An ecological exploration of young children's digital play: Framing children's social experiences with technologies in early childhood.

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An ecological exploration of young children's digital play: Framing children's social experiences with technologies in early childhood.

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Abstract

This article outlines an ecological framework for describing children's social experiences during digital play. It presents evidence from a study that explored how 3- to 5-year-old children negotiated their social experiences as they used technologies in preschool. Utilising a systematic and iterative cycle of data collection and analysis, children's interactions with 24 technological resources were examined over a nine-month period and across three phases. Findings reveal that children played in clusters, exhibiting a multitude of social behaviours and interactions and varied degrees of social participation, and assumed various social status roles and technological positions. These behaviours formed part of a Digital Play System, which in turn was influenced by the preschool system, which comprises children and practitioners as active agents, technological affordances, and the cultural systems, routines and practices of the early childhood setting. Ultimately, children's social experiences during digital play cannot be determined by any single element of the ecological system.

Keywords: digital play, ecology, children as agents, technology, play, social experience

Introduction

Contemporary explorations of technology use in early years education have progressed significantly in the last decade. We are seeing exciting movements away from narrowly defined explorations of children's interactions with specific resources, towards broader investigations of the role and position of technologies within children's early learning experiences. Research is beginning to describe how technologies form one part of the complex ecological system of children's early learning. This account describes how play experiences are being re-imagined in early childhood (Yelland, 2010) and how digital play may be explored or investigated in new ways (Edwards, 2013). For example, the use of technologies in all aspects of early childhood is being explored, widening the earlier focus on technology use in formal educational settings (Plowman, 2015; Plowman et al., 2012). These ecological explorations are facilitated by broader definitions of technologies which move beyond screen-based media (Arnott, 2013) to consider working and non-working technologies (Bird, Forthcoming). Similarly, increasing theorisation – such as the presentation of a Digital Play Framework (Bird and Edwards, 2014) - is helping researchers and practitioners to understand the role of technologies in children's lives, culture and play.

This paper contributes to this evolving body of literature by presenting a techno-ecological framework to explore children's social experiences during digital play. Ecological research about children's social experiences, interactions and behaviours in preschool was widely available in the 1980s but this focus is underdeveloped in contemporary technological studies. Lingering and often

unsubstantiated moral panics continue to influence the portrayal of technologies as deterministically shaping interactions (e.g. Rowan, 2015). In order to challenge these assertions, more evidence is needed of the multitude of contextual and social factors that contribute to young children's experiences of using technologies. This is particularly the case as research demonstrates that technologies are embedded in cultural contexts, resulting in calls for explorations of the wider ecologies of children's digital play (Livingstone et al., 2015). This paper contributes to this perspective by presenting a framework of some of the key contextual and social factors that shaped children's social experiences in a study of 3-5 year olds' digital play.

Technologies as tools in Digital Play and Pedagogies

As technologies have become ubiquitous in life, work and leisure, questions are continually raised about how these resources may be transforming childhood experiences. Concerns were once raised about the developmental appropriateness of such resources (Cordes and Miller, 2000). This was particularly evident with the integration of screen-based media into childhood and early education. The concerns were related to the long history in ecological and human geography literature of exploring the link between toys and children's social interactions and experiences. These perspectives suggest a link between environment and social experiences, behaviours and play (Read et al., 1999). Such perspectives have extended into Education literature and we see popular theorising from approaches like Reggio Emilia that recognise links between the physical environment and children's development and play (Strong-Wilson and Ellis, 2007). Specific toys and artefacts form part of this broad discussion, for example a link between resources being 'social' and 'isolate' – i.e. designed for individual or social use – is discussed (Driscoll and Carter, 2009). The general understanding is that certain resources and artefacts encourage social interaction while others inhibit it (Chandler et al., 1992). For example, dolls, games and dramatic play materials have been linked to more cooperative play or social interaction, while art activities and puzzles have been linked to more solitary or parallel play (Rubin, 1977). For technological resources, questions around their affordances for children's play have consistently been raised, though only relatively recently in relation to empirical evidence.

In recent years, theorising around digital technologies in early childhood has begun to re-evaluate the deterministic link between objects and behaviours or learning outcomes. For example, contemporary research on creativity in a digital age points to the *possibilities* afforded by technologies, rather than deterministic outcomes (Craft, 2012). The focus is on the child as empowered to manipulate and interpret technological tools in multiple ways. Similarly, Brooker and Siraj-Blatchford (2002: 19) showed that young children do not distinguish between screen-based

media and concrete toys in the way that adults do, rather they treat them in a similar manner and as such "manipulation of symbols and images on the computer screen represents a new form of symbolic play". These perspectives began to position children as active, rather than passive, in the technological experience; a fundamental shift in thinking, informed by sociological perspectives on childhood which consider children to be active agents, shaping their own destinies (James and James, 2004).

We are now beginning to see evidence of pedagogical advances in early childhood practices which locate the child at the centre of the learning experience, embodying agency to drive and determine their own outcomes, even with technologies. These ideas are seen in play-based pedagogies and child-initiated learning (whether around traditional or digital resources) which focus on children learning and developing through experience, collaboration and interaction, with the environment but also with peers (Woods, 2013; Fisher, 2008). They are embedded in socio-cultural approaches which see the social and individual as an inseparable dualism where knowledge is co-constructed through social interactions (Vygotsky, 1978; Rogoff et al., 1993). This brings to the fore the need to understand the wider context within which children are playing with technologies as well as children's social play experiences around these resources.

The broader focus on children's social play in early childhood is not new. Frameworks for observing and classifying social play experiences are readily available, including Parten's (1932) Social Participation Framework and Broadhead's (2010) Social Play Continuum. Both seek to describe children's increasing progression of sociability in their play through the actions and behaviours they exhibit. Yet few studies have made links between these models and children's technological play. Similarly, given the complexity associated with children's social play, studies often explore these experiences in their own right, or in relation to one element of the ecological environment (e.g. the focus on toys as presented above). Yet evidence shows that children's social play cannot be devoid of context and in many cases is part of a complex matrix of factors which shape children's experience (Arnott, 2013). A fuller framework is needed to bring together the different elements of the social context which contribute to children's digital play.

Another recent direction for research has been discussion of the Digital Consumerist Context (Edwards, 2013), which emphasises children's right to participate in the evolving digital economy. This approach describes how children's contemporary play experiences are located within a cultural historical context which affords new ways of consuming, and playing with, media. Product designers, engineers, practitioners and researchers are acutely aware of the early childhood technological 'market' and technologies are being designed with younger users in mind.

Developments in touch screen technologies, for example, have eliminated many of the early motor and dexterity challenges that children faced when using more traditional technologies. Increased policy drivers around STEM (science, technology, engineering and maths) in education and society have promoted the development of resources which seek to foster early engineers or computer programmers, such as early programming blocks (Bers and Horn, 2010). Similarly, as we move into the era of gamification of education (Nolan and McBride, 2014) and a period where creativity is valued in education and society, we are seeing an increased interest in open-world games as part of children's learning experiences in school.

All of these developments feed in to the increased focus on play-based pedagogies for developing children's use of technologies. Attention has shifted towards establishing how we can best support children in early learning and development by integrating technologies in playful ways (Bird and Edwards, 2014; Edwards, 2013; Marsh, 2010). Parents want to know how best to support their children in their technological endeavours and practitioners and teachers want guidance on how to integrate technologies into their pedagogies (Palaiologou, 2014). In early years, this has generated an interest in children's digital play.

In light of these new ways of positioning children's technological experiences, an understanding of digital play-based pedagogies is vital. In place of a deterministic perspective which views technologies as driving forces in children's lives, we need to seek to position children's technologies within contemporary socio-cultural and contextual frames. By focusing on a techno-ecological model of children's digital play, this paper offers a starting point for this process. The framework presented below offers some insights into the factors that practitioners may consider when planning for children's digital play experiences. It does not claim to offer a pedagogical model that practitioners can adopt; rather it gives an overview of key contextual and social factors that shape children's social experiences during digital play and thus offers a route for practitioners to critically reflect on these elements of the preschool context in order to inform their own digital pedagogies.

Methodology and Methods

The purpose of the study was to explore children's social experiences during their digital play in early childhood settings. This study was informed by a Contextualist perspective in the sense that it considers "phenomena as being inherently situated within context" (Packer and Scott, 1992: 108). It is therefore concerned with exploring various aspects of context as well as the relationships and connections between these aspects. Importantly, from a Contextualist perspective, the nature

of reality cannot solely be understood through a realist ontology which assumes that structures influence each other in a cause-and-effect manner. Under Contextualist thinking, reality is not 'out there' waiting to be uncovered; rather it involves a level of interpretation and construction on the part of the individual. It therefore adopts elements of relativist ontology and within this frame, multiple realities are considered to exist depending upon the 'social, economic, cultural and historic nature of the group under consideration' (Tudge et al., 2009: 118). Similarly, activities vary depending upon features of the individuals, the setting and the cultural and temporal context (Tudge et al., 2006; Tudge et al., 2009). In light of this perspective the study was guided by the question: *What ecological factors in early childhood playrooms contributed to children's social experiences during their digital play*?

Data were collected from two preschools in central Scotland. The preschools were chosen because of their different approaches to technology integration, with one nursery representing 'typical' technological provision in the area and the other involving staff who had received specific training in framing technological experiences for children. The nurseries also differed in size and available space. One offered a large open planned space, while the other offered a more cosy and confined environment for children's play, particularly as the space was divided into two smaller rooms (although free flow between the rooms was encouraged). Both settings focused on 3-5 provision and the research took place in the main playroom. Scottish Educational Research Association ethical guidelines (SERA, 2005) were followed and iterative institutional ethical approval was granted for this project.

Approximately 90 children were involved in the project, across the two settings. Data were collected across a 9-month period and the same cohorts of children were observed on multiple occasions during these visits (although different children often chose to use the resources during each visit). I visited for morning or afternoon sessions spanning 3 hours. Overall, a child-led approach was adopted where children's participation in various activities was wholly dependent on individual children's desire to take part at any given time. Children drifting in and out of researcher-led games displayed a fluid process which was typical of their early play experiences in preschool (Moyles, 2014).

Parents were not present during the observed preschool sessions but practitioners were sometimes involved in the children's play. In the majority of cases, the observation focused on child-child experiences as practitioner involvement in the play was infrequent. The researcher provided no guidance about how children should play with technologies, instead spontaneous interactions were encouraged in order to observe children's technological experiences in a naturalistic manner.

A broad definition of technologies provided the context to observe children's experiences. Children were not provided with any technological resources to use as part of the project; instead, observations were conducted around any technologies that were readily available within each setting. This meant that observations varied across the settings depending upon the technologies that were available. Table 1 demonstrates some of the technologies observed in use in the two preschools. A focal-technology approach was adopted so that observations were centred around the specific resources available for a designated time and not around case study children. This allowed for an understanding of how children's interactions and experiences continually fluctuated as children and practitioners entered and left the play space around the technology.

[[Insert - Table 1 - Technologies observed]]

Data were collected via systematic observations, cluster mapping (noting down each child's location, activity and social interaction on a classroom map), researcher-led games and interviews with practitioners. Details of each of the methods employed and the volume of data collected can be found elsewhere (Arnott, 2013). The observations and cluster mapping offered an insight into children's digital play processes. The researcher-led games had two purposes: 1) to understand children's perspectives about the structure of the setting; 2) to decipher how their experiences with technologies were shaped by the physical and social structure in place. The interviews with staff provided an alternative viewpoint on the structural systems in place within the environment, which may have contributed to children's play with technologies.

The children's digital play was observed on any occasion when children voluntarily decided to use the resources. In both settings, children were advised that I was writing a story about their play with technologies so they were familiar with my purpose, and they were asked for verbal consent for their activities to be observed and included in my 'story'. The number of observations for each child varied, dependent upon their voluntary involvement throughout the visits. This in itself provided a useful insight into their preferences for resources as well as giving some methodological insights into how to engage children in the research process.

In terms of the more structured activities (researcher-led games) children volunteered to take part. These approaches were described as games to reflect the playful nature of the data collection techniques, which were designed in a child-centred manner to mirror many of the activities that children would typically complete in preschools. They were framed to children as games and activities, not 'play' in the traditional sense which is considered spontaneous and child-led. The children were aware that completing the games meant that they would contribute to the

story about their experiences with technologies. Children could complete the games and not have their data included in the research but no children expressed this desire. The researcher was set up at a table in the middle of the playroom and children approached to ask the researcher about the game. After a brief explanation, children either opted in or out and the researcher confirmed the child's willingness to participate and to be included in the 'story'. Since participation was entirely voluntary, not all children completed the games, and so those involved in the researcher-led games were not necessarily the same as the children who were observed during digital free play.

Due to the exploratory nature of the study, iterative analysis after each session informed the next session and, where appropriate, changes were made to the data collection approach. Initial visits focused on systematic observations and cluster mapping procedures. Mid-way through data collection the researcher-led games were introduced. Interviews with staff were conducted in the concluding phases.

This project aimed to consider what factors shaped children's social experiences with technologies. Qualitative inquiry (Creswell, 2012) provided this rich data. Previous analysis of this data set focused on children's social behaviours and Broadhead's (2010) Social Play Continuum was used to code children's interactions and behaviour. This paper, however, draws on previous knowledge of pedagogies for supporting use of technologies in the early years (Plowman and Stephen, 2007) and was concerned with both distal and proximal influences on children's digital play. In addition, as the data collection progressed, the role of structure and agency within the setting became paramount. Data was stored in terms of episodes and categorised according to the three areas:

1. the role of the children as agents;
2. technological affordances; and
3. the social and cultural framing of children's activities within preschool systems.

While the themes and codes were undoubtedly influenced by my previous theoretical knowledge, the analysis for this paper was in essence grounded in the data.

Theoretical Guide to analysis

Analysis of the data for this project, from an ecological perspective, was influenced by Bronfenbrenner's ecological systems theory (Bronfenbrenner, 1994), particularly the latter developments around proximal processes (Bronfenbrenner, 1995). It was important to recognise the preschool setting as a system, with many interlinking and multifaceted components that were woven together; in this case *person* (children and practitioners), *process* (children's digital play interactions) and *context* (both physical, social and cultural). It should be noted that *time*,

Bronfenbrenner's fourth component, is not considered here as individual children were not tracked over a longitudinal period and the study did not form case studies of individual children's technology use across the project.

Ecology in this paper is used in a broad sense. The discussion is not limited to the physical space but seeks to address the interplay between the physical, social and cultural elements of the environment (physical, social and cultural). The paper moves away from the notion that technological affordances shape behaviour directly, and includes also the children's own motives and attitudes (Walmsley and Lewis, 2014), which contribute to their social interactions and experiences during digital play. Ecology here describes the overlapping and interacting elements of the preschool contexts, including agency, structure and the physical as well as social spaces that shape children's experiences with technologies.

Results and Discussion

The key findings from this project suggest that children's social experiences during digital play are shaped by two inter-connected systems which can be labelled the 'Digital Play System' and the 'Preschool System'. I begin by presenting these as two distinct systems for ease of explanation but as will become clear, these systems actually overlap and are interconnected. It is this complete system (see figure 3) that is offered as a techno-ecological framework for exploring children's social experiences during digital play.

The Digital Play System

The Digital Play System (presented in Figure 1) describes the directly observable behaviours, interactions and negotiation processes that children engaged in when using technologies. It represents the immediate and immersive context of children's digital play and begins to unpick the characteristics of children's digital play from a social perspective. From an ecological systems theory perspective, it could be viewed as one representation of the proximal processes involved in children's digital play; a microcosm of activity which occurs within the preschool microsystem. It can be thought of as a nano-system which describes children's observable digital play.

Insert - Figure 1 - The Digital Play System

Figure 1 illustrates the complex nature of children's social experiences during digital play, as observed in this study. It is essential to start by stating that children's digital play predominantly took place in clusters. Clusters are described as "multiple children standing in close proximity to the

resource and attempting to take part in some way, even if not physically controlling the technology" (Arnott, 2013: 101). Five characteristics could be used to describe the clusters:

1. Close physical proximity to a technological resource (see Table 1), although technologies could be integrated into play themes alongside non-digital resources as well;
2. Members were focused/engaged with other children in the group, the technology or both;
3. Membership was dynamic and changing with children entering and leaving;
4. Membership involved 2 or more children (typically 2-10 children);
5. Sub-clusters could develop.

These clusters were the heart of all digital play and they provided the foundation for interaction and social engagement to occur. When isolated or solitary play did occur, it lasted for a matter of minutes. The free choice nature of children's preschool day and child-centred pedagogies meant that children were quickly joined by new playmates. The clusters were therefore in a constant state of flux as children entered and left.

This continual evolution of clusters is vital to the direction of development of children's digital play experiences. When working from a Contextualist perspective, it must be recognised that the interplay between the person and context is fundamental to the progression of the play. Thus, as children bring with them very different experiences, knowledge, motivations and attitudes towards technologies, the play is continually transformed and redirected, as a result of the particular composition of the cluster at any given time. An ongoing process of negotiation between peers, and between children and technology, facilitated this continual transformation of clusters and helped to describe children's social experiences during digital play in relation to three elements:

1) The reciprocal behaviours and interactions that children exhibited;
2) Children's Social Participation; and
3) The matrix of Social Status Roles and Technological Positions which children adopted.

Reciprocal Behaviours and Interactions

Analysis of the data revealed that the children demonstrated three categories of engagement (pro-social, anti-social and task-driven), during which nine forms of social interactions and 27 behaviours/actions were observed. Broadhead's Social Play Continuum (Broadhead, 2010) was used to begin this analysis and when combined with the grounded data, Table 1 was developed which illustrates the observed engagement, behaviours and interactions exhibited. Multiple behaviours and interactions were exhibited within each observed episode as the clusters evolved and changed.

The interactions and behaviours were apparently unpredictable and no discernible patterns could be established. Nevertheless, it was possible to say that typically, children attempted to establish interactions and their experiences were predominantly pro-social. Children actively sought out interactions and they frequently exhibited helping behaviours and scaffolded their peers' learning with technology. Children rarely exhibited anti-social interactions and when negative interactions were observed they usually revolved around children's desire to establish or maintain access to the technological resources.

The variability of children's behaviours and interactions was one of the first findings that prompted the focus on the wider ecological context around children's digital play. It quickly became apparent that neither technologies nor the children in isolation determined children's social experiences during digital play.

Children's Social Participation

Despite not being able to determine a clear pattern of interactions and behaviours, it was at least possible to discern that patterns for Social Participation (Parten, 1932) could be either: fleeting, sustained or contingent on context. More specifically, it became clear that children's Solitary Play was often 'fleeting' in that it occurred often, in around 51% of focus-technology observations, but lasted for mere minutes before those children were joined by new play partners. Parallel and Associative Play was more sustained. Such play occurred less often but when it was evident it could continue for long periods. Cooperative Play however was highly contingent upon context and framing of the play experience, and was influenced by the varied elements of both the Digital Play System and the Preschool System. It was clear that multiple forms of participation could be observed within one digital play episode as clusters evolved and changed.

The finding that cooperative play was highly contingent on the play context once again led to the need for an exploration of the influence of the wider ecological context in shaping children's social experiences during digital play.

The Matrix of Social Status Roles and Technological Positions

The Matrix of Social Status Roles is discussed at length elsewhere (please see Arnott, 2013). Nevertheless, it is important here to point out that within clusters, children's ability to recognise and act upon their roles and positions in relation to the rest of the group, and in relation to the technology was one more factor which shaped how the social experiences emerged in their digital play.

Fundamentally, it was evident that children themselves had considerable agency in shaping their own digital play. Yet this agency was often constrained or moulded by the child's position in relation to the technology as well as their role within the clusters. The work of Ljung-Djärf (Ljung-Djärf, 2008) was used, and adapted, in data analysis to describe the range of technological positions assumed by children in clusters, including owner, spectator, parallel owners and mutual owners. These technological positions contributed to how they *interacted with the technology*. For example, whether the children physically controlled the resources, observed other children using the resource, or for technologies which had multiple parts and functions whether multiple children could collaboratively control the resource:

> Technologies that afforded collaborative use (e.g. the interactive whiteboard) often resulted in mutual ownership. The interactive whiteboard allowed two or more children to control the large screen simultaneously. Similarly, a nearby desktop computer powered the interactive whiteboard and enabled one child to control the computer while another operated the touch screen whiteboard at the same time. These observations suggest that, using multi-functional technologies can reduce conflict by enabling a number of children to work at the same time. (Arnott, 2013: 104-105)

Similarly, as indicated in literature on peer leadership (Parten, 1933; Shin et al., 2004) it was possible to see that in addition to technological positions, children also assumed social status roles including leader, interacting member and non-interacting member. These roles contributed to how children *interacted with peers around technology.* For example, whether they controlled and directed the other children, spoke to or gestured to other children in a more collegiate manner or whether they were physical present with no interpersonal interaction, as demonstrated in the extract of data below.

> Three boys have formed a cluster around the computer. Chris is controlling the computer by using the mouse. Harvey is sitting next to him in front of the computer and Steven is hovering close by. Harvey offers encouragement to Chris, 'You got 10!' he shouts with an excited tone. Steven becomes more and more excited with this activity and begins to show it by bouncing up and down while he stands next to the computer. He begins to cheer. Suddenly, Harvey turns to Steven and sharply says 'Shhh- Don't do that!'. Steven is immediately silent and observes quietly. (E24h, Harvey aged 4, Computer) (Arnott, 2013: 105-106)

Fundamentally, the data indicated that children assumed both technological positions and social status roles simultaneously and when combined, they influenced the degree of agency for the child in relation to the rest of the cluster or to the technology, or both, depending upon the combination adopted.

The Digital Play System: How Children Negotiate their Social Experiences around Technologies

The Digital Play System – as part of a wider techno-ecological framework –describes the kinds of social experiences that children engage with and exhibit in preschools during their digital play. It offers an insight into how children operate as part of a cluster, constantly negotiating with other children and the technologies during their play to arrive at a multitude of social behaviours and interactions; degrees of social participation; and social status roles and technological positions.

These theoretical concepts are not new, yet the assembly of this data together in relation to technological experiences, and particularly from a social perspective, is novel. It is the process of cluster development and continual negotiation between children, and between child and technology, that is significant when considering this system.

The Digital Play System presents only one element in the puzzle. It demonstrates the processes that children engage in during their digital play but in many cases, it still fails to articulate the broader ecological influences that have a bearing on how these social experiences are formed, negotiated and managed. For this perspective, we need to look beyond children's digital play within clusters, towards the wider preschool system.

Insert - Table 2 - Children's Engagement, Interactions and Behaviours as part of the Digital Play System

The Preschool System

In order to understand the dynamic nature of clusters, presented as part of the Digital Play System in the previous section, it is possible to draw on the Contextualist theoretical frame (Tudge, 2008). From this perspective the multiplicity, and the often contradictory nature, of interactions and behaviours was partly informed by a series of broader ecological factors. That is to say that the negotiation processes in clusters were sensitively framed by the elements of the Preschool System: technological artefacts; cultural systems, routines and practices; and children and practitioners as social agents (shown in Figure 2).

Insert Figure 2 - The Preschool System

Technological Affordances and Digital Play

Findings from this study suggest that the affordances of technologies provided *opportunities* for children to interact in different ways during their digital play but did not determine the play episode. For example in some cases the physical properties of the technology were linked to the various technological positions that emerged. Importantly, in many cases, the affordances of the resource had both positive and negative influences for children's digital play. For example, the limited availability of resources in the playroom or the use of resources designed for individuals (such as desktop computers) encouraged children to share the resource and help their peers. Several instances of scaffolding and Guided Interaction (Plowman and Stephen, 2007) were observed between peers when using technologies. In some cases, the increased challenge associated with the technological toys contributed to the need for scaffolding and helping interactions. For example, an experienced peer familiar with a game may demonstrate or explain to another child how to succeed as shown in the extract below:

> Grace begins to use the SMART board and Chris begins to use his finger to point at the screen to illustrate which selection she should choose as he verbally directs. Chris continues this process for each step of the way and Grace obeys. Then, when the game reaches a section where Grace does not need to make a selection and she needs to wait, he holds up his hand and says, "now wait".

(E50h Chris and Grace both age 4, SMART Board)

Often the technologies required specific knowledge and skills that developed over time. As children reached the middle of the preschool year, those who regularly used the technologies quickly acquired this knowledge and skill and became expert users. Free choice in the playroom then

allowed children to develop clusters as part of the Digital Play System and the combination of cluster development and children operating as experts provided *opportunities* for peer support and scaffolding. The helping interactions were often facilitated by the structure of the preschool culture, which encouraged turn-taking and sharing as part of the preschools' 'golden rules'.

On other occasions, the limited availability of technologies (for example, only one computer being available) or the affordance of 'isolate' resources (i.e. the computer being a personal device, or an individual mobile telephone) encouraged negative interactions and some children fought to gain access to the resource. Yet these instances were minimal and in most cases, children were skilfully able to manage and defuse the situation by referencing the rules and regulations embedded in the preschool context. There were few instances where practitioners had to step in to defuse the situation.

In the very brief examples above, it was possible to discern that varied interactions occurred around the same technologies, depending upon how the children negotiated the situation. In these cases, the affordances of the resource had a role to play in the development of digital play from a social perspective but they did not determine how the play experience would evolve. Indeed, technological affordances were only equally as influential as the cultural systems in place within the preschool and how children and practitioners operated as active agents in the system.

Systems, Routines and Practices in Digital Play

The preschool system and culture contributed to the evolution of children's social experiences as they used their knowledge of the system, routines and predefined appropriate practice as reference points to guide their digital play when negotiating within clusters. Often children used technologies on their own, suggesting that potentially children's digital play is more 'free' than other activities. Yet, while the majority of observations in this project did not involve a practitioner in a proximal manner (Plowman and Stephen, 2007), the distal influences on children's digital play were abundantly clear. Children operated within the confines of a system of well-framed and regulated practice. These settings were social places where practitioners, either implicitly or explicitly, directed children's behaviours, social interactions and how resources were used. The lack of direct involvement by practitioners did not therefore unburden children from the confines of the preschool system during their digital play.

The system was facilitated by the ongoing development and reaffirmation of hierarchical power constructs, with adults and practitioners maintaining an authority that is absolute and unquestioned (Laupa, 1994). Practitioners purposefully construct this power disparity, which contributes to

children's everyday experiences, because it is through the construction of a system of mutually accepted practice, behaviours, routines and rules, that practitioners are comfortable 'affording' children freedom in their play. Thus, in order to give children agency in a world where practitioner accountability is high, practitioners first need to be confident that the children are both safe and capable of managing their own digital play experiences; they develop this confidence by instilling rules and routines.

In order to explain this it is useful to draw on Bernstein's theory of Pedagogic Discourse. It became clear that inducting children into the rules and regulations of the preschool helps to create 'strong framing' through a strong 'regulative discourse' which creates a visible pedagogy for children to follow (Bernstein, 2004). Bernstein argues that with a visible pedagogy, children are aware of the criteria of the discourse.

Nevertheless, children were not entirely devoid of agency, indeed they were able to experiment with the Preschool System, often pushing boundaries, reinterpreting or manipulating the structure. For many practitioners or on-lookers, the pushing of boundaries could be viewed as simple rule breaking, not understanding the rules or defying authority in a negative manner. Yet closer reflection on the data suggested that this process was a very sophisticated element of their negotiation processes within clusters during their digital play, and was not due to lack of understanding on the part of the children. In many cases, children were acutely aware of the expectations of behaviour, practice and play which afforded them the opportunity to find loopholes in the structure. Children, although aware of the adult rules, were able to negotiate their own culture and rules of social order. Thus, analysing the way children invoke or bend rules in the playroom helps to explore "the cultural resources to which members orient in order to make sense of their social worlds" (Cobb-Moore et al., 2009: 1478). This leads us to explore the role of children and practitioners as social agents.

Children and Practitioners as Social Agents in Digital Play

Data collected in this study emphasises the role of the children and practitioners as social agents during digital play. The previous sections have talked extensively about how individuals within the social context shape their own, and others', digital play experiences. Children exhibited their agency in two ways.

1) By assuming various social status roles and technological positions
2) By engaging in negotiation across and within clusters.

Similarly, practitioners exhibited their agency through the development of a system of routines, rules and regulations which are managed and maintained by constructing a power hierarchy between adults and children. Digital play is therefore influenced by the ways in which children and practitioners draw on the various technological affordances and the systems, routines and practices in the environment to make and shape decisions. Children and practitioners actively decide on a course of action in relation to these broader ecological factors, which culminates in their social experiences during digital play.

It was possible to see that children's decision-making within clusters had a considerable influence on their digital play experiences. Children actively sought out interactions with technologies, inviting others to join them in their play, offering help and feedback or just generally becoming a member of the cluster, for example. The decisions they made were informed by a series of interwoven elements. For example, increased challenges associated with technological artefacts at times encouraged requests for collaboration and help. Children were also able to use the cultural systems in place within the preschool as a reference to guide their interactions but equally, at times, they decided to circumvent or bend this system. Thus, their interactions were never consistent or predictable because the context in which they were playing was variable and inconsistent. Ultimately, children drew on the various interlinking elements that framed their digital play to decide on a course of action. Thus it is clear that the two systems presented in the techno-ecological framework - the Digital Play System and The Preschool System - are interlinked.

An Ecological Framework of Children's Social Experiences during Digital Play

The findings from this study offer a new perspective on children's digital play. When the two systems are combined, we are able to see their interdependence, which led to the techno-ecological framework presented in Figure 3.

Insert - Figure 3 - An Ecological Framework of Children's Social Experiences during Digital Play

Here we can see that children engage directly in the Digital Play System where they exhibit a variety of behaviours and degrees of social participation as well as assuming various technological positions and social status roles. All the while, the elements of The Preschool System – the technological affordances, the other agents in the preschool space and the cultural context - encircle children's play practices in the Digital Play System, subtly shaping, altering and framing the social experiences of children. Likewise, children's negotiation processes within the Digital Play System help The

Preschool System to evolve. This relates to Stephen and Brown's (2004: 329) description of insiders who 'construct knowledge about the playroom as they participate in and, to some extent, shape that reality'.

It is not possible to attribute children's social experience and digital play to any one element of the framework in isolation. We need to understand that the ecology is a dynamic system in order to better understand how we can shape and facilitate high quality social and digital play experiences in preschools. This argument generates three important points to consider when trying to understand how technologies shape and contribute to early childhood practice.

1) Technologies are not omnipotent, deterministic artefacts that direct, scaffold or 'teach' children, particularly in relation to social development and social experience.
2) Children's digital play is complex but not entirely unique to other forms of play; particularly when technologies are integrated into children's experiences as part of well-established playful pedagogies and are utilised as tools within the play rather than the central play experience (Arnott, 2016).
3) Technologies form one element of a multifaceted and interconnected ecological preschool system. It is the interplay around The Preschool System, and across the Digital Play System, that results in observable social experiences during digital play.

From this, it is possible to say that practitioners need to carefully construct playful experiences in a manner that positions technologies as facilitating or contributory tools that may enhance the play, rather than viewing digital play as a central activity in itself.

Similarly, we need to consider that children draw on these various parts of the ecology as reference points in their play, which can lead to helpful negotiation processes during digital play. Literature on the structured nature of children's experiences in early childhood settings is widely available (Jordan et al., 1995). A paradox is often evident because early childhood education is portrayed, in theory, as a particularly child-led experience. In reality, however, children's lives are always rule bound, governed by adults in an authoritarian role and framed by a system of routines and 'appropriate practices' (Alcock, 2007). As with many experiences in early childhood, it is the process which is fundamental to children's learning rather than the outcome of the digital play episode. This model demonstrates the factors which shape this process of negotiation and social experience and allows us to begin to understand how our agency, technologies and cultural context shape children's digital play. Not only can practitioners use this model to critically reflect on their own practice to inform planning but researchers are able to engage with the theoretical foundations which inform the framework to better decipher how children's play is evolving in the digital age.

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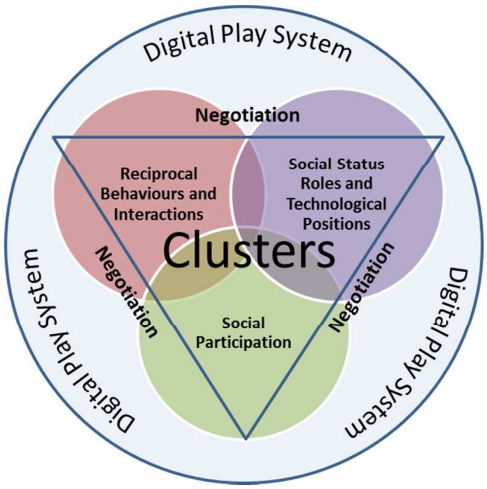

Figure 1 - The Digital Play System

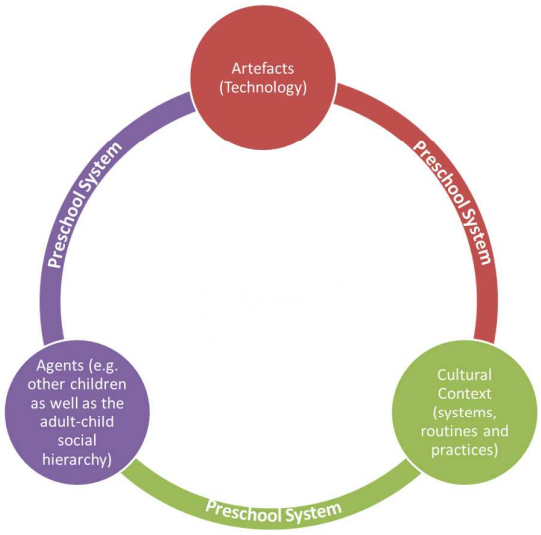

Figure 1 - The Preschool System

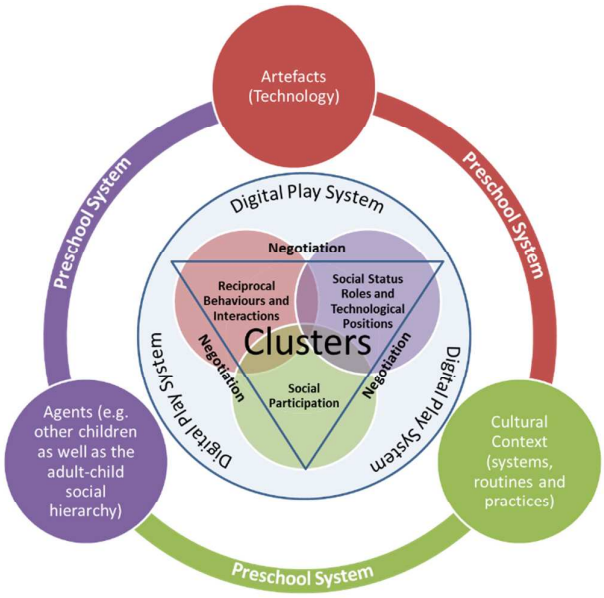

Figure 1 - An Ecological Framework of Children's Social Experiences during Digital Play

Technology
Computer
Interactive Whiteboard
Leappad
Laptop
Alphabet Board
Electronic Bus
Electronic Road
Fire Truck
Landline Telephone
Microwave
Mobile Telephone
Shopping Till
Hair Straighteners
Washing Machine
Digital Cameras
Metal Detector
Fairy Lights
Calculator
Exercise Equipment
CD Player
Musical Keyboard
Tape Recorder
Duplo Techs
Tool Box

Table 1 - Technologies observed

Engagement	Interactions	Actions and Behaviours
Pro-social (Peer Driven) Engagement - *Children were focused predominantly on being involved with other children during the activity and observably contributed to the cluster.*	**Sociable Interactions –** *The child attempts to have an extended interaction with other cluster members and may favour interaction with peers rather than with the technological resource.*	• Extended verbal exchange • Standing/sitting in close proximity to peers • Acknowledging or noticing other children by smiling or nodding • Verbally making their presence known • Verbal Invitation to play
	Sharing Interactions – *The child allows their peers to use resources alongside them or instead of themselves.*	• Allowing others to control the technology (reqlinquishing control) • Offering and receiving objects
	Supportive Interactions – *The child offers, receives or seek encouragement, urging the activity to continue*	• Receiving approval or praise from a peer • Offering approval or praise to a peer • Seeking praise or attention
Anti-social Engagement – *Children were focused on interacting as little as possible with peers and at times actively rejected any interactions.*	**Unsociable Interactions –** *The child actively discards attempts by peers to interact in any form.*	• Ignoring others • Verbally rejecting invitations or help • Walking away
	Hostile Interactions – *The child is violent and angry either verbally, physically or both.*	• Verbal abuse • Arguing • Misleading/'tricking' peers • Pushing
	Possessive Interactions – *The child is reluctant to share the resource and makes every effort to be in sole control of the technology.*	• Taking objects followed by an altercation • Hiding/covering technology
Task- Driven Engagement – *Focused on completing the task, which may include reaching the end of a level in a computer game, taking part in role-play with technologies or building a completed and functioning remote controlled car using Duplo Techs. The important thing, which*	**Helping Interactions –** *children demonstrated or directed the child how to complete the task*	• Demonstrating how to succeed/Modelling • Physically Helping • Verbally directing • Listening to peers

distinguishes these interactions from others, was that task completion was the goal, irrespective of whether children were controlling the technology	**Exploratory/ Investigatory Interactions –** *attempts to obtain knowledge*	• **Verbally Requesting Help** • **Q&A** • **Explaining** • **Observing task**

Table 1 - Children's Engagement, Interactions and Behaviours as part of the Digital Play System