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Play and creativity in young children's use of apps

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Abstract

This study is the first to systematically investigate the extent to which apps for children aged 0–5 foster play and creativity. There is growing evidence of children's use of tablets, but limited knowledge of the use of apps by children of children of this age. This ESRC-funded study undertook research that identified how UK children aged from 0 to 5 use apps, and how far the use of apps promotes play and creativity, given the importance of these for learning and development. A survey was conducted with 2000 parents of under 5s in the UK, using a random, stratified sample, and ethnographic case studies of children in six families were undertaken. Over 17 hours of video films of children using apps were analysed. Findings indicate that children of this age are using a variety of apps, some of which are not aimed at their age range. The design features of such apps can lead to the support or inhibition of play and creativity. The study makes an original contribution to the field in that it offers an account of how apps contribute to the play and creativity of children aged five and under.

Introduction

There is a growing evidence of pre-school children's access to and use of tablets. In the US, a study of 350 children aged from 6 months to 4 years found that 96.6% of the children used mobile devices, and most started using them before the age of one (Kabali *et al.*, 2015). In the UK, Ofcom (2017) has reported that 65% of 3–4 year olds use a tablet (Ofcom, 2017, p. 32), with one in five of this age group having their own tablet (Ofcom, 2017, p. 33). Despite these figures, little is known about how far pre-school children's use of apps promote play and creativity.

Numerous online surveys have been completed by parents on their pre-school children's tablet use, with some attention paid to how such use relates to play and creativity. For example, Nevski and Siibak (2016) conducted an online survey of 198 Estonian parents of children aged from birth to three. Smartphones and tablets were used daily by 25% of the children, who used the devices to watch videos, television programmes and cartoons on YouTube. Children also communicated with family members using apps such as Skype and Facetime and looked at family photographs. A US team (Pempeck & McDaniel, 2016) conducted an online survey of mothers of children aged between 12 and 48 months, which reported that 46% of children used a tablet on

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Practitioner Notes

What is already known about this topic

- Play and creativity can be fostered through the use of technologies.
- Many pre-school children have access to tablet apps in the home.
- Young children engage in a range of activities when using tablet apps, including activities that promote play and creativity.

What this paper adds

- A detailed and systematic investigation of play and creativity in relation to pre-school children's use of tablet apps, involving a nationally representative sample of parents of 0–5 year olds.
- Play with apps leads to a wide range of play and creativity, with most types of play and all types of creative thinking being observed when children use tablet apps.
- The top 10 favourite apps for UK children of this age group vary in relation to how far they promote play and creativity, with age-appropriate apps more likely to foster a wider range of play and creative thinking practices.

Implications for practice and policy

- Policy makers need to be aware of the growing interest young children have in the use of apps that relate to physical toys, and thus ensure data protection policies are adequate.
- App designers need to consider a number of principles of design if apps for pre-school children are to foster a wide range of play and creativity practices.
- Parents and early years practitioners should become familiar with the characteristics of apps that promote play and creativity in order to guide children's choices.

a daily basis. Children engaged in educational and creative apps more frequently than games for fun, although it should be noted that the survey relied on parental self-report. The most popular activities included playing with e-books and art, language, mathematics/counting and matching apps.

A number of studies include observations of children using technology in home contexts. These studies (Chaudron *et al.*, 2015; Geist, 2012; Harrison & McTavish, 2016) indicate that interactions with tablets are embedded in family relationships and often take place with parental involvement. The researchers note the fluidity with which children engage with the technical aspects of using tablets, in addition to the playful nature of use.

Studies of pre-school children's use of tablets in early years settings also suggest that the device can support playful and creative practice. Research has indicated that tablet use can foster art and drawing skills (Couse & Chen, 2010; Price, Jewitt & Crescenzi, 2015) and creative thinking through problem solving (Harwood *et al.*, 2015). There are case studies of early years practitioners supporting pre-school children to use tablets for a range of creative activities, such as digital book creation (Flewitt, Messer, & Kucirkova, 2015; Sandvik, Smørdal, & Østerud, 2012), film-making, music creation and photography (Dezuanni, Dooley, Gattenhof, & Knight 2015; Yelland & Gilbert, 2014). While studies such as these provide valuable information, there is still a gap in knowledge in terms of identifying the types of play and the range of creativity and creative thinking made possible by engagement with apps. The study reported in this paper focused on this issue and, in the next section, the study's conceptual approach to this focus on play and creativity is outlined.

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Play, creativity and technology

There are a number of ways in which digital technologies inform play. For example, Ofcom (2017, p. 108) reports that one in ten children aged three to four play games online, which illustrates the popularity of gaming. Children can use digital objects in their play, such as using mobile phones to engage in pretend play (Plowman, Stevenson, Stephen, & McPake, 2012). Digital technologies can be a stimulus for imaginative play, such as physical play based on characters and narratives encountered in video games or virtual worlds (Marsh, 2014). Finally, children enjoy playing with toys that are digitally enabled in some way.

The present study also examined the relationship between children's use of apps and their creativity. There are close links between play and creativity, as noted by Vygotsky (2004:11), who suggested that play was crucial to cognitive development and that it was a "leading activity," as it leads children on to the acquisition of new skills, knowledge and understanding. Studies of young children's creative uses of technologies in homes have offered some insights into how tablets have been used by children to take photographs or draw (Harrison & McTavish, 2016; Verenikina & Kervin, 2011), but there is a need to identify the range of creativity that apps can promote. Given the relationship between creativity and creative thinking (Csikszentmihalyi, 2002), this study also considered the types of creative thinking promoted by apps.

Two key frameworks were used as a means of identifying play and creativity in young children's use of apps. First, Hughes's (2002) taxonomy of play was utilised to identify aspects of play that emerged in the study. There are many taxonomies of play (eg, Bird & Edwards, 2015; Caillois, 2001; Hutt, 1979), but Hughes's was selected for this study because it identifies 16 different types of play, enabling a finely-grained analysis. For example, fantasy and imaginative play differ in some games and online virtual worlds and Hughes's scheme allows for this distinction, unlike some other taxonomies. A category of transgressive play (see Marsh, Plowman, Yamada-Rice, Bishop, & Scott, 2016) was added to fully adapt the classification for a digital environment. The 17 types of play are as follows: symbolic; rough and tumble; socio-dramatic; social; creative; communication; dramatic; locomotor; deep; exploratory; fantasy; imaginative; mastery; object; role; recapitulative; transgressive.

The definition of creativity outlined by the National Advisory Committee on Creative and Cultural Education (Department for Education and Employment and Department for Culture, Media and Sport, 1999, p. 29) suggests that it consists of imaginative thinking or behaviour which is purposeful and leads to an original outcome which is of value in relation to the original objective. In this study, this was determined by the specific context in which a creative act occurred. So, eg, when a child produced a novel drawing on a tablet that met her objective of creating a drawing and was either of value to the child or judged to be so by an adult working with the child, it was viewed as a creative act. Imaginative thinking or behaviour, the first element in NACCCE's definition, was traced through the use of Robson's (2014) "Analysing Children's Creative Thinking (ACCT) Framework." This places the emphasis on the process of creativity, rather than simply examining original content. Instead of using cognitive tests of divergent thinking which are not appropriate for very young children, such as the Torrance Tests for Creative Thinking (Torrance, 1974), ACCT enables creative thinking to be identified through observable behaviours, which are associated with three main areas: exploration (exploring; engaging in new activity; knowing what you want to do), involvement and enjoyment (trying out ideas; analysing ideas; speculating; involving others) and persistence (persisting; risk-taking; completing challenges). These approaches to identifying creativity relate closely to Hughes' (2002) definition of creative play as "Play that enables children to explore, develop ideas and make things," thus incorporating both creative thinking and the creative act. In the context of this study, the identification of risk-taking took place in relation to the use of relevant features of an app, when certain actions by the player led to the risk of a lack of progress within the app (eg, Minecraft).

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Methods

The co-produced study emerged from a collaboration between academics, media industry professionals and teachers. The research questions focused on what access young children had to apps, how they used them and how far they promoted play and creativity. The project had four distinct stages, as follows.

One of the industry partners in the study, Dubit, a company with experience of researching young children's media use, undertook a survey with 2000 UK parents of under 5s who had access to a tablet in the home, drawing from an established panel. The survey took place in 2015 and was designed by all research partners. A randomised, stratified sampling procedure was used to ensure that it was nationally representative. The profile of the sample can be seen in Tables 1–3.[1]

The survey asked parents and carers to identify the range of technologies that children had access to in their home, in family members' and friends' homes, and in other relevant settings such as nurseries. It requested reports of the types and length of use of tablets and apps and the times of day when they were used. Parents also reported on children's favourite apps, the apps they themselves favoured and the genres. The survey asked for details of parents' concerns and any usage that posed problems, such as access to undesirable content and accidental in-app purchases.

Respondents in an area in the north of England were asked if they wished to take part in Stage 2 of the study, which consisted of case study visits. Families were selected to ensure a mixed sample in terms of socio-economic status, gender, age and ethnicity of the child. Four families were identified through this route, and a further two identified through established contacts of the team. The profiles of the case study children are outlined in Table 4.

Table 1: Age profile of the survey sample

	Under 1s	*1 year old*	*2 years old*	*3 years old*	*4–5 years old*
Age of Child	9%	18%	21%	23%	29%

Table 2: Social class profile of the survey sample

	A	*B*	*C1*	*C2*	*D*	*E*
Social Class	11%	25%	25%	22%	11%	8%

Table 3: Race/ethnicity profile of the survey sample

	White	*Mixed Heritage*	*Asian*	*African-Caribbean/ Black*	*Chinese*	*Other/ prefer not to say*
Race/Ethnic Group	85%	5%	7%	2%	1%	1%

[1]Please note that in Table 2, the UK's National Readership Survey (NSR) classification was used, which determines social grade by occupation. In this system, grade 'A' refers to upper class/upper middle class (higher managerial, administrative and professional), 'B' to middle class (intermediate managerial, administrative and professional), 'C1' to lower middle class (supervisory, clerical and junior managerial, administrative and professional), C2 to skilled working class (skilled manual workers), D to working class (semi-skilled and unskilled manual workers) and E to non-working (state pensioners, casual/lowest grade workers, unemployed with state benefits). Please also note that in Tables 2 and 3, the values are rounded and so will not sum accurately to 100%. For the non-rounded values, see the data tables in the appendices of Marsh *et al.* (2015).

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Table 4: Demographic profiles of the case study children

Family no.	*Name (pseudonym)*	*Gender*	*Age on first visit*	*Social class*	*Ethnicity*	*Siblings*
F1	Arjun	Boy	3.1	B	Indian	Sister, aged 10
F2	Jade	Girl	4.11	D	White	–
F3	Amy	Girl	2.11	C1	White	–
F4	Kiyaan	Boy	2.8	A	Iranian	–
F5	Tommy	Boy	6 months	E	White	Brother, aged 6
F6	Angela	Girl	2.3	C2	White	Brother, aged 7

Families were visited five times (one family was visited four times). Each visit lasted up to 2 hours and consisted of videoed observations of children using tablets, conversations with children, semi-structured interviews with parents about children's use of tablets, and "play and creativity" tours of the household, in which maps were constructed which outlined where children played and how tablet use related to that play. Parents, siblings and children were interviewed about the maps. In addition to this, still images were taken by researchers, and parents were invited to collect data themselves through the use of their smartphones. They were then questioned about these data. Finally, children aged 3 and over were able to choose to wear a "Go Pro" chestcam to film their use of tablets. Three children wore the chestcams: Amy, Jade and Kiyaan.

The third stage of the research study focused on the apps themselves and was conducted in a school in a primarily White, working class area of a city in the north of England. The area is one that is identified as being within the top 2% of socio-economically deprived areas in England, according to national Indicators of Multiple Deprivation. Children aged 3–5 in the Foundation Stage were invited to engage in this stage of the research. Parents of 12 children, 6 boys and 6 girls, agreed that they could participate. The favourite apps of under 5s were identified in the first stage of the study and loaded on to tablets. Children could choose to leave the nursery if they were not involved in other activities to go to a room in which they could use tablets. The children were filmed using both apps that they chose and ones to which they were directed. On the whole, the children used the apps individually, although one of the games required two players. The camera focused on children's interaction with the tablet screen. Overall, 198 separate episodes of use were analysed, which constituted over 17 hours of video recording.

Data analysis

The survey data responses were cross-tabulated in SPSS against a range of variables, including the age and gender of the child, ethnicity and social class. The Chi-square test of association was used to identify statistically significant results. Outcomes at the 0.1% level of significance are reported in this paper. Further, posttest "Cramer's V" effect sizes were calculated in relation to the statistically significant results.

The interview data and observational data from the case studies were analysed using thematic analysis (Braun & Clarke, 2006). Data were coded deductively for play types and creativity and creative thinking types. In addition, inductive coding was used to identify themes emerging from the research questions. In total, there were 165 separate codes identified at the first stage of analysis, grouped into 28 over-arching categories which were then mapped on to the three themes that were addressed in the phase one survey: Access and Use; Parental Engagement; Play and Creativity.

The videos of children using apps in the school were analysed using the software package Scribe 4.2. This enables codes to be entered on particular video sequences. The data were coded deductively for play types, creativity and creative thinking types. Two researchers coded 10 videos together in order to agree approaches and develop shared understandings before coding the rest

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of the videos independently. In total, 20 of the videos (10%) were coded by both researchers and interrater reliability was found to be 89.5%. Finally, the apps themselves were analysed in conjunction with the outcomes of the video data analysis to identify features of the apps that either fostered or inhibited play and creativity.

In this paper, data from all four stages of the study are shared in order to identify the play and creativity demonstrated when children used tablets and apps.

Ethics

Ethical procedures were informed by the BERA Ethical Guidelines (2011). In addition to gaining informed consent from parents and from the children themselves, it was agreed that for young children, the notion of assent is also important (Dockett & Perry, 2011), and thus body language and other markers of discomfort were attended to. For example, if children seemed tired, then the team would stop the interview or video recording. The case study families were given £100 of vouchers in order to acknowledge the commitment they made to the project. The school was also given a payment for taking part in the study. All data were anonymised and names changed for the purposes of reporting.

Findings

Access to tablets and use of apps

In this study, all children had access to tablets in the home, as that reflected the sample of parents who participated in the study. Children from social groups ABC1 were more likely than children in working class families to have access to iPads (56% vs. 48%), whereas children from social groups C2DE owned cheaper tablets, such as Samsung Galaxy. Outside of the home, children largely had access to tablets in the homes of grandparents and friends. A small number (3%) of parents reported that children had access to tablets in early years settings or schools, although this may be due to parents not being aware of such use.

Children used tablets for a mean of 1 hour 19 minutes on a typical weekday and 1 hour 28 minutes on a typical weekend day. This total accounts for a range of different types of uses, including watching television content and playing games. Children were more likely to use tablets between 4 p.m. and 6 p.m. during the week, whereas use was spread more evenly across the day at weekends. Parents reported that children were more likely to use tablets with a parent or guardian (57%), than use them on their own (35%).

There were differences in app use in relation to socio-economic status and ethnicity. Overall, the majority of apps were not paid for, but parents in social groups ABC1 and Black and Minority Ethnic (BME) parents were more likely to pay for apps. Parents had a range of reasons for downloading apps, including educational motivations and a desire to facilitate play and creativity. The favourite app for this under 5 age group was "YouTube." The other top apps used by the under-5s were: "CBeebies" (Playtime and Storytime); "Angry Birds"; "Peppa's Paintbox"; "Talking Tom" (and similar); "Temple Run"; "Minecraft"; "Disney" (general); "Candy Crush Saga"; "Toca Boca" (general). On average, children used six apps regularly.

There were some age differences in relation to the choice and use of apps. More parents of 3–5 year olds than parents of 0–2 year olds stated that one of their children's top 5 apps were *Angry Birds, Temple Run* or *Minecraft*. Older children were more likely to use drawing and painting, story, photograph, gaming and educational apps than younger children, whilst children under one were more likely to look at magazines (such as the *CBeebies* titles) on a tablet than older children. Gender differences in the use of apps were not found to be extensive, but were, nonetheless, of interest. Girls were more likely than boys to use colouring-in and style creation apps (eg, *Stardoll*) and boys were more likely than girls to use basic strategy games (such as *Angry Birds*), sports apps, and virtual world apps such as *Minecraft*.

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Parents reported a range of barriers to downloading apps, the biggest being financial. There were some differences in relation to social class and ethnicity, with a greater barrier for middle and upper class families than others being concerns about children having too much screen time. BME parents were more likely than White parents to state that they could not find their children's favourite media shows and characters on apps, which suggests that apps available for young children are not sufficiently diverse or representative of all communities.

Some parents reported that their children had undergone negative experiences with apps, with 6% stating that their children had been exposed to material that made them feel uncomfortable and 10% reporting that children had made an in-app purchase by accident. Examples of these uncomfortable experiences were not asked for in the survey, but in the case study families, parents reported children being exposed to material that was not aimed at their age group, such as games that included characters killing each other. Health and safety issues were paramount in relation to parental concerns, as reported in a UK study, which included a sample of 339 parents of children under 5s (Kucirkova, Littleton, & Kyparissiadis, 2017).

Play and creativity were key drivers for the children's use of apps as reported by parents. Parents in the survey reported that their children used tablets and apps for a wide range of purposes, including watching videos on YouTube, making videos, taking photographs, drawing and painting, and playing with virtual avatars and pets.

Play and creativity with apps in the home

The case study children's use of tablets across the day related closely to the patterns of use identified in the survey. For example, more creative, interactive use occurred during the day, whilst the tablet was often used before bedtime to engage with bedtime stories or films. The data were analysed in relation to the adaptation of Hughes' (2002) types of play; 15 of the 17 types of play were observed in the home context when children used tablets, with rough and tumble play and recapitulation play not being identified in those instances. Play with tablets was integrated into children's everyday play practices. For example, children used tablets when engaged in traditional play activities, such as making dens, which is made possible by the portability of the device. Apps fostered much imaginative and fantasy play, as children re-played episodes from apps that were based on favourite characters, films and television programmes, such as *Peppa Pig* and *Frozen*. Rule-bound gameplay was also prevalent, and the children played a wide range of games, including basic strategy games (eg, "Angry Birds"), creating virtual worlds (eg, "Minecraft"), nurture and mimic games (eg, "Talking Tom"), and escape and obstacles games (eg, "Temple Run"). In terms of types of play, these apps promoted symbolic, communication, deep, exploratory, imaginative, mastery and object play. For example, in one observation, Jade played on the app "Temple Run." She had to manipulate an avatar (object play) as it was chased by demonic monkeys, attempt to overcome obstacles and collect coins to progress to the next level (mastery play), and encounter risky experiences which heightened emotions (deep play).

One aspect of play that was particularly salient in children's home use of apps was the way in which it took place fluidly across digital and non-digital domains. Children played with physical toys related directly to apps, such as *Furby Boom* and robots, which can be characterised as being part of the "Internet of Toys." These promoted imaginative play in particular (see Marsh, 2017). A quarter of all children in the survey were reported as having experienced augmented reality apps, and so it is clear that the experience of linking online and offline domains in play is becoming increasingly significant in young children's lives. Even when toys did not have apps that enabled children to control them, as in the case of Furbies and robots, many toys did relate to apps. As Amy's mum noted:

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> . . . she's got the Furby and she's got her robot toys, they all interact with the app. The others don't really interact but they do have apps, like we've got Peppa Pigs apps and she's got some pig toys. . . the Paw Patrol, that originally came from the telly, but then we got the app before we got the toys. . .

In the example above, apps and toys both related to television programmes that Amy liked to watch, indicating that play was located in a transmedia world (Herr-Stephenson, Alper, Reilly, & Jenkins, 2013). Sometimes, children singled out specific aspects of an app to support their non-digital play. Amy's mum filmed her daughter in an extended play episode in which she played with plastic *Paw Patrol* toys, taking them on imaginative adventures. Throughout the play episode, she had the *Paw Patrol* app playing beside her, but she rarely interacted with it, instead pausing to glance at it now and again. Her mum felt that Amy was using the app as a musical backdrop to this episode of imaginative play. In this world, as play moved across and between media, it was not always possible to trace the direct influences on play, as Jade's mum identified when she reported on an episode of her child's *Palace Pets* (Disney) play in which she noted transmedia influences on the play and commented, *It's hard to know really what comes from what because. . .there's tablet, there's DS, there's telly, and it's hard to know what comes from where.*

YouTube was the most popular app for the case study families, as reported in the survey. All of the children parents' reported them watching *YouTube* videos, including nursery rhyme and music videos, some of which were culturally significant. For example, Kiyaan enjoyed traditional Iranian songs that his Iranian parents found for him. All of the children apart from 6-month-old Tommy repeatedly watched unboxing videos (in which commercial items are unwrapped) and videos in which Play-Doh models were created. This stimulated children's offline play as children then modelled with their own Play-Doh or played with toys they had seen being unwrapped on screen. The use of other apps also promoted creativity away from the apps themselves. For example, Amy enjoyed playing with her toys related to the Disney film *Frozen* after engaging with the *Frozen* app, and Jade liked to cook with her mum after playing with apps that allowed her to create foodstuffs, such as pizza.

In relation to creativity, children in the case study families demonstrated uses that reflected the survey reports. So, eg, 4-year-old Jade's mum reported how Jade produced slideshows using photographs, which she then used to create, *make-believe stories about princesses. . .and her dolls and everything. You name it, she makes a story up about it*. Three-year-old Arjun edited his own pictures. The two-year-olds, Angela, Amy and Kiyaan, also demonstrated much creativity by using drawing apps to mark-make and/or create pictures and collages, or creating a simple tune with musical apps. For some parents, creativity was evident in their children's use of apps that enabled construction of virtual worlds and objects, such as *Minecraft* or *LEGO*, as Arjun's mum noted, *LEGO app is there, there he has to construct a car or a tractor on his own. . .So I think all those building types and all will be creative for him.*

Apps also fostered playful communication with parents, family members and friends through the use of *Facebook*, *Skype* or *Facetime*. Whilst much of this use was alongside parents, there were reports of children accessing social networking sites independently, sending photographs directly to *Facebook* or other social networking sites, or using *Skype* on their own, as reported by two-year-old Kiyaan's mum, *He'll go to the Skype and dial this person. . . he has no problem doing these things.*

In summary, the case studies provided a rich range of insights into children's play and creativity using apps, with children under 5 demonstrating many of the playful and creative practices with technology that have been found to be undertaken by older children (Chaudron *et al.*, 2015).

App design for play and creativity

Whilst there was much evidence of play and creativity using apps in the homes, with the majority of Hughes' (2002) categories of play noted and all of the categories from Robson's ACTT

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(2014) framework identified, it was evident from the observations that some apps were better designed to promote play and creativity than others. The detailed analysis of the videos of children in the school using the most popular apps for under 5s indicated that they varied in terms of the types of creativity/creative thinking and play promoted (see Appendix 1 for a summary of the analysis). The apps that promoted most types of play and creativity were those developed specifically for this age group, such as "CBeebies Playtime" and "Peppa's Paintbox," whilst the apps that promoted the least number of types of play and creativity were those aimed at older age groups, such as "Candy Crush." Age-appropriate design is, therefore, an important consideration, although children's individual characteristics impact on the level of engagement they demonstrate when using apps. In general, however, age-inappropriate apps were not conducive to extended periods of play for this age group. Prior knowledge of apps was important in relation to one app. The use of the "Minecraft" app led to a range of play and creative thinking, but was only productive for those children who had been inducted into its use by others. Because it did not provide the types of scaffolding used by apps designed for under-5s, it was not intuitive in terms of young children learning to use it independently.

In the analysis of the video data, it was possible to identify those aspects of apps that promoted or limited play and creativity (see Appendix 2 for a list of the key design aspects). For the under 3s, the apps that are the most successful have one or two clear functions, lots of repetition and features that encourage parental participation. It is important for this group that apps provide large margins for error, so that children do not have to touch an exact spot on the screen for the consequences of that action to occur. In addition, apps that relate to children's familiar daily routines, such as dressing and washing, or apps that replicate some non-digital games, such as "Peek-a-Boo," are successful in promoting play for this age.

The issue of developing clear criteria for choosing suitable apps for this age range is key. Kucirkova, Littleton and Cremin (2017) developed criteria for choosing apps to support language and literacy (http://literacyapps.literacytrust.org.uk/how-to-choose-apps/). The design principles outlined in this paper move beyond language and literacy to consider the development of apps across all disciplinary areas. In addition, the research team identified principles of app design for children at specific ages (under 1s, 1–2s, 2–3s, 3–4s and 4–5s). Some designers present apps as being relevant for 0–5s when, developmentally, the specific needs of children at different ages within this age span need to be considered (see Marsh *et al.*, 2015, for further design features of apps for specific age groups).

Conclusions

The data indicate that UK pre-school children who have access to tablets use these on a daily basis and engage in a range of activities that promote play and creativity. Whilst all but two of Hughes' (2002) classifications of play could be identified in relation to the use of apps, it was clear that the play was shaped by the technology in specific ways. For example, socio-dramatic play was less evident because that normally requires two or more players and, for the most part, children tended to use tablets individually in the home. In addition, many apps promoted rule-bound rather than free play because of the game elements embedded within them. There was variability in experience across families, but often this was due to children's individual interests and parental experiences and views rather than larger social demographic patterns.

In relation to creativity, the extent to which apps enabled children to produce new and original texts and artefacts obviously differed according to the aims of the specific apps. Design was key. Even when apps were designed to promote creativity, such as drawing or music-making, those that did not embed some of the positive features identified in Appendix 2 (such as having clear aims, appropriate scaffolding using pictures and/or sounds, and repetition of key features to help

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navigate the app) were less effective. Some of the apps that claimed to foster creativity did so in a way that constrained children's choice and agency. For example, children could paint on a screen, but they only had a selected number of brush types or colours to choose from. Children's creative practices came to the fore when they used apps in ways that enabled them to develop their own texts or artefacts. Robson's (2014) ACCT Framework proved useful in terms of identifying the apps that fostered creative thinking and, from this analysis, it was clear that all three areas addressed by the framework (exploration, involvement and enjoyment and persistence) were supported by the use of apps. Sometimes, even when app design was not optimal for young children, they enjoyed playing with it in ways not conceived of by the app producers. As Sutton-Smith (1997) points out, such subversive play requires a high level of competence: children have to work out the rules to know how to contest them, providing further evidence of creative thinking.

This study has made a contribution to knowledge in the field of pre-school children's use of apps in a number of ways. The study is the first to examine systematically the way in which play and creativity are embedded in young children's (aged 0–5) use of apps and to demonstrate that a wide range of types of play are fostered by the use of tablets. Apps can enable children to engage in creativity and creative thinking which demonstrate exploration, involvement and enjoyment and persistence. The study has also identified the design characteristics of apps that promote play and creativity for pre-school children and offered insights into the ways that commercial interests can limit play and creativity through the use of in-app advertising.

The study has limitations, in that the apps that were analysed used the English language and research is needed that considers the quality of apps in other languages. In addition, only six case studies were conducted, although the rich datasets that were produced in a rigorous manner offer potential for the "transferability" (Simons, 1996) of findings to other contexts, and the data supported the findings of the national survey of 2000 parents undertaken in phase one of the study.

Recommendations

The study has a number of implications for policy and practice, particularly for the children's media industry. The findings indicate that app designers need to take into account a number of characteristics if they wish to design apps that facilitate play and creativity. Some children are more disposed to engaging in playful and creative activities than others, so app design alone is not responsible for promoting play and creativity. The study showed, however, that good design can facilitate such activities. The study also reinforces how tablets are integrated in young children's everyday play practices, and that both digital and non-digital elements are drawn upon in single play episodes. This has implications for app and toy manufacturers, who need to consider ways in which to create playspaces using their products that enable children to move seamlessly across online and offline domains.

The study also has implications for parents and early years practitioners. If children are to be given access to high quality apps that promote play and creativity, then parents and early years professionals should be aware of how to judge the quality of apps as that can make a difference to the choices made by those who buy apps for young children. In addition, the survey data indicated that only a very small minority of children had access to tablets in early years settings. Given the value that high quality apps can have for the promotion of children's play and creativity, it is important for early years settings to consider the use of tablets in the curriculum.

Finally, the study has implications for further research. Whilst there was evidence of play on other platforms/hardware such as Nintendo DS and the XBox, there is little doubt that the tablet is the dominant screen in the children's play lives. Data from Ofcom (2017) suggest that tablets feature in the play lives of children aged over five and additional studies that offer insights into

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the types of play and creativity that emerge in such use are needed. Further research is also required with regard to the extent to which children distinguish between apps in terms of their capacity to promote play and creativity. Identifying the "fun" features of apps which appeal to young children can then inform further development of educational apps. Finally, the study demonstrated that online-offline domains are rapidly merging in children's use of apps. Additional research is required to consider the implications of this, not least with regard to issues of data privacy. Such research is essential, given the extent to which the youngest children in society are now fully immersed in the digital world.

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Statements on open data, ethics and conflict of interest
All of the data from the project can be accessed by registered users at UK Data Reshare: http://reshare.ukdataservice.ac.uk/852030/

Video data from the case studies and observations in schools, and the audio files from the case study interviews, are available with restricted access due to the personal information they contain.

The project adhered to BERA's (2011) Ethical Guidelines and received ethical approval from the University of Sheffield School of Education's Ethical Committee.

CBeebies was a research partner. Two of the apps reviewed in this project were produced by CBeebies and were reviewed because they were identified as being in the top 10 favourite apps of under 5s in the UK. However, CBeebies staff did not contribute to the phase of the research in which the use of the apps was videoed and played no part in the analysis of these data, or the writing up of the results of this element of the study. These tasks were undertaken independently by two researchers at the University of Sheffield, who had no conflict of interest in this regard.

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Appendix 1: Analysis of popular apps in relation to Hughes (2002) play types and Robson's (2014) ACCT framework

App	*Number of types of play observed in use*	*Number of types of creative thinking observed in use*
Angry Birds	1	4
Candy Crush	1	3
CBeebies (eg, Playtime)	7	9
Disney (eg, Imagicademy)	2	7
Minecraft	5	6
Peppa's Paintbox	3	5
Talking Tom	3	5
Temple Run	2	3
Toca Boca (eg, Nature)	4	5

Appendix 2: Features of apps that foster or limit play and creativity

Key features of apps that limit play and creativity	*Key features of apps that foster play and creativity*
• Have no clear aims, or too many aims. • Are narrowly focused, with tasks that contain few challenges. • Are poorly designed so that children cannot navigate them clearly. • Contain very few scaffolding techniques. • There is inconsistency in terms of the demands made on the user (when to swipe, tap and so on), which may cause confusion. • Rely too much on text. • Have too many pop-up menus, often caused by in-app advertising.	• Generally well-designed, having clear aims. • Contain a great deal of appropriate scaffolding that is both visual and aural (ie, not over-reliant on text). • Include text-to-speech instructions and comments where necessary, with highlighting of words when spoken. • Enable parents to activate/ deactivate features and adjust level of challenge. • Use clear icons and contain repetition of key features such as the home page icon appearing on each screen to facilitate easy navigation. • Use of pop-up menus, banner adverts and in-app purchases limited. • Inclusion of open-ended activities, which enable children to experiment for themselves and focus on the process rather than an end product. • Embed problem solving, critical thinking and abstract reasoning activities. • Use prompt questions/ statements to promote play, exploration and/ or experimentation with the app's resources • Include text that stimulates children to ask questions and/ or set challenges. • Embed activities that foster co-production of content (with peers or adults). • Offer the facility to personalise the app, eg, through inserting own photograph or voice.

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