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Young children's at-home digital experiences and interactions: an ethnographic study

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Introduction: Young children are increasingly provided with opportunities to interact with digital technologies in their homes. Despite an accumulating body of research on children's digital interactions, little is known about how these are situated within the social and cultural context in which they take place. In this exploratory study, we aim to extend existing knowledge by offering a contextualised understanding of children's digital experiences. To do this, we draw on Activity Theory as a conceptual framework to explore how various social and cultural factors influence and interact to shape children's opportunities and interactions with digital technologies.

Method: This study draws upon ethnographic and 'day in the life' methodologies to gain rich insight into children's situated digital experiences. Along with other traditional ethnographic methodologies, children aged between 3 and 6 years from 5 families were provided with wearable chest-mounted video cameras to capture their usual daily play activities at home – which included, but was not limited to, digital activities.

Results: Data on digital interactions is presented for the five participating families, and through the presentation of two purposively selected in-depth illustrative examples, we demonstrate how children's digital interactions are part of a larger activity system situated within the social and cultural contexts of their homes. We also elaborate on children's natural inclination to interact playfully with digital technologies.

Discussion: This study extends on current knowledges about the contextual influences of children's digital experiences and has important implications for parents and families trying to navigate the complexities of their children's digital lives.

KEYWORDS

early childhood, play, playfulness, digital technology, digital media, Activity Theory, sociocultural, interactions

Introduction

Digital technologies have become increasingly prevalent in many children's lives. Within the context of their homes and early learning settings, young children are regularly presented with opportunities to interact with a range of digital devices (Plowman et al., 2010). The introduction of the iPad in 2010, with its portable and interactive design features, alongside the proliferation of apps and games targeted at young children (Merchant, 2015), has meant

that play with digital technologies has become a sought after and engaging activity for their users. With this, however, have also come conflicted messages about the role of digital technologies in children's lives. The potential of digital technologies for children's learning is well recognised by many researchers, educators and parents (Palaiologou, 2016). Yet negative discourses rendering children's use of digital technologies as something to be minimised also exist (Aarsand, 2010; Livingstone and Smith, 2014). These conflicted views have given rise to confusion and uncertainty for parents in how best to support their children's digital practices (Kervin et al., 2018; Straker et al., 2018).

Despite the uncertainty and challenges in balancing perceived risks and benefits of digital technologies, parents often govern their child's use (Livingstone and Byrne, 2018) by enforcing rules and regulations about the digital technologies and resources they have access to, when and where they can access them, and how long they can engage with them (Zaman et al., 2016; Lewis et al., 2023). How parents govern their child's use of digital technologies, however, is largely shaped by various factors including their own backgrounds (e.g., socio-economic status, education level), parenting styles, attitudes and beliefs about digital technologies, as well as pressures from outside the home, such as expectations to adhere to screen-time guidelines (Livingstone and Byrne, 2018; Nevski and Siibak, 2020; Konca, 2022). Similarly, the choice surrounding children's access, and the digital technologies and content they interact with in the home, is often made by parents for reasons, including encouragement of play and creativity, learning, entertainment and as a means of occupying children (Marsh et al., 2015).

Young children's increasing access to and use of digital technologies has prompted consideration about what this means for play (Bird and Edwards, 2015; Marsh et al., 2020). Play has been long recognised as a critical contributor to children's development. From a sociocultural perspective, engaging in spontaneous, imaginative play is considered the leading activity of the early years, through which young children make sense of the world around them (Vygotsky, 1978; Leont'ev, 1981). Considering this, and the increasing presence of digital technologies in young children's lives, researchers and educators agree that play and playful encounters should feature in their digital interactions [Kervin, 2016; Early Childhood Australia (ECA), 2018].

Like play, the concept of digital play, which emerged from attempts to understand the relationship between children's spontaneous imaginative play and play with digital technologies (Verenikina and Kervin, 2011; Bird and Edwards, 2015), has generated much interest from researchers, educators, and parents alike. Despite varied conceptualisations of digital play in the literature (Chu et al., 2024), research has consistently demonstrated that children's opportunities for digital play are affected most fundamentally by their access to digital resources, as well as the type and design of the digital resources that they interact with (Verenikina et al., 2016). This can be problematic for children's spontaneous engagement in play.

In addition to digital play, the concept of playfulness offers a way to understand and describe children's spontaneous interactions with digital technologies. On the distinction between play and playfulness, Sutton-Smith (2009) notes that play is an imaginative activity that includes various context-bound scenarios by which children adhere to the rules within the frame (e.g., playing house), and playfulness becomes a "meta-play" that "plays with the frames of play" (p.147–148). Although the concepts are different, they are overlapping and entangled. Playfulness can occur within the context of play yet can also reflect the capacity to use a "mood of frolicsomeness, light-heartedness, and wit" (Sutton-Smith, 2009, p147) outside the context of play.

Some objects have greater capacity to incite playfulness (Sicart, 2014). Smartphones and tablets, for example, offer endless opportunities for children to be playful with various in-built features (e.g., camera) and apps which offer context-bound scenarios (e.g., driving a train). Aarsand (2010) noted that while the notion of playfulness tends to be overlooked in the literature "fun and playfulness are important aspects of children's media practices" (p.143). In Aarsand's studies of children's media practices, he demonstrated how a playful attitude to the use of digital technologies can ameliorate the tension between the rules imposed by the technologies and the children's inclination to spontaneously engage in play. For example, when analysing shared digital gameplay among peers, he observed that the young children he observed were able to "develop the story" in a way that went beyond the game setting "with relatively strict rules" (Aarsand, 2010, p.148). He concluded that playfulness transpired "irrespective of the media producer's intentions" (p. 153) and was expressed in the interactions and talk between the participants. For his participants, playfulness became "a way of trying out media" within their own context as they employed their creativity and agency (Aarsand, 2010, p, 154) within the parameters of the digital activity.

Children's digital activities, like their non-digital activities, are socially and culturally determined (Vygotsky, 1978). According to sociocultural theory, child development is a result of the interactions between people and the sociocultural context in which they interact in shared experiences. This contextualised view of development assumes that relationships and collaborations within the child's context (e.g., the home, community, cultural beliefs) shape the skills and knowledge that are necessary (John-Steiner and Mahn, 1996) and the subsequent development. Thus, the study of the individual child cannot be separated from the social, cultural and societal context in which their development occurs (Rogoff, 1990; Berk and Winsler, 1995). Vygotsky believed that human interaction with the world is mediated by cultural tools or objects (including the digital) and that people use tools to achieve the object of an activity.

Engeström (1993) extended Vygotsky's theoretical work by developing a model that describes the dialectical relations between people, elements of the environment, and artefacts or tools. The implication of Activity Theory (Engeström, 1993) for the use of digital technologies in human activity is that it should be considered as situated within complex interactions between an individual and the surroundings, and the social and cultural contexts of that activity (Verenikina, 2010). Engeström's triangular model allows us to consider all the interacting elements of an activity system and their interconnectedness. This model provides a conceptual framework in the current study for understanding the relationships between digital tools, children and their families, and the environment in which the digital interactions take place. Figure 1 details Engeström's (1993) triangular model and the six contributing elements as they might pertain to children's digital experiences in the home context. Specifically, *subject/s* represents the people engaged in the activity (e.g., the child, and/or sibling); *object,* the goals and intentions of the activity (e.g., to entertain) which forms the meaning of the activity of the subject; *tools,* the tools mediating the activity (e.g., the digital tool);

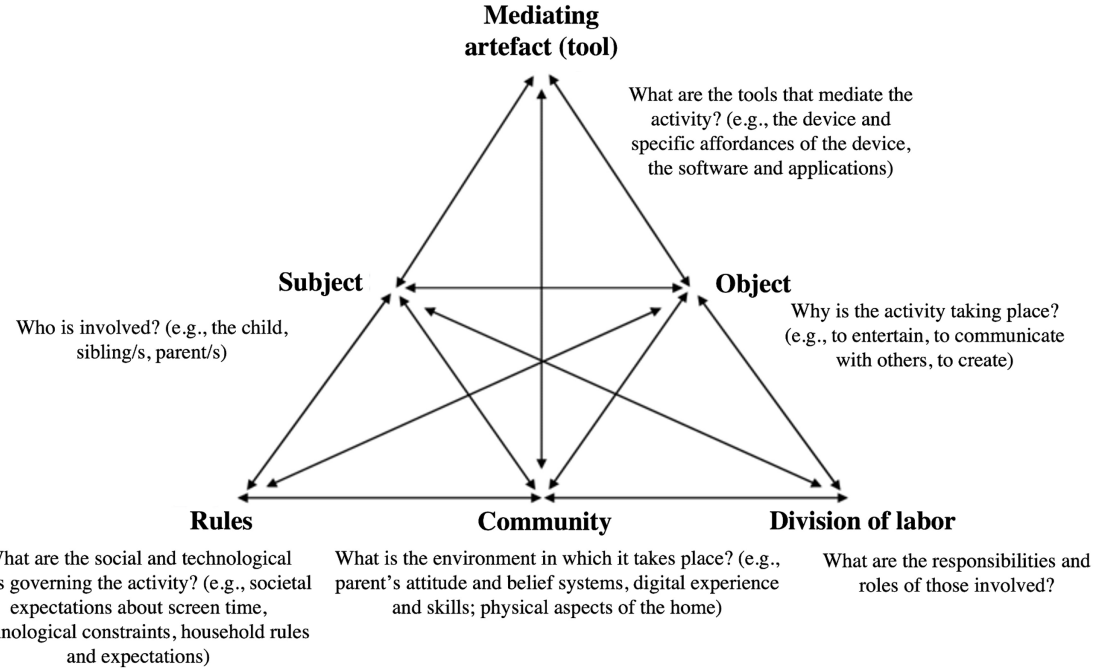

FIGURE 1
Visualisation of the activity theory framework for children's digital experiences in the home context.

community, the social and cultural environment in which the activity takes place, including physical aspects of the home and parents attitudes and belief systems; *division of labour,* the roles of the people involved; and *rules* which govern and regulate the activity (e.g., rules for the use of digital technologies by the child). See Figure 1 for further explanatory detail.

The current study

Children's early interactions with digital technologies most often occur in the home setting, and thus family attitudes, practices, routines, and structures are important determinants of how children experience these (Plowman, 2015; Marsh et al., 2017). The current study, which is an exploratory investigation, aims to extend this existing knowledge and offer rich insight into children's digital experiences at home.

In this study we considered children's digital experiences, like their non-digital experiences, as situated within the social and cultural contexts of their home. Firstly, we draw on Aarsand's (2010) work on playfulness in children's media encounters to ask (i) what is the nature of children's experiences when they are interacting with digital technologies at home? Then, using Activity Theory (AT; Engeström, 1993) as a conceptual framework, we further explore children's interactions with digital technologies as part of a larger activity system situated within the social and cultural contexts of home. Specifically, we ask (ii) how do the various elements of the activity system influence and interact to shape children's opportunities and interactions with digital technologies?

In responding to the research questions, we present two illustrative examples purposively drawn from a larger ethnographic study of 5 families. By doing so, we are able to present a rich and in-depth contextual analysis of children's digital interactions as part of the larger activity system. This study has important implications for families and parents trying to navigate the complexities of their children's digital lives.

Method

The methodology for this study was informed by the Day-in-the-Life method (DITL; Gillen and Cameron, 2010; Flewitt and Clark, 2020), which draws upon ethnographic principles to gain rich insight into children's everyday experiences. The Day-in-the-Life approach is traditionally a participatory method that involves visiting participants homes and collecting data (through observation and video) over one full day (Gillen and Cameron, 2010). In this study however, we leveraged the power of digital technologies to capture children's nuanced experiences in their home (Pink et al., 2015), removing the need for the researcher's constant (and potentially influential) presence. Specifically, we used chest-mounted video cameras to capture the data from the child's unique perspective. Although this approach has been used previously to complement other methodologies in exploration of children's digital literacy practices (e.g., Marsh, 2016), this study examines the children's situated digital interactions within the Activity Theory framework.

Data collection

In addition to the chest-mounted digital cameras, we also employed a variety of other traditional ethnographic methods, including home visits, observations, field notes, parent and focus child semi-structured interviews, and child-led play tours. Specifically, one

researcher (KL) visited each of the children's homes on two occasions, for approximately 60–90 min. On the first occasion, the researcher spent time with the family, developing rapport with the children, providing information about the study, inviting written consent from parents and verbal assent from children, and providing the family with the equipment and operating instructions. Initial semi-structured interviews with the parents also took place during the home visits, as did the child-led play tours. On the second occasion, the same researcher collected the research equipment and conducted another round of semi-structured interviews with the parents and children, discussing any challenges or issues that arose (i.e., the capture of any inappropriate footage or equipment challenges).

All the methods and procedures of data collection, including observations, instructions for collecting video footage and semi-structured interviews were informed by the Activity Theory framework (Engeström, 1993). This multi-method approach facilitated the collection of information related to the six elements of the Activity Theory model (as depicted in Figure 1). Data collection and analysis then aimed at contextualising children's interactions with digital technology within specific social and cultural contexts of each participating household. Further information about the semi-structured interviews, the child-led play tours, and the video capture are provided below.

Semi-structured interviews

Semi-structured interviews conducted on the first home visit took 15–20 min and aimed at generating insight into children's access to digital technologies, family routines and practices, parent attitudes and beliefs about digital technologies and children's play preferences. Parents were asked questions such as *"how important are digital technologies for [child's] learning and development?"* and *"would you say digital technologies are an important part of your family life. Why or why not?."* Semi-structured interviews conducted on the second home visit took 10–15 min and aimed at generating insight into the reliability of the data (i.e., whether they perceived the data to be typical of their usual daily activities), to discuss their general experience with the equipment and their involvement in the study, and to identify any challenges or issues that arose, such as equipment challenges or the capture of inappropriate footage. Parents were asked questions such as *"how typical would you say the recordings are or [child's] daily life? Why or why not?"* and *"how did you find using the equipment?"* Children were asked questions such as *"Can you tell me about what it was like to wear the camera?"*

Child-led play tours

The child-led play tours served as a means of developing trust, rapport, and free flowing conversation with the children. During the initial home visit, the researcher invited the children to take part in the play tour by saying *"I'd like to know more about you and what you like to do at home. Can you show me some of the places you like to play, and some of the things you like to play with?"* This "walk and talk" method (Plowman and Stevenson, 2013), which has been used in other investigations of children's use of digital technologies (Marsh et al., 2015; Plowman, 2015), facilitated further insight into children's play preferences, the families' structures and processes, and provided a useful entry point to enable further conversation and collaboration with the children and families. Moving around the different spaces in the home also helped to contextualise the video footage captured. The child-led play tour ended when the child chose, but generally took about 10–15 min.

Video capture

Unlike other studies using the DITL methodology, the chest-mounted cameras were intended to capture authentic family interactions without the presence of the researcher. Families were provided with the equipment pack, which included the camera and charger, written operation instructions, and wear options, for a period of two weeks. During the first home visit, families were given simple operating instructions, as well as instruction for (i) the child to wear the camera for a good part of a day when they were at home and not expecting any visitors; and (ii) to not wear the camera outside the home or during activities where privacy is required (e.g., bathroom visits). Although families were informed of the study's intentions, which was to capture a typical 'day in the life' of the child, having the equipment for two-week period meant that children and parents were able to exert agency in choosing when and for how long the equipment was worn, as well as what was captured and shared with the researchers. Families were informed of the studies focus on digital interactions but were advised that a typical day may or may not have included play with digital technologies. Given the participant autonomy offered in the capture and sharing of data, children and parents were considered as co-researchers. This relationship between the research team and participants also helped to address and minimise the potential for any ethical issues to arise.

Ethical considerations

Because this type of research generates deep insight into families' private lives, the ethical framework for wearable cameras proposed by Kelly et al. (2013) was also used to guide the methodology and instructions to participants. Derived from the key principles of respect for autonomy, beneficence, non-maleficence, and justice, they address the unique challenges of using automated wearable cameras, which include but are not limited to; passive image capture (e.g., unwanted, inappropriate or unflattering images), confidentiality and privacy, and the capture of data from non-consented third parties. The framework, which is intended for the use of automated wearable cameras in health behavior research, promotes participant autonomy in the research and appropriate approaches to informed consent (Kelly et al., 2013).

This study was reviewed and approved by the institution's Human Research Ethics Committee. Data collection for this study was carried out over a period of 9 months, commencing in December 2021. Although this fell shortly after the second and last Covid lockdown period in the Australian state where this research occurred (June to October 2021), no data was collected during any lockdown period and there was no impact on the methodology and collection of data.

Data analysis

The DITL methodology enabled the capture of large volumes of data on children's digital and non-digital experiences. As an initial step, the footage obtained and shared by the families was viewed in its entirety by one member of the research team (KL). This process enabled the identification of the time and frequency of children's

interactions with digital technologies, but also revealed that children's digital encounters were not isolated to physical interactions with digital devices. Specifically, it was observed that children made various references to, and had various encounters with digital technologies and digital media over the course of the day. In consultation with the full research team, several codes from this inductive analysis were devised to represent children's digital encounters, and the footage was coded accordingly.

Specifically, the footage was coded and time-stamped to identify: (i) any instance in which the child was interacting with digital technologies; (ii) any instances in which the child or parent made any references to digital resources or content (regardless of whether digital technologies were present); and (iii) the presence of digital technologies (turned on) in the space, but not being used by the child. References to any popular media culture (e.g., Peppa Pig) and instances where children were engaging in both digital and non-digital activities (e.g., building Lego with instructions on the Lego Builder application) were also noted. This coding process served as an important first step in gathering and providing overview about how children encounter and interact with digital technologies in their homes.

Next, we narrowed our focus on the time-stamped instances whereby (i) the child was interacting with digital technologies. These instances, referred to as digital interactions for the purposes of this paper, were further explored. The time-stamped digital interactions were transcribed (with gestures noted alongside) and mapped onto the six elements of the Activity Theory Framework (Figure 1), along with other necessary contextual information gathered from the various data sources. Other time-stamped data offering supporting contextual information (e.g., children's requests to access devices in the lead up to the digital interaction) was also drawn upon and mapped accordingly within the larger activity system. This process enabled qualitative exploration of the relationships between various elements of the activity system, as well as the identification of any tensions and/or contradictions that were present.

This study set out to facilitate rich, in-depth contextual analysis of children's digital experiences in their homes. Although knowledge of children's digital interactions across the sample is valuable, providing adequate response to the research questions requires an in-depth investigation of individual cases. Thus, in the sections that follow we first provide a brief overview of the coded instances across the corpus of data, followed by the comprehensive presentation of two illustrative examples. These illustrative examples were purposely chosen because (i) they were complete in the capture of the full digital experience, including the leading into the digital interaction, the actual digital interaction, and the conclusion of the digital interaction, and (ii) they were representative of the digital interactions across the corpus of data, yet also demonstrate the diversity in how the digital interactions were experienced by children, and the contexts in which they occurred.

Trustworthiness

Various strategies were used to ensure the trustworthiness of the data in this study (Stahl and King, 2020). Ethnography, by its nature, involves a multi-method approach to collecting and analysing data (Wollcott, 2008). Information gathered from participants through various sources in this study (e.g., semi-structured interviews, play tours, conversations during home visits) was used to augment and elaborate on the video recorded observations. In addition, for some of the coded data (including the illustrative examples presented here), we also engaged parents in a stimulated recall process, inviting them to elaborate on and verify our interpretations of the observed events. Although only one member of the research team developed the rapport and relationships with families, coding, analysis, and interpretation was achieved with ongoing collaboration and consensus amongst the research team.

Participants

Participants in this study were a convenience sample of five Australian families who had either participated in earlier phases of a broader research project focused on adult-child interactions or were recruited via snowball sampling. To be eligible for participation in the study, families had to have at least one child aged between 3 and 8 years, who would be the focus child, and were geographically close to the research institution to allow the researcher to visit and to enable the distribution of resources. All families were drawn from the same geographical location on the South Coast of New South Wales. Focus children ranged in age 3 through 6 years, and siblings, who were also included in data collection, ranged in age 1 through 8 years. Families were single ($n = 1$) and dual parent households ($n = 4$), and all parents were aged in their mid-thirties to early-forties. All parents ($n = 9$) were either employed or studying, and all households had at least one parent with a university degree.

Results

In total, 23 h and 13 min of footage was captured and shared by the 5 families, with an average of four hours and 40 min of footage per family. A broad range of "play" activities were captured, including but not limited to play with digital and non-digital toys, outdoor play, watching television, mealtimes, family conversations, phone calls, and independent and shared reading experiences. Of the data captured in relation to digital encounters, 16 instances involved the focus child interacting directly with a digital device (e.g., play with a iPad or watching TV); 18 instances whereby the focus child made references to digital technologies or content without directly interacting with a digital device (e.g., requested access to a digital device); and 41 instances whereby digital technologies were present, but not being used by the focus child (e.g., parents using their mobile phone). In this study, we were most interested in the children's interactions with digital technologies, and the various contextual influences that shape their experiences. Thus, we focused our analysis on the instances that involved children using digital technologies ($n = 16$). However, these instances were often enabled by other coded instances, such as children requesting access to use digital devices, and therefore were considered in this analysis where appropriate.

All focus children were captured directly interacting with a digital device at least once (ranging 1 through 5 digital interactions). Of the 16 instances, 10 involved shared use with a sibling, one involved shared use with a sibling and a parent, and the remaining five involved the child using the digital device independently. With regard to the

digital activity, five involved play with apps on an iPad; six watching YouTube or Netflix; three watching programs on the television; two as props in non-digital play (e.g., smartwatch, phone). Most often, these digital experiences were enabled by the focus child, through the requesting or demanding of access, or by the parent offering access to occupy the child while they attend to other activities (e.g., household chores or work/study duties). A brief description of each family and coded digital interactions is provided in Table 1. This table provides an overview of how digital play was experienced by the children across the sample.

Prevalent in the children's social interactions with parents were negotiations about access and rules of use (e.g., about time spent, what digital technologies they could use and what digital resources they could access). These negotiations occurred prior to the granting of access, as well as throughout the experience, and were highly influential in the digital experience that unfolded.

Illustrative examples from two focus children (Josie and Archie) and their families are presented. These examples enable the comprehensive, in-depth analysis required to respond to the research questions. As with all the findings we report, the footage described here was captured by the chest mounted cameras, and we draw on contextual information gathered through various other sources of data (e.g., parent and child interviews, play tour, knowledge of the family) to make sense of the observed phenomena. Note, pseudonyms have been used in this study to maintain and protect participant anonymity.

Illustrative example 1: Josie – watching YouTube on a shared family iPad

The first illustrative example involves Josie, a 5-year-old girl who lives with her parents (Tanya and James, both aged 40) and older sister (Sienna, aged 7). Josie is in her final year of preschool and will begin her first year of formal school in February. Josie's mother describes the family's interactions with digital technologies as "basic" and places minimal value on technology beyond obvious affordances for work, communication and education. The children's interactions with digital technologies are limited and often a last resort when all other activities have been exhausted or the children need a "wind-down." The children have occasional and regulated access to the iPad and television. Josie's mother worries about the impact of digital technologies on physical development, particularly in relation to eyesight.

Josie wears the chest-mounted camera on what is described by her mother as a typical Saturday at home. Throughout the day, Josie makes several requests to access the iPad. Although access is eventually granted by her mother, it is granted with conditions of use, including restrictions on the duration of use (20 min), the content accessed (chosen by her mother) and the location in the home in which the experience can take place (on an armchair nearby, but separate from the rest of the family). In what follows, data from the chest mounted camera is used to piece together the events of the afternoon.

Josie's first request to access the iPad occurs during the researcher's visit to the family home in the morning. Josie and the researcher have just returned to the living room after the play tour. The researcher continues a conversation with Josie's mother about the research. Josie spots the iPad, which is sitting on top of a cabinet, and turns to her mother. She asks, *"Can I go on the iPad today?*." Her mother responds, "*later this afternoon*." Josie does not verbally respond, but her actions suggest she has accepted the response. Following this, Josie and her sister, Sienna, engage in play with various non-digital toys (including play with a Barbie doll house and board games). Their non-digital play continues, until 90 min later when Josie makes another request for the iPad, which is prompted by their mother's attempts to engage them in a shared activity. Sienna and her mother are sitting side-by-side on the lounge, looking at the Christmas activity book. Their mother invites Josie to join.

> Mother: Yeah, we'll work on this until Daddy gets home because then we have to have lunch. Sit down. *[She pats the space on the lounge next to her, as if to instruct Josie to sit down. Josie sits down. Sienna is sitting on the other side. Mother is holding a Christmas activity book].*
> Josie: But when will I go on the iPad?
> Mother: You can go on the iPad when Mummy and Daddy have our meeting.
> Josie: Hmmm [*disappointed*].
> Sienna: No, on TV.
> Josie: But… but the videos? [*whines*].
> Mother: You wanna watch videos? Yeah, but I do not really like you watching videos when I cannot see what you are watching.
> Sienna: We'll only watch Di – Diana.
> Mother: Well you have to be careful. You can both watch it together and make sure that you don't watch inappropriate stuff, okay?
> Sienna: I'll make sure that because I'm the oldest.
> Josie: And I can help Sienna and we can close our eyes, and when we hear if it's done like we can open our eyes.
> Mother: Okay. [*Begins reading*] "Where's little sprout?" Oh, who put all these stickers on here?
> Josie: I do not know. Maybe me?
> Sienna: Little Sprout is here [*pointing*].
> Mother: Oh, look. [*Continues reading*] "Cheeky little sprout—everyone's favourite Christmas vegetable is hiding on some of the pages of this book. Add a sprout sticker below every time you spot her".

Josie's use of the word "but" in her request suggests some disappointment with the current activity her mother has chosen for them (the activity book). Although her mother indicates again that she *can* go on the iPad, it is met with negotiation of conditions governing its use (rules). Specifically, her mother indicates when this can occur (during an online meeting that the children were not to attend), and the content she can engage with (Diana videos). For context, Josie's reference to "Diana" videos alludes to a popular children's YouTube channel *Kids Diana Show* featuring a sibling duo engaging in various activities and adventures.

Josie's mother does not follow through with her promise that she can watch the iPad during their meeting. Rather, whilst the parents are having their meeting, the chest camera captures the siblings watching free-to-air television programming in a separate room. After their meeting, Josie's mother enters the room, and asks the children to turn the television off at the completion of the program. Once the program finished, the children turn off the program and return to the living area where their parents are sitting. As they enter, they are greeted by their father. Josie makes her third request to access the iPad.

> Father: Heya! *[he asks a question in Portuguese].*

TABLE 1 Overview of participants (*N*=5 families) and coded digital interactions (*N*=16).

ID	Participants name (age, sex)	Contextual information	Recording time	Coded interactions	Description of coded digital interactions
1	Josie⁺ (5, F) Sienna (7, F) Tanya (40, F) James (40, M)	Family interactions with digital technologies are described as "basic." Parents place minimal value on digital technologies for children beyond educational purposes. Children's interactions with digital technologies are limited, often as a "last resort" or to "wind-down".	5 h 3 m	3	Shared viewing (with sibling) of free-to-air programming on TV. Shared viewing (with sibling) of YouTube on iPad. Shared viewing (with sibling) of Paw Patrol episodes on DVD.
2	Paige⁺ (5, F) Harry (8, M) Naomi (38, F)	Naomi acknowledges children's rights and desires to engage with digital technologies. There is no television in the home, but children have regulated access (1 h/day) to a shared iPad to choose and interact with the apps available to them.	2 h 59 m	3	Shared viewing (with sibling) of Netflix on iPad. Shared viewing (with sibling) of YouTube on iPad.
3	Archie⁺ (6, M) Beau (9, M) Kara (37, F) Brendon (37, M)	Family are "high users" of digital technology, for work, education and leisure purposes. Children have access to their own iPads, and regularly engage in shared digital play. Although use is governed, parents demonstrate flexibility in rules as the situation necessitates.	6 h 27 m	5	Independent play with apps on iPad. Shared play (with sibling) with apps on iPad. Shared play (with sibling and mother) with apps on iPad. Video recording on iPad during shared (with sibling) outdoor play.
4	Andy⁺ (3, M) Elijah (1, M) Jasmine (36, F) Sam (37, M)	Parents recognise opportunities of technologies for work, education and communication, but describe themselves as "not really tech savvy". Although mindful of time, there are no strict rules for use of digital technologies. Family prioritises outdoor activities and traditional play.	39 m	1	Independent play with apps on father's smartwatch.
5	Alice⁺ (4, F) Hayley (1, F) Amy (32, F) Scott (33, M)	Digital technologies are considered by parents as a useful tool for entertainment. The TV is often on in the background, and Alice accesses and interacts with YouTube Kids regularly through her mother's iPhone.	8 h 5 m	4	Independent viewing of YouTube on smartphone. Shared viewing of YouTube on TV (with sibling). Independent play with smartphone (as prop in non-digital play).

⁺ is used to denote focus child.

> Josie: *[responds in English]* Yes, I'm done *[walks toward her mother who is sitting on the lounge]*. Mummy, can I go on the iPad now?
> Mother: Umm, yeah, you'll have to get it off charge.
> Josie: *[Turns to walk upstairs]*.
> Mother: But listen, listen. Before you go on the iPad, just have a little break for your eyes. So you can go and get it and get it ready. But because you have just been watching the screen for almost an hour *[exaggerated tone of voice]*. So just go and get the iPad and get it ready but you need to have a little break with your eyes okay?
> Josie: *[Does not respond verbally but continues upstairs before returning briefly with the iPad in hand]*.

Again, Josie's request to access the iPad is promised, but not granted. Josie's mothers' suggestion to give her eyes a "little break" stems from her worries about screen-time and the potential detrimental health effects of digital technologies. Josie is obliging with her mother's instructions. She collects the iPad and sets it down on the ottoman where her mother and father are sitting, while she gives her eyes a "little break".

Half an hour later Josie makes her fourth request for access. At this time, Josie's mother and sister Sienna are sitting on the lounge, playfully conversing over a search and find Christmas activity book. Josie is kneeling over the ottoman eating a biscuit and listening to their conversations. The children's father is close-by, also watching on.

> Sienna: You have to find that Santa.
> Father: *[Speaks in Portugese]*.
> Josie: You have to find the good ones, not the bad ones.
> Sienna: Yeah, that's him. Competition.
> Josie: *[Leans in to examine the pictures in the activity book]*. Penguin li – lifeguards. Really?
> Sienna: Haaa haaa, I already saw that.
> Josie: Really seary, weary? Mummy?
> Mother: Yeah?

> Josie: *[Gestures to the iPad that is sitting in front of her, pointing]* Mmmmm.
> Father: *[Speaks in Portugese, ending the sentence with iPad]* iPad?
> Mother: Hmm yeah okay. Only for a little while.
> Josie: *[picks up her mother's phone which is sitting beside the iPad].*
> Mother: No, not my phone. What do you want? Just give me my phone.
> Josie retracts and passes the phone to her mother, picking up the iPad instead.
> Josie: But how do you put the video on? I want Elsa.

Josie does not verbally request access here, rather she uses gestures, to which her mother responds accordingly. This time, Josie's mother concedes, but with some hesitation ("hmmm yeah okay") and immediately places restriction on the access she grants ("but only for a little while"). Josie does not know how to access the content, and hands the iPad to her mother. Because Josie has requested to watch "Elsa" now (not "Diana" as previously requested), with full control of the iPad Josie's mother types 'Elsa' into Google, selects 'videos' and opens the first link (to YouTube). She then hands the iPad back to Josie, instructing:

> *"How many videos? Four. You can have 20 min… I'm gonna set the alarm. Go away, go and sit on the armchair please. Your time is starting now. Twenty minutes."*

Josie's mother instructs her to sit on the armchair, which is several metres from the lounge where the rest of the family are sitting. Josie follows her mother's instruction. Sitting on the armchair, with the iPad resting on her knees, she begins to watch the first YouTube clip her mother has selected. Shortly after, Sienna joins her, also sitting on the armchair. Initially the siblings sit quietly watching the videos as their mother has instructed and occasionally commenting on the content (often without response from the other). In the second video, Josie and her sister begin to converse playfully, commenting on and engaging with the on-screen antics of the characters. Their playfulness is exhibited by giggling, singing and gleeful conversations about what they see on the screen and beyond.

> Josie: Hey, they did a love heart!
> Sienna: Mmm hmm.
> Josie: Whoa, with stickers!
> Sienna: *[Giggles].* When their Mumma comes they're gonna be like "no, no, no. It's not ready"
> Josie: He's their Daddy. I knew it was Mother's Day. I beg me pardon. Oh god, babies. Adorable. This is number 2.
> Sienna: Number 2, number 2, number 2, 2, 2 *[singing]*
> Josie: Ahh, the dog is a [inaudible].
> Josie: Soon the Mum and Dad are gonna—soon the Dad's gonna see.
> Sienna: They didn't notice.
> Josie: But when it comes out, they will notice.
> Sienna: Mmm hmm.
> Josie: He's all [inaudible]. Now he's gonna see.
> Mother: I've got a craft project for us. Just finish that video, okay? Because that's gonna be your time.

During their YouTube viewing, Josie's mother has given several reminders about the 20-min time limit. As the 20 min draws near, Josie's mother re-enters the conversation, instructing Josie to end her video. When Josie notes that she did not get to watch the four videos as promised, her mother responds.

> "Well it does not matter. You've had your time. There's 12 s to go. So you have to finish that video and that's it, okay? Okay?"

Initially Josie resists, but after some brief conflict she hands the iPad back to her mother who is standing nearby. She walks into the kitchen, where her mother has prepared a craft activity for the girls.

In this illustrative example, Josie is persistent in her attempts to access the family iPad so that she can watch "videos." Although Josie's mother does not directly say "no" to any of these requests, she responds in such a way that builds anticipation for Josie. With her repeated attempts, negotiations, and compliance with her mother's conditions, Josie appears to have gone to significant effort to gain access—yet the access that was granted did not necessarily match what was negotiated or promised (e.g., she was permitted to watch 4 videos but was instructed to stop during the second). Although Josie initiated the digital activity through her requests, the experience that she was able to participate in was largely controlled by her mother's rules about time, location, and content – which appeared to be driven by her own concern for screen time and its potential detrimental effects on eyesight and worries about exposure to inappropriate content.

This example provides a clear illustration of Josie's activity of the use of digital technology, as being part of a larger activity system in which it is embedded. Analysis of the relationship between elements of the activity system (Figure 1) reveal some tensions and contradictions, influencing Josie's experience with digital technology. These are further elaborated below.

The example is assembled around Josie's activity of using the iPad for entertainment (*activity object*). Her motivation for using the iPad was enjoyment, which served as the meaning of the activity for her. Although Josie made several unsuccessful attempts to use the iPad, when she was granted the opportunity, it was used for entertainment in a playful manner. Josie, who was the *subject* of this activity was joined by her sister in this instance. Neither of the parents participated in the activity, however their input filtered through other elements of the larger activity system. Specifically, for Josie's mother, the use of digital technologies by Josie (and her sister) is not valuable, unless it serves "educational" purposes. This contradiction between Josie's motivation and her mother's attitudes and beliefs about the use of digital technologies leads to a tension in the activity system, resulting in a dissatisfying and interrupted experience for Josie.

Further, the *division of labour* element, indicates that parents (the mother, in this instance) established the rules and regulations for Josie's activity according to their values. The rules of use for digital technologies appear firm. That is, Josie's mother allows minimal access (no more than 20 min), restricted content, and only as a last resort when other activities have been exhausted. In this instance, Josie was also restricted in where she could use it (in the armchair, close by for surveillance, but distinctly separate from her parents). The length of recorded interactions between Josie and her mother about the use of technologies was skewed towards access and the rules of use, with no talk about the content of the play or its meaning for Josie. This further adds to the tension in her interactions with mother in relation to her activity – using the technologies for entertainment and fun.

Despite this, and within the parameters of the experience, Josie's interactions could still be described as playful. The siblings gleefully conversed, sang and giggled together over the content, and invented creative subplots based on the characters and situations on the screen (e.g., *"when their Mumma comes, they are gonna be like no, no, no. It's not ready"*).

Illustrative example 2: Archie – shared virtual gameplay on individual iPads

The second illustrative example involves Archie and his family. Archie is a 6-year-old boy who is in year 1 at school. Archie lives with his parents (Brendon and Kara, both aged 37) and older brother, Beau (aged 9). Brendon describes the family as "high users" of digital technologies. The children have access to a varied range of digital devices, including their own personal iPads. Although there is an expectation for children to seek permission to access, the parents have no explicit rules about the use of digital technologies. Rather, the children's interactions with digital technologies are guided by the events of the day and interests of the children. Children are encouraged to play and interact with apps, as opposed to sit-back experiences, such as viewing programs or YouTube on their devices. The children often engage in shared digital play, using avatars connected in virtual worlds. Kara works from home regularly, and digital technologies are often used to occupy the children.

This illustrative example occurs on a Saturday morning. Archie's mother and father are doing chores about the house. Archie asks to play his iPad, and his mother indicates he can play for "half an hour." With permission from his mother, he sets off to gather his iPad from another room. On his way, he bumps into his father, and shares "Dad, Mum said we can have half an hour on our iPads" to which he responds, "okay buddy." Aside from time, Archie's mother or father do not voice any other rules. However, his father shares that there is an established expectation that the children use their iPads in a shared area of the family home, and that they play within the realms of what is available to them (e.g., apps that have either been selected or approved by their mother). As such, Archie returns to the loungeroom to play. His parents are nearby, enabling them to listen in for most of the digital play experience. In instances such as this (weekend mornings at home), Archie's father reports that requests are typically granted.

Following permission from his mother and approval from his father, Archie sets himself down on the lounge, opens Roblox as his app of choice, and selects the game Vehicle Tycoon, sharing with his mother that it *"is my new second favourite game."* As Archie plays, he comments on and reads-aloud to himself the on-screen content (e.g., *"There's one. Yep, claim tycoon"*) before excitedly making a discovery:

> "Second floor twenty-five thousand! Second floor! Give me that second floor right now. I'm telling—I have to tell Beau this".

He jumps up off the lounge and looks for his brother to share his discovery. When he finds him in the bathroom washing his hands, he shares his discovery and invites him to join in on his play.

> Archie: Beau, guess what?
> Beau: What?
> Archie: I got the roof and guess what?
> Beau: What?
> Archie: I can get the second floor but it's twenty-five thousand.
> Beau: Hmmm! I thought you were playing Club Roblox *[a game they've previously shared]*.
> Archie: No, I'm playing that—do you wanna play Vehicle Tycoon?
> Beau: Yeah.

Beau accepts his brother's invitation to play. He collects his iPad and sits down on the lounge next to Archie. The brothers sit side-by-side, each with their own iPad. The siblings play this way regularly. Without discussion, the boys connect virtually. Throughout their digital play, they move in and out of various games on Roblox – negotiating their preferences and playfully interacting with various characters and scenarios. For example:

> Archie: Oh dude! Look what there is. Dog pool!
> Beau: There's a dog pool?
> Archie: Yeah. There's a pool for the dogs! But I'm just gonna get all the stuff off me.
> Beau: *[leans in to see]*.
> Archie: I got it from here.
> Beau: I'm getting it in this area. Tricks. Whoa!
> Archie: How deep—this is a deep pool.
> Beau: Huh.
> Archie: My dog can go in the um—here. It's right across the road—it's right across from that.
> Beau: Right across?
> Archie: Yeah. If you see a dog jumping that's it. Can you see a dog jumping? It's inside. If you can see a dog jumping.
> Beau: Oh, there?
> Archie: Yeah in here. Here. Hm.
> Beau: Oh yeah. There it is. It is quite deep. It is quite deep.
> Archie: There's even um – Beau look!

The brothers, who have been playing together for longer than 30 min, are gently and indirectly prompted by their mother to finish up their digital play (e.g., *"hey guys, think about what you might like to do this afternoon … that does not involve playing Roblox"*) to which they do not respond. Their mother does not follow through with her instructions about time, choosing to leave the children to play, presumably because they are playing together well. Archie's mother has demonstrated flexibility in the rules here, allowing the positive play experience to continue. The children continue their play, until their mother returns half an hour later. This time, instead of prompting the children to move on from their digital play, she invites herself to join (*"Hey guys, what are you playing? I'll play with you for 15 min"*). She sits down in between the children and opens up Roblox on her phone. The children welcome their mother's interest, promptly supporting her to join in their virtual world and playfully interacting with the characters. Although their mother plays Roblox on occasion with the children, she is less experienced and less knowledgeable. The children share their expertise, supporting their mother in the play (e.g., *"It should be near you"*).

> Archie: Where's the baby food?
> Beau: So you go over –.
> Mother: Oh, I've got a baby bottle. I'll give it a bottle then.
> Beau: But you are drinking it.

> Mother: I'm drinking it?
> Beau: Yeah.
> Mother: Whoopsie *[laughter]*.
> Beau: So you go over here.
> Mother: Oh I lost—I think I lost my baby. Oh no!
> Beau: It should be near you.
> Archie: I'm drinking baby milk *[laughter]*.

Fifteen minutes into the trio's play, the children's mother indicates that it might be time to end their digital play, without indicating her reasons for making this suggestion. There is a brief negotiation about when they should end their play, but they agree to set a timer for fifteen minutes.

> Mother: Okay guys. Do you guys wanna set a timer? We might need to think about doing something else.
> Archie: Yeah, we'll set a 30.
> Mother: No not a 30. That might be a bit long darling. What about a 15?
> Archie: Okay.
> Beau: I'm going on that long bridge. I'm doing the truck thing. Okay.
> Archie: Oh me too.
> Beau: You need to leave the game.
> Mother: Did anyone set one?
> Beau: I'm setting one now.
> Mother: Thank you.

The 15-min timer goes off and briefly after Beau announced his "iPad is dead" to which their mother responds, "Oh well, that's time anyway." The children have now played for approximately 2 h. Beau puts his iPad aside and watches on with Archie as he continues to play.

> Mother: Alrighty guys, could you turn it off.
> Archie: *[Sighs. Turns off iPad and sets it aside]*.
> Mother: Thanks Archie. Thanks for doing the right thing.

Example 2 presents an account of Archie's activity – the use of digital technology for entertainment (*activity object*). Archie is the *subject* of the activity, although his brother, and later his mother, shares in this activity as well. The *tool* of Archie's activity is his own iPad (separate from his brother's) and the available apps within.

The values of Archie's parents (*community*) in relation to the use of technologies align with Archie's motivation. His parents are comfortable with Archie and his brother being "high users" of technologies, even for entertainment purposes. The children are encouraged to be active users of the apps (e.g., playing games) rather than engaging in less interactive experiences (e.g., watching programs). Archie's mother usually establishes the rules and regulations with regards to the children's activity with technology (*division of labour*). Unlike the first example, the rules and regulations are not a salient feature of the conversation, as they are already established (e.g., the children use their iPads in a shared area of the family home, and they play within the realms of the apps that have been made available to them by their mother). In terms of access, children are required to ask permission, although this is usually granted without much negotiation. Finally, the time of access is initially indicated, but this is flexible and can be re-negotiated depending on the circumstances (as seen in the example).

Analysis of this example demonstrates that during their use of the technologies, the brothers had the time to engage in imaginative play, using avatars, creating plots a based on the parameters of what was available to them in the app. The siblings' interactions could be described as playful as well—they are non-serious, joyful and frolicsome (e.g., "Oh dude! Look what there is. Dog pool!"). They share excitement while exploring and conversing about the possibilities offered by the game. Archie's mother, who at the beginning provided some parameters for their play (time), gives gentle reminders (*"hey guys, think about what you might like to do this afternoon … that does not involve playing Roblox"*) but, prompted by her observations of the positive play experience, allows the play to continue. The flexibility in rules with screen time offered by Archie's mother, in contrast to illustrative example 1, allowed time and space for the play to progress. In this example, we also observed how the play evolved when their mother joined, with the development of more complex plots, and on and offline interactions. The children welcomed their mother into the play, supported her, and shared their expertise.

Discussion

In this study we considered children's digital experiences as situated within the social and cultural contexts of their home. We drew upon the notion of playfulness (Aarsand, 2010; Sicart, 2014) to examine and characterise children's interactions with digital technologies as they engage with them for entertainment. The use of Activity Theory (Engeström, 1993) as a conceptual framework also allowed us to analyse these digital interactions as part of a larger Activity System and explore how elements of the social and cultural context influence how children experience their digital interactions.

By drawing on two purposively selected illustrative examples from a larger ethnographic study of 5 families, we were able to present a rich and in-depth contextual analysis of children's digital experiences. These two illustrative examples were representative of the digital interactions captured across this dataset (e.g., watching YouTube, or play with apps or games on a tablet device), yet also exemplify diversity in how children encounter and experience digital technologies in their homes.

In responding to our first research question, "what is the nature of children's digital experiences at home when they are interacting with digital technologies?", we drew on Aarsand's (2010) work on playfulness in children's media activities to inform our understanding of digital interactions. Across all families in this study, we observed children's natural inclination to playfully interact with digital technologies, and the presentation of the illustrative examples allowed us to elaborate on this further. Using the definition of playfulness as a "meta-play" that "plays with the frames of play" (Sutton-Smith, 2009, p.147–148), in both examples the children exhibited creativity (Aarsand, 2010) in their encounters with digital technologies. Children gleefully conversed with family members, giggled, shared excitement, and created shared plots and sub-plots within the digital parameters.

In the first illustrative example, Josie and her sister exhibited playfulness in their conversations irrespective of their limited opportunities to digitally interact with their YouTube clips – demonstrating how, as Aarsand (2010) suggests, a playful attitude to the use of digital technologies can ameliorate the tension between the rules and boundaries imposed by the technologies and children's inclination to spontaneously engage in play. Playfulness, which has also been described as existing within the realms of play (Sutton-Smith, 2009; Sicart, 2014) was also exhibited in the second illustrative example. Archie, his brother, and their mother demonstrated playfulness in their virtual play with avatars. The platform Roblox, through its in-built features and context-bound scenarios offered opportunities for the brothers to playfully converse on and offline, to share their expertise (with their mother), and to create and develop shared plots and scenarios. Although both examples demonstrated playfulness (albeit to varying extents), how the digital experience unfolded and was encountered by the child, as well as the potential for positive digital play experiences, differed considerably.

The application of Engeström's (1993) Activity Theory as a conceptual framework allowed us to explore these digital interactions further as part of a larger Activity System. By drawing on the principles of the model, we asked 'how do the various elements of the activity system influence and interact to shape children's opportunities and interactions with digital technologies?'. By triangulating the various sources of data gathered in this study and mapping onto the Activity Theory model, we were able to qualitatively investigate the influence and dialectical relationships between various elements of the social and cultural context on children's digital experiences. In doing so, we were also able to identify any tensions and/or contradictions that influenced the child's experience.

Although children in both illustrative examples exhibited playfulness in their interactions with digital technologies, the experiences of Josie and Archie differed. Analysis of the relationships within the activity system helped to better understand the digital experiences within their social and cultural context. For Josie, tension in the activity system, stemming from contradiction between her mother's rules governing the digital activity and Josie's motivation for play (for enjoyment) led to an interrupted and comparatively less satisfying experience. Her opportunity for an enjoyable and playful digital experience was limited first by her access to digital technology (or *tool*) which was highly contested, and although through her persistence access was eventually granted, it was done so with firm parameters (*rules*), which stemmed from wider beliefs about screen time (*community*). Combined with the imposition of rules by the technology (e.g., YouTube and its limited opportunities for digital interaction), Josie's opportunity for agency, creativity, and interactivity in the digital activity was comparatively more limited.

In contrast, congruence within the activity system enabled a more positive and enjoyable digital experience for Archie. Alignment between his parents' values (*community*) about the use of digital technologies for entertainment and Archie's motivation for play also enabled free and spontaneous digital play. Established rules governing the children's digital activities (e.g., what apps and games they can access) and where to play in the home (e.g., in a shared space) did filter through into the digital experience. However, these were more flexible, less explicit, and less interruptive than the first example. The flexibility in time from his mother's observations of their play allowed the continuation of a positive shared play experience between siblings. The mother's request to join in on the play also demonstrated the importance of co-play for interaction and represented a creative approach to following the rules of access by making them playful too. It also appeared to empower the children to become experts in the play, validating their experiences of playing with digital device. Finally, the expectation for children to play with their devices in a shared space (e.g., the loungeroom) also likely contributed to more social interaction within the family unit, by enabling others to come in and out of the play.

Across the examples, parent input into the children's digital experiences was shown to be strong, filtering directly and indirectly through most elements of the activity system, and extending knowledge on already established associations between parent's attitudes and beliefs, and children's access to and uses of digital technology (e.g., Lauricella et al., 2015). The findings also highlight not only how parent's attitudes and beliefs inform how they govern and regulate their child's access as previous literature has shown (e.g., Zaman et al., 2016), but also, how their attitudes and beliefs permeate and shape their children's overall experience before, during and after the digital activities.

Conclusion

This study sought to further existing knowledge about children's at-home digital experiences. The importance of sociocultural factors in determining children's access and use of digital technologies are well established in the literature (e.g., Lauricella et al., 2015), However, the approach taken in the current study enabled us to extend on these by facilitating an in-depth examination of the dialectical relationships between the digital tools, the children and their families, and the environment in which children's digital interactions take place. By drawing on the illustrative examples from a larger corpus of data we have demonstrated the influential role of parents in not only granting access to digital technologies, but also in determining their opportunities for playful and positive encounters with digital technologies. The findings presented here align with Aarsand's (2010) observation that playfulness is a "central aspect of children's media practices" (p. 153), and also highlight how children's opportunities for agency, creativity, and interactivity in digital activities are largely shaped by the rules (e.g., household rules and expectations) and community governing the activity (e.g., parent attitude and belief systems) (Engeström, 1993).

The Day-in-the-Life methodology employed in this study (Gillen and Cameron, 2010; Flewitt and Clark, 2020) enabled a "contextually sensitive" means of capturing the situated and nuanced processes (Kumpulainen et al., 2020, p. 493) of children's digital activities. The use of chest mounted cameras also facilitated the capture of activities from the child's own viewpoint, enabling insight into their perspectives of the experience. However, although this study offers breadth and detail in the presentation of illustrative examples, it is exploratory, small in sample size, and lacking in generalisability. The sample of 5 families were geographically constrained to one location on the South Coast of New South Wales, Australia, and were similarly high in socio-economic advantage and parent education. The aim of this study however was not to look for patterns of associations across families, rather to explore how the nuances in the children's social and cultural

contexts influenced how children experienced digital activities. Nevertheless, future work could benefit from the inclusion of more socio-economically diverse samples.

This study provided important insight into children's interactions with digital technologies – highlighting their natural desire to interact playfully with them, and the interconnectedness between various elements of the social and cultural context in shaping the overall experience. The use of Engeström's (1993) Activity Theory as a conceptual framework offered a unique means of methodically capturing and analysing data within an Activity System and could serve as a useful means to gain further knowledge about children's digital experiences in other contexts (e.g., educational services and public settings). This study, which highlights the situated nature of children's digital experiences, has implications for parents and families trying to navigate the complexities of their children's lives. Specifically, the findings point to the need to shift thinking away from the negative discourses surrounding digital technologies and screen time (Aarsand, 2010; Livingstone and Smith, 2014) to emphasis on the contextual factors that may facilitate or hinder positive and playful interactions with digital technologies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Wollongong Human Research Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

Author contributions

KL: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. LK: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing. IV: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. SH: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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