Their data displayed significantly high levels of on task engagement talk and minimal disputational talk. Their recordings showed that children were often passing the tablet to each other and seeking for comments or advice from their peers or checking their work or steps.

Study 6 reported above medium engagement in all involvement areas except for verbal utterances which means interactions via speech was not much. They noted that this can be a concern for adults and professionals however, lack of words does not mean no interaction, other interactions beyond speech happen during digital play. They stated that children socialize with peers to support theirs and their peers' social and emotional development while interacting with technologies. Study 5 found that children were socially engaged during playing

with technology and they stated that digital competence is built through socially engaging in it with their peers. They found that children collectively solved problems by monitoring each other's games and giving instructions. Study 8 compared various social skills of two groups of children, where the intervention group had access to collaborative activities with a computer and the control group did not. They found that the social skills of the intervention group had improved by 10.09 % and the control group's social skills worsened by 8.19 %.

Children exhibited some anti-social interactions as well and when negative interactions were observed they usually revolved around children's desire to establish or maintain access to the technological resources (1) (see Table 5 for the list of anti-social behaviors), however, prosocial behaviors outnumbered antisocial or nonsocial behaviors (11). According to the results of study 9 prosocial group behaviors were the most common for all participants with constituting 73% of total behaviors and anti-social behaviors were the least common for all participants with 2.6% of total behaviors. They even found that children displayed more prosocial behaviors during activities with media and technology 44.4% of total behaviors than activities without media and technology 21.5% of total behaviors. They found strong association between sharing behaviors and media and technology. Children were motivated, excited yet calm to use the technology in the classroom with their peers. According to them positive effects of using an I-pad included more opportunities for prosocial learning behaviors, increased interest and motivation.

Study 4 reported that children's interactions changed during the course of the project, in the beginning of the project while exploring the features and use of the app, children mostly interacted non-verbally by moving their bodies, singing and mainly expressing feelings verbally, however, as they learnt how to operate the device and the software children started to interact more verbally, discussing their next moves and scaffolding each other. Similarly study 10 found that children displayed a range of behaviors from competitive to collaborative and some in between during the project and observed that children's competitive actions in the beginning shifted towards more collaborative behaviors with time and they stated that the nature of the play, individual children and their relationships with their peers, environment and the app design can influence the quality of play.

During the project the researchers (10) in fact observed that children displayed more collaborative actions with an open design drawing app rather than

closed design apps where children completed tasks and received prizes or verbal affirmations. They provided the example of two children, who engaged with closed design apps during the majority of their session and displayed a lot of competitive behavior such as making demands, fighting for control, moving the device out of the view of their partner. However, once they chose the open design drawing app their interactions became more agreeable and they actually started to enjoy their play. With open design app children struggled less for control, demands and commands to their partner were less. Children enjoyed using the app features, suggesting and helping their partner.

While digital play was mostly social, solitary play was not completely absent. Study 1 found that solitary play happened often, however, it only lasted few minutes before other children joined and played together. Study 9 observed solitary play happening only for a few occasions in 300 minutes of data they collected during their research and found that at those times children either recruited peers to join them or left the play themselves. Contingent on the context and framing of play children sustained Parallel and Associated play for long periods as well (1). Even the children who engaged in cooperative and collaborative play, used parallel play to reach their personal goals. Individual play with digital devices helped children build self-efficacy and children's own achievements encouraged them to work together with their peers. Study 9 noted that although the nature of digital play is different than traditional play in early childhood education, it seemed to fit the description of traditional play in a way that children enjoyed using the device and playing with their peers.

According to study 12 although adults separate digital play and tools from non-digital play and tools children do not see them differently. Children use experiences they gain in both worlds interchangeably to enrich experiences in both worlds, build and display agency, produce complex texts, negotiate and create stories. They claim that digital play and nondigital play cannot be separated in children's world. Study 10 found children displayed similar interactions during digital play to those they display during traditional play. Participant teachers mentioned that they did not find digital play very different than traditional play, one teacher marked that she viewed digital play as "*another means of learning*".

Study (2) noted that technological tools provided the opportunities for interactions to occur however, did not determine what kind of interactions would

develop if they develop. The likelihood and nature of the interactions depended on the children's ability and decision-making. According to study 8 mediation plays an important role in supporting children's learning of collaborative play. The technology did not immediately make children collaborate and the modelling provided by the teachers proved to be essential for children's learning to collaborate during digital play.

### *5.3 Research question 2: What features of social interactions do technologies enhance in ECEC context?*

All 12 studies reported that children were highly engaged with their peers during digital play and interacted in various ways. Children were excited, interested and motivated during digital activities and willing to interact and collaborate with their friends. In this section I will list children's observed behaviors and actions during digital play as reported by the included studies and categorize them according to the features of interactions they enhance. 11 studies (all studies except study 7) listed actions and behaviors children engaged in (for complete list look at Table 4).

All studies reported that their results were very hopeful for children's social interactions and development during digital play. These findings are proof that features of traditional play that promote children's interactions, learning and development are not missing in digital play, rather it is a new field of play and an exciting and engaging component of a developmentally appropriate program (6).

According to studies that answered this question, children displayed various social and anti-social behaviors and actions. Playing children were not the only ones interacting around the technology, other children from time to time approached the play, watched the game, interacted with their friends or disrupted the game. Study 6 mentioned that when digital play was not restricted at times there were up to nine children gathered around the technologies interacting by watching, discussing, explaining or disturbing the game. They stated that digital technologies can be more engaging to children when they are allowed to play with peers, promoting interactions and collaboration and children are more than capable of inviting others' input into their game and sharing this time with a friend significantly positively effects children's confidence and competence around technologies.

According to results children's interactions during digital play promoted many features of interactions and allowed children to develop social skills. When I categorized children's behaviors, I found out 17 features of interactions and skills promoted during digital play. They are; helping, sharing, sociability, learning, listening, supporting, confidence, negotiating, creativity, using manners, recognizing facial expressions and body language, positivity and joy, collaborating/cooperating, leading, investigating, communicating, planning/organizing.

Children displayed actions such as standing in close proximity, talking about their lives while playing, inviting others and joking which promoted their sociability and social skills. They showed empathy by acknowledging friends' feelings and expressing their own and provided support towards their friends by offering praise and advice, commenting on peers' moves and work. Children negotiated by sharing contradictory ideas and providing reasoning, built confidence by showing their works, expressing ideas and sharing accomplishments. Children got creative together and started to invent goals or scenarios and co-constructed narratives. They shared joy and promoted positivity around technology by clapping, hugging, giving high fives, smiling, laughing and singing. They communicated by talking about other things than the game, investigated by tapping, clicking and trying to find how devices or the software worked, they organized and planned their game by discussing next steps and creating activities with common goals. Some more dominant children started to lead their peers, monitor their actions and divide roles and tasks. Children communicated through non-verbal interactions as well such as making eye contact, showing things with body movements and practiced recognizing facial expressions and body language. Study 9 found a significant association between children's media and technology use and their sharing behavior. According to their results when children used media they tend to share more and sharing behaviors increased.

According to study 11 the students were not distracted or over-stimulated while using the device rather they were motivated excited and yet calm. The researchers stated that they arranged developmentally appropriate digital activities and results were very positive. Supporting the idea that digital technologies can be very beneficial when appropriately integrated into the overall curriculum and be seen as another field of play and learning.



Despite these hopeful results study (6) reported that all schools supported concrete learning materials to technological tools therefore children had less digital play opportunities. They noted that in some of the settings adults intentionally restricted children's digital play to solitary play by moving children who were watching and interacting with children playing with technology.

#### *5.4 Research question 3: What kind of technology is available in Early Childhood Education settings?*

In this review the technology used in early education classrooms and activities was categorized as hardware and software. After carefully analyzing the studies, it is evident that still the hardware technologies used in early childhood education are mostly limited to a few devices. 5 studies used computers (1,2,4,8,12), among these studies two of them used Interactive Whiteboard, laptop, digital cameras, mobile telephone alongside computers (1,2). 5 studies employed tablets (5,6,7,10,11), one study used an interactive table top (6) and one study used a multi-touch table (3). According to these results, the most common digital devices used in early education are tablets and computers with other devices occasionally being used. Tablets and computers were available in some of the classrooms already (1,2,4,5,6,7,8,12) or schools had a computer lab, whereas, in some classrooms, devices such as interactive table tops, multi-touch tables or tablets were provided by the researchers (3,9,11). One study did not give enough information to determine whether the devices were already present in the classroom or provided by the researchers (10).

According to study 10 due to its size and portability tablets are the most sought-after devices in classrooms and it is like an interactive toy rather than a technological device for children. Its properties such as being interactive, easy to move around, allowing more than one player to engage at the same time, easy navigation with touch and swipe features made tablets popular devices in technology education and digital play. It's simple features also make it easier for children to troubleshoot problems.

**TABLE 4.** Behaviors and actions displayed by children during digital play and enhanced features of interactions

Enhanced features of interactions	Behaviors and actions
Sociability	standing or sitting in close proximity verbally making their presence known swapping stories from their life talking about other things than the game asking to join in joking acknowledging others by smiling and nodding watching from the side inviting others to play
Learning	observing a task
Listening	accepting ideas from peers listening to peers
Supporting	offering and receiving objects offering approval or praise seeking approval or praise receiving approval or praise commenting on others' moves and success
Confidence	expressing ideas sharing accomplishments displaying agency showing their work
Negotiating	sharing contradictory ideas providing explanation and reasoning recognizing others' agency
Creativity	inventing goals or scenarios co-constructing narratives
Using Manners	thanking
Recognizing facial expressions and body language	showing things with body movements getting interested in the game by others' reaction making eye contact trying to out do each other like be more scary or laugh louder than the other in a friendly way
Helping	demonstrating how to succeed physically helping,directing verbally directing,giving instructions verbally requesting help explaining things (how the game or the device works etc.) solving technological problems sharing expertise/knowledge helping others find things in the game suggesting solutions problem solving mentoring others offering help offering advice

Positivity and joy	cheering clapping giving high fives sharing smiles hugging raising hands to celebrate dancing singing and laughing jumping to celebrate
Cooperating/Collaborating	trying to meet app goals together following peer instructions
Sharing	taking turns allowing others to control the technology
Leading	monitoring others' actions leading the group, sharing tasks and roles
Investigating	tapping or clicking around to see how the apps or device work talking about how the app worked
Communicating	exchanging ideas talking about different aspects of things in the game
Planning/Organizing	discussing next steps organizing group activities with common goals

**TABLE 5.** Anti-social behaviours exhibited by children in the studies

<u>Anti-Social behaviours displayed by children</u>
ignoring
verbally rejecting invitations or help
walking away
misleading/tricking
demanding things
hiding/covering technology
resisting instructions
pushing
finger disputes
taking/stealing objects followed by an altercation
arguing
sabotaging others' game
keeping quiet
physically stopping others
shouting
not sharing
grabbing the device
restraining hands

Despite the limited number of available devices, there is a great variety of software available for this age group. 9 of the studies detailly name the applications and software they use (3,4,5,6,8,9,10,11,12), one of the studies do not mention the name of the software or applications they use, but refer to the software as “apps aimed at developing certain skills (7)”. Two of the studies does not name the software they use as they observe children around various technologies alongside the technologies defined as digital technologies in this review (1,2). Refer to Table 7 to see the complete list of digital technologies included in these studies. The table displays the list of hardware and software technologies used in the early childhood education.

**TABLE 6.** List of technological tools used in the studies

Technological tools used in studies
Computer
Interactive Whiteboard
Leappad
Laptop
Alphabet Board Electronic Bus Electronic road
Fire Truck
landline Telephone Microwave
Mobile Telephone shopping Till
Hair straighteners Washing Machine Digital Car
Metal Detector
Fairy Lights
Calculator
Exercise Equipment CD Player
Musical Keyboard Tape recorder
Duplo Techs
Tool Box
Engage-2 multi-touch table
interactive table (Nikivision tabletop device
Tablet

**TABLE 7.** Hardware and software digital technology used in the studies

Hardware	Software
Interactive table top	Nikivision Software app
Computer and mouse	Sibelius Groovy Shapes
Tablet	JamMo
Multi-touch table	Single display groupware application
Interactive White Board	Math Bubbles
Laptop	Group Bubbles
Mobile telephone	Puzzles
Digital Cameras	Insect Creator
	iWriteWords
	Word Wagon
	Park Math HD
	Bugs and Numbers
	Monkey Preschool Lunchbox
	Doodle Buddy
	Chatterpix Kid app
	Communication skills software

## 6 DISCUSSION

This review was conducted by using systematic methods in order to investigate the state of the existing literature about digital technologies and children's peer interactions. The review was guided by three questions on whether the technologies (digital devices and games in this review) enhance or hinder peer interactions, if enhances what features of interactions are enhanced and what kind of technology is available in early education classrooms.

The results of this study supports the claim of Lawrence, (2018) that research in this field is still not enough and the lack of research based information can be an important factor in why professionals are still reluctant to integrate technology in early education. More studies concerning children's social development and interactions should be conducted in the future.

After analyzing the twelve studies included in this review, it is possible to say that digital play definitely provides children with a social environment where they have the possibilities to interact with their peers. In a world that rapidly becomes technologically complex early technology education can be a powerful tool when developmentally appropriately integrated with the purpose of developing children's awareness to the real world situations and using technology in a meaningful way such as exploring and problem-solving (Weng & Li, 2020). Children possess the ability to invite others to their play and collaborate in order to complete a task when the task is developmentally appropriate. Children display prosocial and anti-social behaviors during digital play as they do with any other tools and traditional play. Digital play provides children with a different field and tools for learning and cannot be separated from traditional play. Children are interested and motivated to use these interesting devices, countless software and applications. They are more eager to share the device and excitement with their friends. Children help their peers, scaffold each other, share joy, display their work, problem solve together, plan and organize scenarios and games, chat about other things than the game. Digital play does not only provide interaction opportunities to the playing children but others around them as well. Children get

interested in their friends' game and join them by observing, commenting or disturbing their game. Sometimes children who struggle are able to call for help from their more experienced peers, or experienced players can offer help to novice children without being asked. Children enjoy sharing the digital play experience with their friends, celebrate their successful moves and accomplishments together in various ways such as clapping, singing, dancing, giving high fives, hugging which promotes positivity around technologies. Children understand the idea of supporting their friends, they help each other, share the devices and collaborate. Together they build various skills such as negotiation, confidence, empathy, communication, planning and organizing, their creativity is supported while inventing new goals and different ways of playing. Children learn by observing others, practice more socially acceptable manners, recognize physical and facial cues from others. More dominant and competent children lead their friends and they learn to take on different roles in a group. All these interactions develop children's social skills and their belonging in the group and later in school and society.

Generally, teachers do not find digital play to be very different from traditional play and they do not see children's behavior around technologies very different from how they behave during any other play (Lawrence, 2018). In a classroom that the technology is new obviously they will initially be popular but teachers think that once its newness wears off children will treat it as any other toy.

Children display unwanted behaviors around digital technologies as well, such as pushing their friends, screaming, covering others' view of the device, finger disputes. These actions mostly occur due to children's desire to control the device (Falloon & Khoo, 2014). However, these are not strange to children's play as they display similar anti-social actions in their play all the time and prosocial behaviors outnumber anti-social behaviors (Lawrence, 2018). Anti-social behaviors can change and turn towards more prosocial behaviors overtime by practicing these skills during play as well.

While collaborative activities constitute the majority of the time during digital play, parallel play and solitary play still happens as well. One of the biggest concerns about digital play was that it is more suited to individual play and hinders interactions, however, individual time spent with technologies help children build self-efficacy, accomplish individual goals and become more competent and

confident around technologies which eventually promotes interactions as children like to share their knowledge with their friends.

With all these hopeful results the most important thing to remember in technology education and digital play is that digital tools do not possess the power of magically making children interact with each-other, many contributors play important roles in making this happen. As all the studies state that technology and digital activities should be integrated in the daily activities appropriately for the level of children. Lim (2015) states that developmentally appropriate integration of technologies means the integration of technology in the ongoing classroom theme, she found that students interact more when they work on the same topic (ongoing classroom theme) even if they are using separate devices. In order to accomplish this, teachers should be provided proper training and supported. According to Jack and Higgins (2019) the factors influencing technology integration related to teachers in early childhood education are, teachers' attitudes, teachers' prior knowledge and skills about technologies. The lack of knowledge and skills among the teachers is a major factor in slow integration of technology in early childhood education. It is considered as the second most important reason that inhibits the integration of digital play. In Jack and Higgins's (2019) research teachers mention the importance of having support and easy access to the technology such as having the technology in their own setting rather than borrowing or going to a different setting which makes it easier to implement digital activities with young children. Secondly, the app design plays important role in what types of interactions children engage in. Closed design apps such as games children play to complete a task and receive instant feedback may limit interactions and collaborations, however, encourage helping, sharing, problem solving interactions. Open design apps provide more opportunities for collaboration as these types of apps allow children to use their imagination to create products. Finally, getting more familiar with technology can change what kind of behaviors children display and the nature of their interactions. Novice children spend more time exploring the device and games initially, however, once they are more experienced with device features and software design they collaborate more and create stories and products more.

Despite these promising results technology use in kindergartens is still very limited to certain devices, and mostly children have access to the technology during certain times in a day or week. Tablets and computers are the most used



devices due to their easy-to-use features such as tapping, swiping, easy navigation between applications, and being more familiar devices. Play is generally monitored by the adults, they also mostly assign who will play and how long, Generally, children are happy to play with anyone, however children's social dynamic with each other can either promote more collaboration or competition with each other. While hardware technology in the classrooms is limited to a few devices, there are plethora of software, game and application options. There are countless software and game applications developed to support children's development and interactions.

This review makes a valuable contribution to the literature about technologies and young children. Results of this review inform professionals in the field of education about digital play's contribution to children's social and emotional development when developmentally appropriately integrated. Results can encourage teachers to integrate technology in their classrooms or use already integrated technology more. This study can provide a basis for researchers interested in this area by providing information about the state of the literature, identifying gaps and providing suggestions for future research.

This study proves that there is still a big gap in the literature and more studies should be conducted on digital technologies' contributions to children's social and emotional development in early education settings in the future. Most studies utilize tablets and computers as technology in the classroom, more studies employing other technological tools are needed in order to generate a bigger and better picture of the relationship between technologies and social development in early education. Comparison of different devices can provide valuable information on what devices can benefit the practices of early education centers and children's skills. Research on developmentally appropriate practices of digital technologies can provide professionals working in ECEC with information on how to integrate these devices and help teachers see how digital play can support meaning making and development (Edwards, 2013).

Alongside the valuable information provided by this study there are some limitations. Systematic literature reviews are generally conducted by a group of researchers; however, this review was conducted by a single researcher which may have affected the results such as missing some related studies. The database search was conducted one and half years ago from when the work is

written, so, there could be new studies conducted and published during this time which are not included in this review.

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# APPENDICES

*Appendix 1: Screening tool adapted from Polanin et al., (2019)*

## **Citation, Title, and Abstract Screening**

### **General scope**

**Time: from 2012-2022**

**Language: English**

**Field of Science: Education, Social Sciences**

**Type of study: qualitative, quantitative or mixed-method empirical studies**

**Keywords:** (social interactions OR group dynamics OR peer interactions OR collaborative/cooperative learning) AND (new technology OR digital technologies OR mobile digital technologies OR digital play OR computer-supported collaborative learning OR technology integration) AND (early childhood education OR preschool OR young children OR early learning OR kindergarten classrooms)

1. Does the **title or abstract** use English?
  - a. Yes: continue screening
  - b. No: stop screening
  
2. Does the **citation** indicate publication on or after 2012?
  - a. Yes: continue screening
  - b. No: stop screening



3. Does the **title or abstract** NOT indicate that a systematic review or meta-analysis was conducted?

a. Yes: continue screening

b. No: stop screening

### **Abstract Screening**

5. Does the **abstract** indicate that the study reports on practices in Early Childhood Education school settings?

a. Yes or Unsure/Unclear: continue screening

Keywords: kindergarten, daycare, preschool, early childhood, early childhood education center, preschool students, preschooler, kindergartener, children, young children, primary school/education, elementary school/education

b. No: stop screening

6. Does the **abstract** indicate that children's social interactions/learning experiences were studied?

a. Yes or Unsure/Unclear: continue screening

-Key words: social interaction, group dynamics, peer interactions, peer relationship, relationships, behavior, social learning, social behaviors, verbal interactions, non-verbal interactions, collaborative/cooperative learning, learning together, collaboration

b. No: stop screening

7. Does the **abstract** indicate that the study was conducted in the context of digital play

a. Yes or Unsure/Unclear: continue screening

-Key words: digital activities, technology integration, I-pads, computer supported learning, computer area, computer, touch screen, digital play, digital tools, technology-enhanced learning, new technologies, any other digital tool

b. No: stop screening

**Decision: Should this article be included?**

- a. **Yes**, all 7 screening questions answered Yes or Unclear
- b. **No**, at least one answers definitely “No”