Extending on Our Understanding of Digital Play: Children Co-designing Apps for Children

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Extending on Our Understanding of Digital Play:

Children Co-designing Apps for Children

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Abstract

Understanding the intricacies of digital play and its role in early childhood is complex given that adults drive the design, development and distribution of children's access to digital technology. The lack of representation of children's perspectives of digital play suggests that current understandings of children's play with apps is limited. This study is situated as part of a larger research project, “Conceptualising digital play: The role of tablet technologies in the development of imaginative play of young children” (ARC DP140100328). In the larger study, the multiple perspectives of families, educators and young children is the premise with which a holistic understanding of digital play is formed.

This thesis reports on the unique perspectives of children with emphasis on their experiences of engaging with digital play in apps from a very young age. It adopted a Design-Based Research (DBR) approach to explore children’s perspectives of digital play and to add their perspectives to the existing criteria for quality digital play. The study draws on children's rights methodologies combined with participatory methodologies adapted from computer-child interaction (CCI) to engage six children aged five to seven years as members of a Children's Research Advisory Group (CRAG) and four preschoolers aged two to five in the co-design of an iPad app for preschoolers. The primary roles of the CRAG involved them as co-researchers and co-designers. As co-designers, the CRAG performed the role of technology design partners in iterative cycles of co-designing and redesigning an app for preschoolers. As co-researchers, the CRAG collected data on the preschoolers' views and opinions as they played with the app during a series of Digital Playgroup sessions.

The study contributes valuable approaches for obtaining children’s perspectives of digital play experiences. Co-designing and redesigning the app over ten research sessions
provided the children with space and opportunity to express their views. The facilitation of children’s voices supported their understanding of interactivity to identify motivational features of apps suitable for preschoolers and to distinguish features which they perceived were vital elements for the design of digital play. The children developed an awareness that they have an audience for their views regarding digital play through their role as design partners. Collaborating with an adult to develop an app empowered the children to influence their digital play experiences. This inquiry offered children a medium with which they can form a better understanding of their everyday experiences and the world around them.

New and complementary insights into a set of design principles for preschooler apps from the perspectives of children is presented based on the analyses of data. Meaningful explorations of digital play allow children to gain a sense of control through the choices made available to them in play. Design features which offer interactivity, discovery and exploration permit children to represent themselves and reflect on their experiences. Enabling the blend of digital play with children’s non-digital play means that digital play experiences can build a sense of agency and promote positive experiences especially when these relate to the individual contexts of children’s lives. A wider analysis of children’s perspectives on digital play is recommended to reveal the advantages and limitations of digital play in children’s development. Further, obtaining children’s perspectives can impact on the quality of future digital play experiences for children.
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Certification

I, Maria Clara Selina Rivera, declare that this thesis submitted in fulfilment of the requirements for the conferral of the degree, Doctor of Philosophy from the University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

__________________________

Maria Clara Selina Rivera

31 March 2020
List of Names or Abbreviations

**ARC**: Australian Research Council

**CCI**: Child–computer interaction

**COW**: Computer on wheels

**CRAG**: Children’s Research Advisory Group

**DBR**: Design-based research

**DCC**: Digital Consumerist Context

**EYLF**: Early Years Learning Framework

**GUI**: Graphical user interface

**HCI**: Human–computer interaction

**MIT**: Massachusetts Institute of Technology

**UNCRC**: United Nations Convention on the Rights of the Child

**ZPD**: Zone of proximal development
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Chapter 1
Introduction

Overview

The proliferation of digital technology in modern everyday life means children are increasingly utilising digital technologies available to them in the context of their families and homes. Current statistics indicate that 89% of children aged five to eight years old engage with digital technologies (Australian Bureau of Statistics [ABS], 2019), demonstrating that access to technologies for all young children as a form of recreational activity for children is commonplace. Particularly, technology is the most popular recreational activity for children from five to 14 years old (ABS, 2019).

Over 75,000 of the 1.4 million digital applications (apps) available from the App Store™ are classified as educational (Apple, 2016). Eighty percent of these educational apps are targeted at children and 90 percent are recommended for children under five years of age (Vaala, Ly, & Levine, 2015). These statistics indicate the expectations around children’s practices when engaging with digital technologies, though their “educational” value is arguable as apps tend to reinforce skills through rote learning involving repetitive drill and practice activities, which are not suitable for the play-based pedagogy of preschool settings (Goodwin & Highfield, 2013).

Children’s engagement with technologies for play has been defined as a “qualitatively different form of play”, warranting an ongoing investigation into its role in the lives of young children (Salonius-Pasternak & Gelfond, 2005, p.6). Over the past decade, the term “digital play” was introduced to capture this new phenomenon; however, its meaning varies with the context of its use (Edwards, 2014; Bird & Edwards, 2015; Marsh et al., 2016). In this research, the term is defined as preschoolers engaging with applications for digital tablet technologies for recreational purposes (Verenikina, Kervin,
The design of apps significantly influence the type of activities and experiences in children’s digital play (Hirsh-Pasek, et al., 2015; Marsh et al., 2015; Verenikina & Kervin, 2011). While certain apps are known to limit imaginative play (e.g., Marsh, et al., 2015; Schuler, Levine & Ree, 2012) and constrain opportunities for interaction (Verenikina, Siraj & Kervin, 2018), a play-based investigation of children’s digital play reveals its affordances. For example, the use of some apps in playful contexts was found to be supportive for children’s sense of agency (Burke, 2010; Edwards, 2014), meaning-making (Kervin, 2016) and engaging with symbolic meaning (Marsh et al., 2015; Verenikina, Herrington, Peterson & Mantei, 2010).

Recent studies in disciplines of early childhood learning and development and child-computer interaction (CCI) have investigated the characteristics of apps which are conducive to children’s learning and development. A multidisciplinary literature review (presented in Chapter 2) identified a number of major themes regarding the design features for apps aimed at young children. By and large, these themes have emerged from qualitative research conducted from adults’ perspectives. This study attempts to interrogate the role of adult perspectives in forming new understandings and recommendations regarding children’s use of technologies. There is a demand to understand the role of digital play in the lives of children. This is particularly important given that adults often create the opportunities for digital play (e.g., app development) and determine recommendations through policies in early years. To build our understanding of digital play, children should be offered opportunities to give feedback, direction and critique.
Purpose of the Inquiry

The purpose of this study is to extend existing understandings of the roles that digital technologies have in the lives of young children through children’s perspectives. The aim of the study is to obtain children’s views as they engage in the co-design of an app targeted at preschoolers. The process of co-designing an app for preschoolers allows the children to explore and describe their understanding of preschooler apps, offering opportunities for children’s perspectives to contribute towards a set of design principles for the design of preschooler apps.

Research Questions

This study is guided by the following overarching research question:

*How are design principles for preschooler apps influenced by children as co-designers and co-researchers in the development of an app?*

This research question is further explored through two sub-questions:

1. How do the children’s perspectives contribute to design principles of apps for preschoolers?
2. What processes do the Children’s Research Advisory Group (CRAG) enact as they co-design and trial an app for preschool children?

Significance of the Study

This research investigates the phenomenon of digital play from children’s perspectives. It obtains children’s understandings of digital play by engaging them in the process of co-designing an app for preschooler. This research offers contributions to a theoretical understanding of children’s digital play with apps and offers a methodological contribution in terms of obtaining children’s perspectives of digital play. It is expected that the findings of this study will have significance to children, families and the field of early childhood education in regard to digital play practices within the home and learning.
environments and in the development of policies which aim to inform these practices.

*For children:*

This research offers children a unique opportunity to share their views regarding digital play and to appreciate the influence of their ideas on their own digital play experiences. The opportunity to give feedback, direction and critique on the design of apps is valuable considering that majority of app design and children’s access to technologies is often driven by adult concerns. Moreover, the children have an opportunity to gain a better understanding of the world around them as they offer their insights into aspects of digital play that are meaningful to them.

*For research:*

The approach employed for obtaining children’s perspectives of preschooler apps reveals valuable methodological considerations. The involvement of children as design partners and co-researchers facilitates children to reveal their insights into digital play with preschooler apps. The design-oriented study creates a space in which children can express their voices through a range of activities such as informal conversations, production of artefacts and drawings. The findings from this study indicate that the use of rights-based methodologies in obtaining children’s perspectives has implications for developing existing understandings of digital play.

*For practice and policy:*

Positioning children as experts of digital play enables them to offer significant contributions to a holistic conceptualisation of digital play with apps. Considering that the experience of engaging with digital technologies for play is distinct to this generation of children in their early years, children’s contributions to the design principles for preschooler apps can inform practices and policies in relation to children’s use of technologies. Government policies such as the Department of Health’s 24-Hour
Movement Guidelines for the Early Years assign the use of technology as a detrimental factor to children’s health and well-being while the Department of Education’s Early Years Learning Framework sets out guidelines which include the integration of digital technologies within a play-based curriculum for learning in the early years (Commonwealth of Australia, 2019; 2009). While the former is based on popular discourses which focus on the protection of children from harm (Lievens, Livingstone, McLaughlin, O’Neill & Verdoordt, 2018), the latter acknowledges the benefits of engaging with technologies in early childhood. The advantages of engaging with technologies is further addressed within the Statement on Young Children and Digital Technologies (Early Childhood Australia, 2018), which recommends specific practice advice for early childhood educators encompassing the different implications that technologies have on children’s relationships with others, the development of their sense of citizenship, and children’s learning, development, health and wellbeing. Such government policies and guidelines play an integral role in identifying quality and informing children’s everyday digital play practices.

The aspects of digital play that children consider valuable was highlighted through the study’s engagement of the often-unheard voices of children. These findings offered validations and refinement to principles for the design of preschooler apps. Such theoretical implications contribute to ongoing research in relation to children’s use of technologies which can inform government policies and guidelines especially since these have significance towards children’s access and habits of practice when engaging with technologies. Furthermore, validation and refinement of our understandings of preschooler apps can support families, educators and designers in the evaluation and selection of preschooler apps and in defining quality in current and future forms of digital play experiences.
Methodology

The study is organised around a design-based research (DBR) methodology, suitable for researching the design of an app for preschoolers with children and researcher as co-designers (Bakker & van Eerde, 2013). Traditionally, DBR methodology in education include the design, development and evaluation of teaching and learning materials including technology products. Utilisation of a DBR methodology in this research provides sequential cyclic steps for framing the work towards understanding children’s perspectives on the design principles for an app for young children.

This research is situated within a qualitative paradigm, allowing for the investigation of digital play from the perspectives of children. Qualitative research permits the exploration of a problem from the voices of participants who are not represented in literature and empowers individuals to share their views (Creswell, 2013). Qualitative research, in the case of this study, allows for the exploration of the contexts of children’s digital play and children’s understandings of design features of preschooler apps to inform a set of design principles for preschooler apps.

To facilitate the expression of children’s views regarding digital play, this research draws on children’s rights methodologies (Lundy & McEvoy (2011), both conceptually and methodologically. Conceptually, a Model of Participation is used to ensure that children were provided with “space” to develop and form their views; that their “voice” is encouraged and supported to enable their views to be expressed, that their views are communicated to an “audience” and that these views are acted upon and have visible effects (“influence”) (Lundy, 2007). Methodologically, the participation of children as co-researchers is established through the “Children’s Research Advisory Group” (CRAG), which meets with the researcher in a number of sessions to develop, express, communicate and implement their views.
The children’s rights research methodology is complemented by methodological approaches to children as design partners from the research in discipline of child-computer interaction (CCI) that involves children as co-designers or design partners (Druin, 2002; Markopoulos & Bekker, 2003). This allows for the engagement of young children as design partners in co-designing an app for preschoolers using particular techniques of designing and evaluating products (Read & Bekker, 2011; Sim & Horton, 2012). Thus, this methodology assists the researcher in involving children in making and expressing their design decisions for creating prototypes of an app for preschoolers.

The theoretical and conceptual underpinning of this study is expressed by conceptualising digital play through the development and refinement of a set of design principles for the design and development of apps for preschoolers. The close interrelations between theory and practice in DBR (McKenney & Reeves, 2019) are suitable for the extension and enrichment of current design principles in literature with children’s perspectives.

**Personal Orientation to the Study**

Children’s use of technology to explore their own interests through design experiences forms the foundation of my work with children, which began 15 years ago as a coordinator at the Computer Clubhouse based along Ireland’s Peaceline communities in Belfast. Children’s activities revolved around their engagement in a range of design experiences such as making computer games, robotics with LEGO Mindstorms™, digital art, photography, film and animation. The Computer Clubhouse Network, in collaboration with the MIT (Massachusetts Institute of Technology) MediaLab, founded this initiative to provide access to technology for young people in underserved areas with the aim that children and young people will develop technological fluency as producers of digital content rather than consumers (Resnick & Rusk, 1996b). The Clubhouse’s
ideals built on children’s interests, seeking to engage them as active participants in their role as designers and creators. I was privileged to witness children develop a sense of ownership, not just of the products they designed, but also of knowledge in areas of interest that may not have been otherwise available to them. The constructivist theories promoted in the Clubhouse environment emphasised the use of technology to develop creative thinking in children. The interactions that occurred in the Clubhouse were developed in an environment in which children and adults treated each other with respect, learned from each other and enabled children to develop a deeper understanding of technology and its role in their lives (Rusk, Resnick & Cooke, 2009).

I complemented my work at the Clubhouse with further studies into the development of educational multimedia resources, during which study it became evident that existing interactive educational resources such as internet pages and CD-ROMs presented static information that did not seem to reflect the same rich practices exhibited by the children’s experiences in the Clubhouse. A growing understanding of the effects of software design on children’s development had begun. While common drill and practice software applications did not afford children opportunities for developing socially constructed knowledge, the potential of computer games to support the cognitive development of abstract thinking was identified (Peterson, Verenikina, & Herrington, 2008).

The early years of mobile technologies and proliferation of educational apps marketed to young children coincided with my entry into the field of education seven years ago. The learning-by-doing approach adopted by the Clubhouse for children aged 10 and above bears a strong pedagogical approach to the concept of young children under the age of five learning to use technology through play in early childhood (Bird & Edwards, 2015). The freedom to explore technology and how it functions eventuates into more creative exploration, enabling children to exhibit imaginative play and develop creative thinking through their engagement with digital technologies. The educational value of children’s
play with apps is queried, especially when the majority of apps seem to focus on digitised reproductions of drill-and-practice worksheets especially even though apps can actively engage children in authentic learning situations and encourage the formation of socially constructed meanings (Hirsh-Pasek, et al., 2015). Children’s play with apps can be supported by design features that facilitate young children’s engagement in self-initiated exploration, which motivates the development of imaginative play (Verenikina & Kervin, 2011). Further, it had become evident to me that the pedagogical role of an educator was crucial in environments wherein children engaged with technologies. Interactions between adults and children are central in extending the thinking of children during digital play (Verenikina, Siraj & Kervin, 2018), just as the Clubhouse environment valued the interactions among the children and adults (Resnick & Rusk, 1996a). As an adult within a child-centred environment, my role as an educator, parent or researcher dictates that I do not merely transmit knowledge to children but have a vital role in supporting interactions wherein children are enabled to develop their own understandings and make sense of the world around them. This requires skills and experience to actively listen to children.

**Locus of the Study**

This study is situated within a larger research project funded by the Australian Research Council (ARC) Discovery Project (ARC DP140200328) — “Conceptualising Digital Play: The Role of Tablet Technologies in the Development of Imaginative Play of Young Children” — which explores the multiple perspectives of families, educators and children. This doctoral thesis reports on the exploration of children’s perspectives and contributes to the findings of the ARC-funded project.

**Participants**

The CRAG consisted of six children between five and seven years old. Their participation in the study engaged them in the dual roles of co-designers and co-
researchers. They were involved in generating and refining design ideas for an app for preschoolers.

The children participants were recruited from the families participating in the larger ARC project. This sampling method ensured that the participating children met the criteria of prior access to and engagement with mobile technologies for play. Additionally, this method of recruitment allowed the researcher to develop a relationship with the families and build a rapport with the young children, both of which are essential elements in obtaining children’s perspectives.

**Site**
The Playful Learning Space within the Early Start facility of the University of Wollongong was the selected site for the study. The Playful Learning Space is an early childhood facility with child-friendly furniture that also functioned as the site for the Digital Playgroup sessions conducted as part of the larger ARC project. Retaining the same venue for this study meant that the families and participating children associated this site as a space for exploring digital play.

**Definition of Key Terms**
This study uses words and terminologies that may have specific meanings to the context of young children’s development and software design. As some of these words may herein adopt different meanings to their common uses, key terms are defined below. Including the definitions of these words and terminologies is important to ensure that readers have a complete understanding of the research being reported (Creswell, 2009).

*app*
An app refers to a computer program designed to run on mobile devices such as touchscreen tablets, mobile phones and similar devices. The word “app” is a shortened
terminology for computer or software applications accessed on mobile devices. Apps can have a range of features depending on their designed functions. For example, some apps include features that records the voices of children and repeats their spoken words back to them using a synthesized voice for a character. In this study, children engaged in identifying design features of apps that they selected to play with and identified typical design features of apps for preschoolers.

**App Store ™**

Apps that are not pre-installed on devices are available through distribution platforms typically operated by the owner of the operating system that runs the mobile device. In this study, the App Store is referred to since the co-designed app was developed to be used with an iPad, the touchscreen tablet manufactured by Apple. The App Store is Apple’s distribution platform for apps that run using Apple’s iOS operating system.

**Child-computer interaction**

CCI is an area of study within the field of HCI. HCI, described in more detail below, aims to evaluate and understand people’s use of interactive technologies and how these interactions evolve. CCI focuses on children’s engagement with technology with the aim of developing methodologies for the design and evaluation of technology (Read & Bekker, 2011). Participatory methodologies employed in CCI have influenced the involvement of children in this study as co-designers or design partners in the development of an app.

**Children’s rights methodologies**

Rights-based research is influenced by the United Nations Convention on the Rights of a Child (UNCRC) and theories on the sociology of childhood that recognise children as experts of their own lives. Children’s rights methodologies refer to the methodological and ethical issues surrounding the participation of children in research, which include
gaining the consent of children to participate in research, the types of data collection used to obtain the perspectives of children and the protection of their confidentiality (Fargas Malet, McSherry, Larkin & Robinson (2010). Children’s rights methodologies held a principal role in the study’s approach to obtaining children’s perspectives of digital play with preschooler apps.

Co-researchers

The meaningful engagement of children in research is achieved by their level of participation in the research process. An emphasis on conducting research with children rather than for children has paved the way for involving children as co-researchers (Alderson & Morrow, 2011). Children as co-researchers may be involved in one or more stages of the research process: identifying research questions, contributing towards the study design, influencing and leading the collection of data, interpreting the data and disseminating the study’s findings (Bradbury-Jones & Taylor, 2015). A group of children participated in this study as co-researchers. They were involved in shaping the design of the study, guiding the research questions and leading the collection of data for the phase in which another group of children, the preschoolers, were involved as participants of the study.

Co-designers

Involving children as co-designers or design partners in the development of technology was identified as an ideal methodology for exploring the relationship between children and their interactions with technology. As co-designers and design partners, children and adults work collaboratively through the different stages of co-designing a product, from generating ideas to testing prototypes.

Children’s Research Advisory Group

Children’s role as co-researchers can be supported by establishing a CRAG (Lundy &
McEvoy, 2011). As members of a CRAG, children hold a position of expertise within the specific role they undertake as co-researchers. As detailed earlier, the CRAG in this study guided the design of the study, the research questions and the collection of data when engaged in the observation of another group of children, the preschoolers who interacted with the co-designed app as participants in the study.

Design-based research

DBR, in the context of educational research, is a methodological approach that explores an educational problem then presents a resolution that is tested and evaluated over cycles of iteration (Bakker, 2019; McKenney & Reeves, 2019). The findings of DBR offer both theoretical and methodological contributions. Theoretical understanding is derived from the empirical findings of a DBR study, while the iterative testing of solutions develops an intervention or educational product that is designed for actual use (McKenney & Reeves, 2019). This study employs a DBR approach to obtain children’s perspectives of digital play. The theoretical understanding of children’s digital play is validated in the analysis of findings throughout the iterative cycles. The methodological approach for obtaining children’s perspectives is refined throughout the study.

Design partner

Design partner is another term for co-designer. Children were involved in this study as design partners or co-designers with an adult in designing an app for preschoolers.

Digital play

Digital play refers to children’s engagement with technologies in early childhood research (Edwards, 2013; Marsh, et al., 2016; Stephen & Plowman, 2014; Verenikina & Kervin, 2011). Studies regarding children’s experiences of digital play have emerged with the increasing access that young children have to digital technologies for play. As a recent phenomenon, digital play and its role in young children’s lives is yet to be fully
understood. This study explores the conceptualisation of digital play from the perspectives of children.

Feedback

Interactions with technology require a response from the computer program or app in question after it receives input from person using it. Feedback refers to the programmed response. Feedback from a computer or an app can be exhibited visually through images, icons, text, animation, video or through sound. In this study, children’s engagement with the interactive features of apps include a description of the feedback expected from apps.

Human-computer interaction

HCI is a field of study that explores the interactions between humans and technology. It was initially incorporated in the field of computer science, cognitive science and human factors engineering, exploring the interactions between people and their use of computers (Carroll, 2013). HCI is a dynamic field of research that has now expanded to explore the design of all types of information technology, including the internet and mobile technologies, within multidisciplinary fields. Currently, the three areas of exploration in HCI involve the exploration of human interactions with technology, human interactions via technology and the incorporation of computers into human habitats such as cars and home appliances (Carroll, 2013). In this study, HCI is referred to when describing the field of research that explores user interaction with technology.

Hypertext markup language

(Hypertext markup language) HTML is the standard markup language used to script the display of pages on the Internet. HTML pages are stored on a web server and are accessed via web browsers (e.g., Safari, Google Chrome or Firefox). The web browsers display the HTML pages, which are connected to each other through hyperlinks. HTML relies on the semantic description of the structure of each page, detailing how images,
text, links and any embedded multimedia format appear on the screen. In this study, HTML was used by the researcher to demonstrate the concept of interactivity of the children’s design ideas. Note that the HTML designed pages were not available on the internet and were stored within a local server. The participants in the study had access to and interacted with these pages at the time of data collection.

*Input*

The input from a person operating a computer or interacting with an app generates a programmed response enabling interactivity in the use of computers and mobile devices. The types of input recognised between a computer program and an app have both distinct differences and similarities. The input from a person or user operating a computer typically involves the use of a mouse, trackpad or other pointing device to click on the screen interface. The input from a person or user operating a mobile device typically involves touchscreen gestures such as tapping or swiping on the screen. Typing on a keyboard to enter text is another common type of input recognised by computers and mobile devices. For some computer programs and apps, voice recognition is identified as input from the user.

*Interactive / interactivity*

Interactive devices and interactivity in the use of devices and computers refers to the two-way flow between the human (user) and the device or computer. The user input triggers a programmed response from the device or the computer. This study demonstrates children’s understanding of the interactive features utilised in the design of apps.

*Interface*

The interface of an app or computer program refers to graphical user interface (GUI). GUI allows users to interact with devices and computers using icons. This is considered to be more user-friendly than text-based interfaces, which require typed line commands.
For example, opening an app or a software application usually requires a double tap or a
double click of a mouse. A typed line command for the same action is achieved over three steps. The user is required to type the command to display the files of a directory,
type a command to show the files within that directory, then type a command to open the program. As text-based interfaces are no longer commonly used, the design of interfaces referred to in this study pertains to children’s use of graphical interface in the design of apps.

Navigate

The term “navigate” is used in computing to describe a user’s input to move from one linked page to another in a website or to move from one section of an app or piece of software to another. Children’s navigation of apps is referred to in this study when describing interface designs that are suitable for children.

Preschooler

Early childhood development in Australia encompasses the development of young children aged zero to five years old (Commonwealth of Australia, 2009). Toddlers, aged between three and five years old, are also known as preschoolers and are identified as the age bracket prior to the commencement of formal schooling. The members of the CRAG in this study were aged five to seven years old. They reflected on their digital play experiences of apps designed for preschoolers. The CRAG also acted as co-researchers in observing a second group of participants who were aged three to five years old. The preschool-aged children were observed as they interacted with an app that was co-designed for preschoolers by the CRAG and the researcher.

User

The user of technology is the person operating the computer or device. In this study, the children interacting with the apps may be referred to as users in regard to the interactions
between the children and apps.

Limitations

This research was limited by the small number of participants and its focus on the use of tablets and iPads to represent children’s digital play. The small number of children who participated in the study come from a specific social and cultural context within Australia. The views and experiences that have informed their ideas are not representative of all children’s perspectives of digital play with apps; therefore, the findings cannot be generalised in this manner. However, the number of children participating in the study was appropriate for the qualitative methods used, which gathered the perspectives of children via multiple forms of data collection and involved complex data analysis (Creswell, 2013).

The study acknowledges the rise in children’s use of tablets and iPads™ since its inception in 2010 (Soni, Aloba, Morga, Wisniewski & Anthony, 2019). Therefore, the exploration of children’s digital play experiences in this study was limited to children’s play with apps. Additionally, the perspectives shared by the children were possibly limited by their own experiences of digital play with apps.

The time constraints involved in conducting the study meant that the children were involved in shaping the study design and data collection but not necessarily in the analysis and theoretical reflection of the design principles for preschooler apps. Obtaining children’s perspectives indicate that at a highest level of participation, children have the autonomy to initiate actions on issues they have identified instead of acting on adult concerns (Lansdown, 2005).

Therefore, further research into children’s perspectives to conceptualise digital play is
advocated. The study’s methodological contribution in terms of gathering children’s perspectives through a design-oriented process can impact on the design, practices and policies of children’s digital play experiences. The involvement of children as decision-makers throughout the different stages of the research process, the incorporation of the views of a wider range of participants and offering children more opportunities to share their views can enrich understandings of children’s current and future digital play experiences.

**Thesis Overview**

*Chapter 2: Literature Review*

Chapter 2 conducts a review of literature, situating the role of digital technologies in young children’s lives with a focus on young children’s digital play with apps. It explores the recommended criteria for the design of computer games and apps for children in two fields of study: education and HCI. A summary of design principles from both fields is presented in relation to children’s play and software design features. The review acknowledges the unique position of children who have the opportunity to use digital technologies for play in early childhood and also recognises the limited influence that children have in the design, development and distribution of their play with apps.

*Chapter 3: Methodology*

Chapter 3 describes the methodology used to explore children’s perspectives of digital play and add children’s perspectives to the existing criteria for quality digital play. The aims and research questions are discussed alongside the study design, followed by an explanation and justification of the research approach employed to the study of children’s perspectives on preschooler apps. The participants and methods of data collection are explained in relation to each phase of the inquiry. The data sources, data analysis and ethical protocols are subsequently identified in connection with the broad nature of the
Chapter 4: First Cycle, Development of a Co-Designed App for Preschoolers with the CRAG

Chapter 4 reports on the first cycle of the DBR approach employed during the iterative cycles of co-designing of an app for preschoolers. The findings demonstrate the perceptions of children when considering their own digital play environments through two processes. The children explored the contexts of the spaces where their own digital play regularly occurred and shared their motivations for using the apps they typically played with at home. This first step in gathering the children’s perspectives of their digital play experiences was extended by exploring the CRAG’s perspectives of apps designed for preschoolers. An initial set of design principles for presholer apps is proposed based on a thematic analysis of the data.

Chapter 5: Subsequent Cycles, Development of a Co-Designed App for Preschoolers with the CRAG

Chapter 5 reports on subsequent cycles of the design-based study, which engaged the CRAG in a range of experiences designed to support the development of their ideas for an app for preschoolers. The findings presented in this section trace the modifications of the design process from individual design ideas into one combined idea for a co-designed app and address the shift from individual understandings of digital play practices to a shared understanding of preschooler apps among the children. The analysis of the findings from this chapter confirms and offer adjustments to the initial set of design principles presented in Chapter 4 and also identify emerging design principles. These are consolidated and then presented as a refined set of design principles at the conclusion of the chapter.
Chapter 6: Discussion and Conclusion

Chapter 6 presents and discusses the implications of the findings of this study in relation to the research questions and the design-oriented methodological approach employed. The study’s theoretical contribution to understandings of digital play is examined through a comparison of the children’s perspectives with the current design criteria presented in literature from the fields of education and software design. The study’s practical contribution is presented, with evidence of the successful application of methodologies based on children’s rights and CCI as a novel methodology for obtaining children’s perspectives regarding digital play. The chapter concludes with recommendations regarding the implications and the significance of the study for research, policy and practice.
Chapter 2
Literature Review

Chapter Overview

The aim of this study is to explore children’s perspectives on digital play and incorporate these perspectives to enrich existing criteria for quality digital play for young children. This chapter provides an overview of the relevant literature to identify the existing gap in and justify the significance of the study. The literature review starts with an analysis of digital technologies in young children’s lives, the role of play in young children’s development and its role in providing an understanding the newly emerged phenomenon of digital play.

The review then investigates the notion of quality in digital play presented in the guiding criteria for the selection and design of children’s apps from two fields of study: CCI and education. In the field of CCI, the design criteria for children’s use of technology put emphasis on the improvement of the design of a product while the design criteria in the field of education include a review of children’s use of technology for recreation and learning which focus on the achievement of developmental and learning outcomes. A summary of design principles and their implications is reviewed in relation to children’s play and software design features.

Digital Technologies in Young Children’s Lives

Children’s engagement with digital technologies is captured within an ongoing debate; its advantages are set against its negative influences on young children’s development (Plowman, McPake, Stephen, 2010). Children’s use of digital media has been criticised for its negative effects on the development of children’s social skills and its contributions
to delays in learning and general behavioural problems (American Academy of Pediatrics [AAP], 2016; Commonwealth of Australia, 2019). It has also been associated with health concerns such as obesity, cardiovascular risk, bullying and mental health issues (AAP, 2016). Negative effects on children’s posture are attributed to the repetitive movements of tapping, swiping and seated activity (Straker, Zabatiero, Danby, Thorpe & Edwards, 2018). Further, children’s engagement with digital technologies is said to have a negative effect on their sleeping patterns (Radesky & Christakis, 2016).

The dire consequences presented in these discourses have been reflected in cautionary measures to monitor screen time. The American Academy of Pediatrics (2016) and the Australian 24-Hour Movement Guidelines for the Early Years (Commonwealth of Australia, 2019) urge families to recognise that cumulative hours of media use and exposure to digital content of limited quality is not ideal for children’s growth and development. The guidelines, therefore, direct families to limit young children’s use of digital media to an hour or less of “screen time” per day and stipulate that digital media use should not displace sleep, exercise or play — reading, singing, puzzles and storytelling are suitable substitute activities for children to engage in (AAP, 2016; Commonwealth of Australia, 2019).

However, while there have been significant concerns regarding screen time, the increasing access that younger children have to digital technologies prevails. In line with this, increasing numbers of studies have investigated the positive influences of these technologies on young children’s development. The format and features of iPads and other touch screen devices are considered highly suitable for very young children to use (Wohlwend, 2016). These technologies have been lauded for enhancing the earlier development of infants’ and toddlers’ fine motor skills (Bedford, De Urabain, Cheung, Karmiliff-Smith & Smith, 2016), in contrast to studies which identify its potential implications on posture and physical activity (Howie, Coenen, Raanelli & Straker, 2017).
Touch screen devices allow infants and toddlers to engage in interactions independently, a benefit not afforded by computers and laptops using a mouse and a keyboard (Neumann & Neumann, 2014).

There are various differing recommendations regarding technology use for young children that can cause confusion for families and educators (Straker, Zabatiero, Danby, Thorpe & Edwards, 2018). The tensions and contradictions surrounding children’s use of digital technology in the home settings for play have been expressed by parents of young children (Kervin, Verenikina, Rivera, 2018). While families consider digital to be the “new basic” (Kervin, Verenikina, Rivera, 2018, p. 120), there is uncertainty about whether children’s engagement with technologies displaces educational basics such as literacy and numeracy. The value in supporting children to play with quality apps has been expressed, yet guidance for families in finding quality apps is limited. Families lean towards encouraging children’s learning and development through independent and creative interactions with apps, yet they are obliged to make decisions regarding screen time and the types of interactions made possible through children’s engagement with digital technologies.

Until recently, there was no clarity in literature on whether digital technologies limit or facilitate the development of children’s interactions (Mantilla & Edwards, 2019; Commonwealth of Australia, 2019). The most recently released Statement on Young Children and Digital Technologies offers early childhood educators a comprehensive set of guidelines as to how engagement with technologies is beneficial for children (Early Childhood Australia [ECA], 2019). With consideration for the specific context of each child, a holistic understanding of children’s engagement with digital technologies involves the relationships that occur with other people during interactions with digital technologies, the balance of children’s health and wellbeing in relation to their digital practices, the development of a child’s digital citizenship and the effect of technologies
on children’s play and learning (ECA, 2019).

Substantial amounts of research in the field of early childhood describe children’s use of digital technologies to enhance children’s learning (Mantilla & Edwards, 2019; Miller, Paciga, Danby, Beaudoin-Ryan, & Kaldor, 2017) and the evident impact of technology use on the development of various skills. These include literacy skills (Beschorner & Hutchison, 2013; Burke, 2010; Kervin, 2016), sequencing skills through programming and coding (Flannery, et al., 2013), music knowledge and related skills (Dooley & Dezuanni, 2015) and the ease with which children produce digital media such as storybooks (Kucirkova, Messer, Sheehy, & Flewitt, 2013). The development of social skills can be noted in the use of video conference messaging through apps such as FaceTime and Skype, which provide a unique opportunity for the development of social interactions for infants and toddlers (Radesky, Schumacher & Zuckerman, 2015; Roseberry, Hirsh-Pasek & Golinkoff, 2014). The interactive experiences offered by digital technologies expand the types of possible social interactions for children with others who can only be reached through the means of technology. Engagement with technologies is influenced by the relationships and interactions that children have with adults (parents, caregivers and educators) and their peers. The variety of interactions that children have can promote social interactions and offer opportunities for collaborative learning between peers (ECA, 2019).

It is important to note, however, that in early childhood education and care settings, play is considered the central tenet of learning. It is essential to acknowledge that children’s play has evolved to include the use of digital technologies for play. To that end, the notion of “digital play” has recently emerged in this field (e.g., Edwards, 2013; Marsh, Plowman, Yamada-Rice, Bishop & Scott, 2016; Verenikina & Kervin, 2011). This concept of digital play will be discussed in the next sections, after the role of play in young children’s development is explored.
Researchers have identified many ways that play may advance children’s cognitive, social and emotional development. From the sociocultural theoretical perspective adopted in this study, young children’s play is conceptualised as an essential contributor to their psychological development (Vygotsky, 1967). Specifically, this perspective recognises imaginative play as the most significant “leading activity in the early years” (Leontiev, 1981). Through imaginative play, children acquire the foundations for abstract thinking including symbolic thought, meta-communication skills and the rules of functioning of adult society (Leontiev, 1981; Vygotsky, 1978). This development is most effective in the zone of proximal development (ZPD), which is created by make-believe play (Vygotsky, 1978). Within the ZPD, children independently accomplish tasks within the extent of their own understanding, the development of which can be achieved through children’s interactions with others. From a sociocultural perspective, the fundamental role of social interactions and language in play are acknowledged. Language development has a strong connection to the development of thought: “Language is the most powerful tool of any human being … language and thought are inseparable” (Vygotsky, 1986, p.10).

Lillard et al. (2013) emphasised the importance of recognising not only imaginative play but also other types of play — specifically rough-and-tumble and constructive play — and their influence on children's development. Additionally, various levels of social engagement in play have been recognised, including social categories of play such as solitary play or playing alone; parallel play, wherein children play alongside one another but there is little interaction among them; associative play, in which children play together and do similar things; and cooperative play, wherein children play together and coordinate their actions to achieve a particular play goal (Piaget, 1962; Smilansky, 1968). Despite the variety of types of play, there are numerous characteristics that distinguish
play from other forms of human activity. Play has been characterised as a spontaneous, self-initiated and self-regulated activity of young children that is motivated by playful goals. In Western cultures, children have an internal desire and interest to engage in play, create their own play and are in control of it (Garvey 1977, cited in Verenikina et al., 2003).

A play-based approach to early childhood education is widely recognised in the Early Years Learning Framework (EYLF) (Commonwealth of Australia, 2009). In the EYLF, “play is a context for learning” and, thus, considered essential for young children’s cognitive, social and emotional development (Commonwealth of Australia, 2009, p.9). Children’s play practices are identified as evidence of learning outcomes for supporting children’s development of a sense of identity, exploration of their place and contribution to the world, development of a sense of wellbeing, active participation in learning and effective communication in their interactions with others. The EYLF invites educators to participate in children’s play and to use a range of play strategies to plan for and promote purposeful opportunities for intentional teaching (CoA, pp.17-18). Through play, children form the foundations for their future learning and development.

Increasing expectations to align play with learning outcomes, however, poses challenges for early childhood educators. The integration of play and intentional teaching has been viewed to disrupt children’s sense of autonomy during their engagement in free-play particularly when open-ended play and intentional teaching is viewed as dichotomous constructs (Edwards, 2017; Pyle & Danniels, 2017). Educators have expressed difficulties in implementing intentional teaching within play-based environments, preventing educators from offering support when directing children’s learning despite the recognition that adult support is needed for co-constructing knowledge with children (Lewis, Fleer, & Hammer, 2019; Pyle & Danniels, 2017). In reverse, educators are challenged when integrating play into early learning experiences particularly where the
achievement of learning outcomes is prioritised through play-like activities (Wood, 2014b).

Edwards (2017) proposes that play and teaching are not contrasting elements. Instead, these constructs can be viewed as a continuum of types of play that are not hierarchical. Each type of play, ranging from open-ended play to modelled play and teacher-oriented play, influences the type of planning, the design of lessons and the support offered to children and can be used in combination to support children’s learning (Edwards, 2017; Edwards & Cutter-Mackenzie, 2013). Without adult intervention, children’s open-ended play is limited to the reproduction of what children already know. Through modelled play, educators support interactions that children may apply during their own open-ended play, but it is through the purposely-framed play where educators can enact pedagogical strategies which incorporate detailed concepts. The authors found that it is this type of supported play which developed children’s imagination. The concepts that the children acquired during this type of play tend to be included in their open-ended play (Edwards & Cutter-Mackenzie, 2013).

Often, classifications of play are viewed as either being open-ended play when it is child-directed and intentional teaching when adult-guided. For example, children’s perspectives of play are informed by their sense of autonomy. Breathnach, Danby and O’Gorman (2013) reveal that children classified writing activities initiated by educators as ‘work’ whereas child-initiated play involved multiple instances of writing endeavours that were integrated with children’s sense of play. Pyle and Danniels (2017), however, claim that such classifications put emphasis on the locus of control of the activity. Instead, the authors propose that putting emphasis on the developmental needs of children with the notion that child-centredness, instead of the locus of control, will support educators in extending children’s learning in a play-based environment. Ghirotto and Mazoni (2013) highlight the interdependent relationship between adults and children
as an essential component for supporting child agency and autonomy. In their study, the
realisation of a garden designed by young children was modified by their interactions
with the children’s grandfathers. The process highlighted the role of adults in supporting
the development of children’s thinking and action, illustrating how child-centredness as a
means of pedagogical scaffold during play supported children in achieving their goals.
Such queries regarding the notion of play give us space to consider a widening
conception of how play is defined.

The theoretical conceptions of play, in fact, involves a range of perspectives that
interrogates the normalised conceptions of play, including materialist, post-structuralist
and feminist perspectives. In the following examples, the role of objects and place in
informing play is presented. The influence of social construts on children’s choices of
play is also explored.

Materialist views of play acknowledge that material objects and the environment are
granted agency, meaning that, in play, humans and non-humans have the power to act
and transform each other (Taguchi, 2014). An analysis of children’s play with paper
identified that the paper was as much an actant as the children in co-producing play
(Wohlwend & Thiel, 2019). The paper, as a cultural artefact, allowed itself to fold, create
and bend, thus, inviting children to manipulate the paper. In this example, the paper
presented itself as a co-collaborator during play because it allowed the child to make his
own version of a mobile phone using paper. Apart from objects and materials, the places
or the environment also engage in interactions with children during play. Observations of
play between a child and a display in a history museum revealed how it incited a child to
repeatedly visit the space (Procter & Hackett, 2017). Despite the child’s announcement to
his mother that the space was scary, the darkness of the space, the skeletons and
taxidermy of animals continued to attract the child to return to that space.
On the other hand, post-developmental theories, such as sociocultural theories and post-structuralism, interrogate the varied social constructs that inform children’s play. Such theories acknowledge that in many Western contexts, like Australia, play-based approaches are fixed to their one particular cultural and historical context which can silence different ways of thinking about children’s play (Pacini-Ketchabaw, 2014).

Post-structuralism, for example, acknowledges that language and power discourses are present in children’s play. Children’s play is informed by their own cultural and racial belongings and other norms of oppositional binaries such as adult-child, boy-girl, good-bad and weak-strong (Blaise, 2014, Fleer, 2013). An analysis of children’s play reveals some way in which children establish power relations amongst their peers by employing strategies such as whispering and silence to include and exclude others (Blaise, 2014; Wood, 2014a). Additionally, the children exercised agency by circumventing rules set by adults during play, e.g., The children stood on chairs to build towers higher than their chests and assigned a child to the role of a pet dog so that they could add an extra child into the playhouse (Wood, 2014a).

Feminist views of play, in the meantime, draw attention to gender and sexuality discourses in children’s play that are based on assumptions of gender stereotypes. Blaise (2014) suggests that children’s play should promote the varied ways in which children can personify being a girl or a boy in a manner that is not determined by their biological bodies or social norms of sexuality. For example, the use of outdoor space for to play football should not be distinctly associated as the area for boys’ play and an interest in make-up should not be exclusively for girls only. In these examples, post-structuralist, materialist and feminist views of play illustrate how children’s free play allows children to exercise agency to express a sense of freedom, power and control.

Over the past two decades, there has been a concern that children's engagement with
emerging digital technologies, including digital gaming and web searching, might have a negative effect on children’s participation in spontaneous types of play, which, in turn, might be detrimental to the development of their imagination (Singer & Singer, 2009; Elkind, 2001). Therefore, it is important to ensure that children’s play is supported while children are engaged in digital experiences. This study investigates young children’s recreational use of mobile technologies for play, as distinguished from the studies with a focus on the educational types of play that are also associated with children’s digital experiences.

Understanding Digital Play

The concept of “digital play” has been introduced to the early childhood literature only recently to stress the significance of play for young children’s development in a modern era of digital technologies (Bird & Edwards, 2015; Edwards, 2013; Marsh et al., 2016; Verenikina & Kervin, 2011). Broadly, it refers to the use of digital technologies for children’s recreational activities such as play. However, given the diversity of the types and forms of children’s spontaneous play, there is no single definition of digital play (Edwards, 2013; Fleer, 2016). Specific conceptualisation of this notion is diverse and varies according to the context of its application (Edwards, 2013; Marsh et al., 2016). Digital play can be defined in relation to the cultural contexts in which children’s use of digital technologies is situated (Edwards, 2013). By focusing on how children use digital technologies for play, understandings of digital play centre around the capacity of digital play to support the development of children’s meaning-making. Another definition of digital play categorises play in relation to existing play classifications, with considerations for an evolving definition of play that draws from both digital and non-digital play experiences (Marsh, et al., 2016).

Children’s digital play is influenced by children’s everyday lives and, simultaneously, children’s play is influenced by their digital play experiences (Verenikina & Kervin,
Children move between digital and non-digital play without clear boundaries (Marsh, 2016; Kervin, Verenikina, & Rivera, 2015), just as they shift between imaginary play and what is happening in reality through traditional play (Elkonin, 2005, cited in Bodrova & Leong, 2015). The merging of off-screen and on-screen play is a play effect that is unique to digital play (Kervin, et al., 2015). The essence of digital play can only be conceptualised when traditional play and digital play are analysed as part of a whole in defining play (Fleer, 2016). Children move in and out of imaginary situations during play (Fleer, 2013) in what is sometimes referred to as “hybrid play”, “bi-directional play”, or the “digital and non-digital domains of play” (Bird & Edwards, 2015; Marsh et al., 2015). Therefore, the relationship between children’s real-life experiences and the imaginary situations created in digital play is a characteristic considered as a blend between children’s traditional and digital play.

Competence in managing off-screen and on-screen interactions is exhibited by children during their engagement in digital play (Danby, et al., 2018; Danby, 2013; Kervin, et al., 2015). Early childhood educators are also encouraged to include digital play to blend traditional and digital play activities for children (Edwards, 2015). As such, the observable experiences that children have during digital play supports the intertwining of traditional or off-screen play with children’s digital play experiences and facilitates the formation of additional understandings of the phenomenon of digital play.

The shift from off-screen play into on-screen play is facilitated through the capacity of digital technology to take photos, record voices, other audio and videos, allowing children to manipulate familiar artefacts from everyday life. In reverse, this play effect can be exhibited in situations in which children recreate on-screen play using props during off-screen play.

The reviewed body of literature highlighted the need to investigate digital play in relation
to its blended nature which brings together the major developmental characteristics of young children’s traditional play, and the affordances of digital technologies such as photo and video recordings (and most recently - search engine capacities). However, by and large, it does not take into account a relatively recently emerged type of digital play such as children playing with computer or mobile device applications specially manufactured for young audiences (e.g., Kabali et al, 2015; Neumann, 2014; Wood et al., 2016; Zack & Barr, 2016; Verenikina & Kervin, 2011). This is an important aspect of digital play, as the characteristics of the design of such applications largely affect the ways that children’s digital play is shaped. This type of play has been the major focus of this doctoral research study.

As such, for the purpose of this research, digital play is defined as preschoolers engaging in playful activities with apps on digital tablet technologies for recreation during their free playtime (Verenikina & Kervin, 2011; Verenikina, et al., 2016). This type of children’s play is becoming increasingly common among very young children (Danby et al., 2013; Kervin, et al., 2015; Kabali et al, 2015; Neumann, 2014; Wood et al., 2016; Zack & Barr, 2016) and it requires researchers’ attention. Children’s digital play with apps is affected by the design of apps and the subsequent activity that apps encourage. Therefore, it is necessary to investigate the key ideas presented in literature regarding children’s engagement with digital technologies such as apps and computer games, and the characteristics of such apps and games that can afford developmentally advantageous responses from children. The literature presented and critiqued in the next section discusses the design conditions (often referred to as the guiding “design criteria”) that afford opportunities for high quality in children’s experiences with digital technologies.

**Guiding Criteria for Selecting and Designing Children’s Apps**

Existing guidelines and frameworks for evaluating children’s engagement with digital
technologies predominantly reside within two fields: CCI (Child-Computer Interaction) and children’s education and development. This section reviews key literature from both fields to identify how these recommendations were determined and the significance of each to understanding design features that shape the experiences of digital play.

**Design Criteria for Children’s Use of Technology in the Field of Child-Computer Interaction**

The field of CCI presides over the design, development and evaluation of computer software, including educational games and apps, for children. As such, numerous CCI frameworks and guidelines have been presented in recent years.

In CCI literature, Shoukry, Sturm and Galal-Edeen (2015) conducted an extensive literature review dealing with rating systems, criteria and guidelines for educational app design in CCI literature, to determine their suitability for young children. They proposed a framework (Pre-MEGa) based on three facets for app design: ease of use, gameplay and learning (Shoukry, Sturm, & Galal-Edeen, 2015). Based on their review, they identified the design features that make the apps for young children easy to use, engaging and motivating, and that maximise their intended learning potential by offering support.

In this framework, the “ease of use” of an app can be observed by focusing on what is visually displayed on the screen, the types of touch-screen input required from the children, the ways in which young children can navigate to the different sections of the app and the reactions initiated by the app as a response to the children’s input. The framework stipulates that certain “game design” features such as the type of game, its scope and the variety of challenge elements can motivate children to engage with the app. The “learning potential” of an app is integrated through different levels of difficulty, the delivery of content and how relatable its presentation is to children. “Support for the use” of the app is offered through the types of messages and characteristics of an agent such as
an avatar, which also can promote interaction between the child and the app. Additionally, the ability to customise features of the play experience offers children a choice, making the experience adaptable. “Technical features” such as security of information, accessibility and promise of the value of the app are also addressed within the framework. The framework does not indicate that all categories should be met within each app, stating that the purpose of the app will determine which categories should be awarded high or low priority to meet the relevant design requirements. It suggests that the framework can be used as a guideline for designing apps, to support the documentation of newer versions or updates of apps, to evaluate apps or as a framework for comparing apps.

While the framework proposed by Shoukry, Sturm and Galal-Edeen (2015) provides an important set of criteria for evaluating the quality of educational software such as apps, these criteria were created from the perspective of the field of child-computer interactions and therefore bare some limitations. The main limitation is that this framework was drawn from generic features of an app’s design, traditionally known in the field of CCI, however the developmental perspective was not addressed. That is, the psychological characteristics of children of different age groups were not taken into account. When the authors reviewed the educational literature for their framework (Shoukry et al., 2015), the children’s ages were rarely specified as part of the presented guidelines. Similarly, while the proposed Pre-MEGa framework offers design criteria for preschooler educational games, it utilised a set of heuristics for mobile games (e.g., Korhonen & Koivisto, 2006) and video games (e.g., Pinelle, Wong & Statch, 2008) not specifically aimed at preschoolers. Therefore, a more detailed analysis of selected primary sources from the CCI field which relate to young children’s use of technology is necessary. The aim was first to identify the studies with young children as participants and then to identify individual criteria that are evidenced as applicable to young children’s apps. Such analysis is presented below.
Alsumait and Al-Osaimi (2009) proposed a set of usability heuristics or guidelines to identify any issues in the design and development of children’s e-learning software. These guidelines draw from Nielsen’s usability heuristics (Nielsen, 1994), which stipulate requirements such as consistency in the use of text and visual display of the program, the design of interfaces that children can intuitively navigate and control, and interactions that adequately challenge children with expertise yet can cater for children with less experience in the use of e-learning software. E-learning heuristics such as designing lesson activities that illustrate abstract concepts, including assessment activities and encouraging motivation through interactivity and meaningful rewards are also included. Further included within the set of heuristics, are guidelines specific to children’s use of e-learning applications, such as design considerations for the motor skills of children and the inclusion of design features that appeal to children’s imagination either through their interests or the inclusion of characters from their culture. The proposed heuristics stipulate that considerations for children’s preferences and abilities extend the use of Nielsen’s (1994) general usability criteria and the existing e-learning heuristics to adequately evaluate children’s use of e-learning software. This set of heuristics proposed by Alsumait & Al-Osaimi (2008) was tested on the design of an application for children aged five to six years old; however, the set of heuristics was aimed for the design of e-learning software for an overall category of children, regardless of age.

Revelle and Reardon (2009) reported on the challenges associated with redesigning five literacy desktop screen-based games accessible on web interfaces accessed via standard computers to suit a touch screen interface for the smaller screen size of an iPod Touch. The observations of students during a usability test produced a set of recommendations, which included making considerations for children’s difficulty in identifying where on a screen input is required, controlling the tilt functionality to control the play experience and recognising touch screen terminologies like “scroll” that children were unfamiliar
with at that time. Evident from these recommendations are the rapid changes in technology. Mobile screen sizes are growing, allowing close similarities between the visual design and functionality of desktop and mobile screens interfaces. The affordances of touchscreen technology present young children with better input control than a mouse and a keyboard, considering the hands-on nature of their learning in the early years (Berk, 2012).

Considering the recent development of the technological features of the apps and children’s increased competencies in their use, the focus of usability tests in the field of CCI has shifted from ease of use to enjoyment of play experience – the criterium relevant to young children’s play (Fleer, 2016). Zaman & Vanden Abeele’s (2007) Likeability Framework draws on theories of gratification, which are then applied to children’s use of technology. This framework was extended to form a set of design recommendations for the design of interactive media and toys based on a study involving eight families with preschool children aged five years old, responding to why an interactive toy was considered “fun” by the children (Vanden Abeele & Zaman, 2008). The design recommendations included providing opportunities for dress-ups, engaging children in a narrative to fulfil the gratification of “fantasy”, allowing opportunities for self-expression by “creating or constructing”, and including amusing “sensory stimulation” such as “eating, watching colour patterns and making strange noises” (Vanden Abeele & Zaman, 2008, p. 9). Playing together either with siblings, peers or with adults is recommended to fulfil the gratification achieved from “social experiences”. Finally, a sense of “challenge” can be achieved by offering the right balance between tasks that are not too easy and not too hard. This provides support to the user’s agency and enhances their sense of “control” over their engagement with the digital technology (Alsumait & Al-Osaimi, 2009; Malone, 1980).

In summary, the above literature review from both frameworks — heuristics and usability
testing — identified in the field of CCI provided useful information for the design of apps for young children to inform the methodology of this doctoral study. The analysis of studies of young children allowed to identify some of criteria for the design of apps suitable for young children, including hands-on tasks, sensory stimulation, narrative design, fantasy and enjoyment and fun. Heuristics in software design provided a useful approach to guide the process of the evaluation of the apps including the checklists for designers to determine any potential issues arising from the design of software or apps (Alsumait & Al-Osaimi, 2009; Shoukry, et al., 2015). The usability testing involves observation of the intended users (e.g., children) with the intention of identifying any further issues that become apparent during the use of the software (Revelle & Reardon, 2009; Vanden Abeele & Zaman, 2008; Zaman & Vanden Abeele, 2007). In both forms of framework, regardless of the objective of the study design, the aim of the criteria presented is to offer a better designed product.

**Design Criteria for Children’s Use of Technology in the Field of Education**

The literature review of research on children’s use of technologies in the field of early childhood education allowed to further extend and enrich understandings of the developmentally sound criteria for the design of apps for young children. The benefits of digital technologies for children’s learning and the capacity by which digital technologies stimulate digital play are highlighted. However, the distinction between play and learning is often not clearly outlined which is taken into account in the review of the literature below. The studies addressing children’s use of technology as a learning tool and studies addressing children’s use of technology for digital play are analysed separately and then synthesized, to provide recommendations for quality in the design of apps for children for this study.

Goodwin & Highfield (2012) conducted an analysis of apps regarding their pedagogical design, identifying three classifications of apps: instructive, manipulable and
constructive. Instructive apps tend to rely on drill-and-practice and rote learning. Manipulable apps allowed guided exploration and experimentations, while constructive apps have open-ended designs through which children can create their own content and construct artefacts. Analysis of the 240 most popular apps classified as educational between 2010 and 2011 demonstrated that 75 percent of apps were classified as instructional. The valuable contribution made by the authors highlighted the issue that the lack of representation of open-ended learning apps — classified as manipulable, constructive or a hybrid of both — limits opportunities for young children to develop creative and thinking skills. Indeed, learning oriented apps are often focused on the instructional aspect of apps and learning as a drill and, therefore, it is important to distinguish the apps designed for learning and those designed for play.

Cherner, Dix and Lee (2014) classified apps as skill-based, content-based or function-based, based on a representation of 10 apps for each of the core learning areas: science, mathematics, English and social studies. Their framework is classified based on the purpose of the app design while also considering how educators may integrate the use of the app in their classroom practice. Each classification in the framework is linked to Bloom’s taxonomy of cognitive skills. Skill-based apps that tend to rely on instructional strategies to develop children’s skills in literacy, numeracy and key areas of knowledge are considered to develop lower-order thinking skills, requiring students to demonstrate only what is remembered of previously learned information and their understanding of facts. Content-based apps offer children information that allows them to demonstrate thinking skills, such as how they might apply or conduct an analysis of the knowledge they have acquired. The framework emphasises the capacity of function-based apps to engage students in the higher-order thinking skills of synthesising and evaluating, transforming students’ acquired knowledge as they create and construct new representations of their understandings through apps that allow note-taking or the creation of graphic organisers and presentation software. Since the framework presented
in this study focused on the classification of educational apps based on their purpose, content and value for the development of major cognitive functions in children, it is limited to school-based contexts and does not provide insights in specific characteristics of apps for younger children.

The analysis of the pedagogical design of apps (Cherner et al., 2014; Goodwin & Highfield, 2012) classified the purpose of educational apps, ranging from the simplistic promotion of rote memorisation, through a more cognitive experience of exploring information within a subject area, to constructive apps that allow students to transform their learning by creating other own content. The classifications of apps were intended to assist educators in integrating quality apps in their classroom practice. In both studies (Cherner et al., 2014; Goodwin & Highfield, 2012), the authors emphasised the beneficial use of digital technologies for exploring and creating, which develops creativity and higher order thinking in children.

Hirsh-Pasek, et al., (2015) provide an interesting argument that, initially, educational apps were mere reproductions of non-digital games and learning activities, thereby generating a quantity of instructional apps that did not promote the development of higher-order thinking in children. The authors suggested a different approach based on developmental characteristics of young children as they developed four principles of learning to support educational experiences when applied to the design, development and evaluation of apps: “active learning”; “engagement” to stay on-task; “meaningful” play experience related to real-life situations and opportunities for “social interactions”. These principles are highly applicable to the development of apps for children in the yearly years and they inform the methodology of app design in this study.

According to Hirsh-Pasek, et al. (2015), applying these four learning principles in the design of apps, alongside scaffolded exploration in the form of hints, adjusting levels of
difficulty to match the progress of each child, and personalised learning sequences, can elevate random touch interactions with devices to intentional steps towards achieving learning goals. “Active learning” in apps requires the attention of children and refers to the different interactions they have with an app. The focus of this learning principle is to engage children in “minds-on” activities rather than a range of actions — such as tapping, swiping or waving at a camera — that require little mental attention. Active learning when using apps is identified as involving activities in which children are engaged in the interpretation of written and oral language and in the interpretation of symbolic systems such as maps or icons. Active learning within apps allows children to manipulate the symbolic material within the app.

“Engagement” in the learning process is reliant on the meaningful feedback the children receive from the app, the extrinsic motivation received in the form of points, badges, motivational messages and the intrinsic motivation instilled during play. “Meaningful” learning occurs when children learn with a purpose, such as through meeting learning objectives set within a narrative, integrating learning in personally relevant contexts (e.g., using the device camera to take photos within their home setting) and making connections between what is new to what children already know.

The value of “social interactions” in children’s development is emphasised given that social interaction and collaborative learning when using apps are limited in comparison to human interactions. Engaging children in face-to-face interactions through devices or interacting with on-screen characters are some recommendations for facilitating social interactions through children’s play with apps (Hirsh-Pasek, et al., 2015)

Given that early childhood education values play-based learning, the literature reviewed in this section present recommendations which contribute to design principles for preschooler apps wherein children engage with digital technologies for play. Research in
digital play can have varied objectives (Edwards, 2013). One such objective is to identify any different or new types of play to emerge from children’s play with both traditional, technological toys and digital devices (Marsh et al., 2016). Another objective is to understand digital play in relation to the cultural situations in which children’s use of technologies are situated (Bird & Edwards, 2015; Edwards, 2013; Edwards & Bird, 2017). Applying theories of play is an additional approach to define digital play wherein children’s engagement with technology is further investigated (Verenikina, Herrington, Peterson & Mantei, 2010; Verenikina & Kervin, 2011).

Marsh, et al. (2016) conducted an analysis of preschool children’s use of apps to determine the ways that different play types are manifested in digital play, using Hughes’ (2002) taxonomy of play. Marsh, et al.’s (2016) framework adapted the detailed description of the 16 categories of play to children’s use of tablets. Imaginative play, one of Hughes’ categories of play, was identified in the use of apps when children referred to pets in an app as real animals and engaged in pretend to look after the pets. Deep play, described in Hughes’ taxonomy (2002) as risky experiences in outdoor play, was exhibited in digital play in an app involving “fight-for-survival” situations such as running from evil monkeys. Marsh, et al.’s framework (2016) proposed a new type of play, “transgressive play”, in which children played with the apps in ways that were not part of the original design. Transgressive play was exemplified by a child engaging in hide-and-seek play with letter blocks, which disappeared when dragged off the screen and then reappeared with a bounce.

This analysis of play types was part of a larger study which examined how apps for children aged zero to five years old promoted play and creativity (Marsh, et al., 2015). The study analysed how play is manifested in children’s digital play, as discussed above, to determine how apps promote play. Instances of children producing content such as drawings or demonstrating the development of creative thinking (Marsh, et al., 2015,
were identified to indicate features of apps that promote creativity. The results of interviews with parents, observations and interviews with preschool children regarding their use of apps at home, and observations of young children’s use of apps in a school setting identified design features of apps that promoted and limited play and creativity. Play and creativity were found to be promoted through the experimentation and exploration afforded by open-ended apps, opportunities for interactions with peers and adults, and instances in which the occurrence of physical and digital play merge. Other features that promote play and creativity are the clarity of purpose of the app to the children during play and in the marketing of the app, scaffolding to support children’s play with spoken instructions, modelling of responses and offering positive feedback or rewards. Further, appropriate visual design features, ease of navigation and consistent touch expectations avoid confusion in children, which is deemed to limit children’s creative engagement in digital play. Reliance on written text, limited scaffolding strategies and the presence of commercial properties such as in-app purchases or pop-up advertisements also limit children’s play and creativity during digital play.

Additionally, the results from the study were translated into a set of design principles that differed for different age groups (under 1, 1-2, 2-3, 3-4, and 4-5). The design principles stipulate that apps designed for children aged two to three should encourage cooperation and turn-taking in children, while apps design for children aged three to four should nurture curiosity that will lead children to wonder about the world around them. The design principles also indicated that apps for four- to five-year-old children can engage users through narratives that assist in developing literacy skills and independent reading. Acknowledging that such distinctions must be made because children develop rapidly between zero and five years, the design principles were formulated to inform the future development of apps and to assist parents, carers and educators in selecting apps for children.
The Digital Play Framework (Bird & Edwards, 2015; Edwards & Bird, 2017) conceptualises how children learn to use technologies through play. It illustrates that children’s familiarity with the use of technology as a tool occurs during “epistemic play” such as exploration, problem-solving and skill acquisition. The progression of children’s use of technologies from epistemic to “ludic play” allows them to intentionally engage in symbolic and innovative ways to play with digital technologies. The authors offered children’s use of a digital camera as an example of the progression of play from epistemic to ludic. A child might explore the device by working out the location of the “start recording” and “stop recording” buttons or recording random footage, then may start to problem-solve by performing recordings of uncontrolled footage. The child’s knowledge of how to use the camera as a tool progresses as the child acquires skills in the zoom function or starts filming more controlled, intentional footage. Ludic play in the use of the camera is exhibited when the child deliberately plans and takes footage of content or scenarios specifically generated for the purpose of filming. Reiterating that ludic play allows children to engage in imaginative play and is, therefore, the more developmentally appropriate type of play for children in their early years, the Digital Play Framework recommends that early childhood educators provide children with adult support and adequate opportunities to engage with digital technologies to progress from epistemic to ludic digital play. The Digital Play Framework (Bird & Edwards, 2015; Edwards & Bird, 2017) informed this study in relation to its methodology and the play approach to the design of apps, with particular emphasis on adult guidance.

The review of the following three pieces of literature traces the development of an initial criteria for evaluating the developmental value of computer games (Peterson, Verenikina & Herrington, 2008) to the formulation of a set of design principles for the design of developmentally appropriate computer games (Verenikina et al., 2010). These design principles were expanded to incorporate digital play with mobile technologies (Verenikina & Kervin, 2011). These criteria formed the initial basis for the design of the
developmental criteria for app design in this study.

Peterson, Verenikina and Herrington (2008) justified the value of computer play to children’s development by defining an initial set of design criteria applicable to computer games for entertainment, education and edutainment, a combination of both. The design criteria, compiled from a review of literature on game design and educational research, identify design features that enable children to develop curiosity, engage in fantasy and maintain a sense of control during play as beneficial to children’s development. Peterson, Verenikina and Herrington (2008) further stated that attention to appropriate learning activities and considerations for the needs of young children are aspects of computer game design that can guide parents and educators in selecting computer games with developmental benefits for children. The identified design criteria informed the selection of developmentally appropriate computer games in the succeeding phase of the study.

Verenikina, Herrington, Peterson and Mantei (2010) observed two children aged five and seven engaging with three computer games selected based on the criteria identified in the earlier phase of the study above. From these observations, a set of design principles were defined that game designers may use a guide to create developmentally appropriate games for young children. The design principles fall within four categories: motivation, context, path and access. Design features within these categories afford opportunities for children to engage in developmental play that promote higher-order thinking.

“Motivation” is established in computer games that allow children to play for the sake of playing. Reaching goals, such as learning a specific skill, is less important. In Verenikina, et al.’s (2010) study, this was observed in children’s game play wherein the children were intrinsically motivated to look after a pet dog, since the situation related to real-life; the family of the participating children was about to become new owners of a dog. Another example of intrinsically motivated gameplay was evident in children’s enjoyment in
creating worlds in an open-ended virtual environment that allowed them to spend as much time as they wanted creating and refining their worlds.

The “context” within which games are situated enables children to engage in imaginative play. Game features that incorporate objects, sounds, situations and even actions of game characters should be relevant to children’s lives. Examples of these presented in the study included children’s expectations to be able to select the treatment for a sick dog as a vet, instead of the app determining the best treatment for a dog. The restricted representation of the role of a veterinarian in the game was identified as not ideal for a child’s engagement in developmental play. Another example presented in the study was the manner in which children incorporated aspects of their digital play into their everyday lives. A child demonstrated make-believe play as he rearranged his bedroom to mirror that which appeared in the app and modelled the character’s behaviour, hair and dress styles. Children incorporated the notion of dog ownership into their everyday conversations, making recommendations for each other’s play and re-enacting their play as dog owners after playing the app through make-believe actions such as taking each other’s dogs for walks.

The “path” identified in game characteristics that are developmentally appropriate for children should be discovery oriented. The exploration of an app should allow children a selection of choices without any anticipated time pressure imposed on their play. Game features should permit children to view how their choices are implemented in the game so that the visual feedback can affect their perception of a sense of progress through the game. The study acknowledged the affordance of gameplay for the manipulation of objects and symbols yet also recognised that opportunities for children to engage in make-believe through the symbolisation of on-screen objects are also possible. This was demonstrated in the observation of children’s play when red hearts appeared while a child stroked his pet dog’s hair. The act of pretend in the repetitive action of stroking the dog
extended the child’s symbolic representation of caring for the dog. Moving through levels of complexity and offering opportunities for children to participate in the game collaboratively with others were also identified as game characteristics that promote play.

Game features that affect children’s “access” to the developmental benefits of computer games include the types of assistance and support available to assist the child in playing the game and the mode in which instructions for progressing through the game are presented. This was demonstrated in observations of children completing a training session within the app or requiring the assistance of a more experienced adult or a sibling. The use of clear spoken directions should also be considered for young children when reading text may be a deterrent for their engagement in play. The visual design of the interface also affects how children respond to the game; as such, the interface should not be distracting, with meaningless items or have a cluttered screen design.

It is important to note that the above criteria we designed based on literature on computer games and trialed in the similar digital environment of desktop computers. Verenikina and Kervin (2011) expanded on these design principles presented above by applying theories of play to preschool children’s digital play using mobile technologies such iPads within the home context. The study analysed the top 50 educational iPad apps and incorporated the same gaming principles of motivation, context, path and access to determine play effects or how play theoretically manifests through children’s play with a digital app. The observation of three preschool children’s video footage provided empirical evidence of how these play effects manifested in their digital play practices. The design principles applied to children’s digital play with apps are detailed below.

“Motivation” manifests in digital play with apps in design features that allow children to participate in unintentional play and are intrinsically fun. This was exemplified in the design of apps wherein children could create puppet shows based on a narrative created
by the children themselves and in their interactions with building an ecosystem inhabited by koi fish. The open-ended design of both apps allowed children to create and interact as they wished, without specific goals to achieve. The puppet app did not include other motivational features apart from design features that allowed children to record, archive and play the recording of their puppet shows again.

Verenikina and Kervin (2011) extended the design principles to include the notion of challenge as a motivational aspect, wherein the design features of an app engage children to participate in play that is doable yet challenging. This was exemplified when children were afforded control of the complexity of the ecosystem in one app design and when they had capacity to customise their play based on their own interests without any requirements for additional features to be included to proceed with their play.

The “context” in which the design of apps is situated should relate to daily life. Just as the images of the pond, the fish and the sounds used in one of the app designs were representative of reality, the themes of characters in the puppet app — which included fairy-tale, Wild West and monsters — were ideal as children were able to relate to and recognise these as relevant to their daily lives. Therefore, the use of these characters and the stories developed by the children were influenced by the associations the children made between their digital play and lived experiences, enabling children to engage in pretend play.

The design principles classified under “context” were also expanded to acknowledge that apps that present opportunities for problem-solving are ideal in promoting play, exemplified in how a child creating a puppet show could resolve any complications in the narrative experienced by the puppets.

The “path” in the design of apps should be discovery-oriented, allowing children to
explore as they wish. This is exemplified in the design of apps wherein children can engage in trial and error as a way of exploring the app and also when children moved between different scenarios during their play with the puppet app. Design features that allow children to make choices offer a sense of control to children as they play. Choices may include selecting characters, choosing from backdrops and creating different scenarios. When there are no set times within which play should occur, the design of apps should allow children to engage with the app at their own pace. This is another design feature of apps that instils a sense of control in children as they play. Similarly to the computer games from the earlier study, the apps observed in the study did not allow more than one person to control the app, but collaborative decisions — for example, regarding characters and backdrops — and conversations to support each other’s skill development were observed when children played with the puppet app. The design of apps should provide visible transformation that demonstrate to children how their actions affect the app. For example, the decisions made by a child were observed to have implications on the rippling of water as the child moved her finger up and down the screen. Likewise, once a child selected characters and backgrounds in the puppet app, the visual design of the app changed to a stage with curtains, depicting that the child could proceed with creating the story for the puppet show.

The design features classified under children’s “access” to digital play with apps include the visual design displayed on the screen and the interface with which children navigate from one section to another. Employing a simple visual display of colour, background and graphics can effectively engage children in play, as in the use of a stage and curtains to communicate that the story creation using puppets take place at this stage of app play. Another design principle under the classification of access addresses the type of support that a child may receive during play with an app. In the observed instances of digital play, the design of the apps did not include spoken or extensive directions to guide children regarding how to interact with the apps. Therefore, it was identified that assistance from
other more experienced users such as an adult or an older sibling may be valuable to encourage children’s play with the selected apps.

The design criteria for preschooler apps, summarised below, stipulate that quality digital play experiences are made possible through quality in app design (Verenikina & Kervin, 2011). Apps for children should:

- allow self-motivated play that is intrinsically fun for children, in which reaching goals is less important
- provide opportunities for children to act in “as if” situations, especially as children’s imagination is engaged when there is no right or wrong answer
- engage children in a discovery-oriented type of play that presents choices, allowing multiple paths of play, problem-solving and the manipulation of objects
- engage children to collaborate and interact with others rather than as a single player.

Analysis of children’s play in the home setting is significant since children’s first engagement with digital technologies for play occurs at home (Kervin & Verenikina, 2018). The observations of two children’s digital play experiences at home demonstrated how children’s engagement with digital technologies was not limited to merely viewing or consuming content. The observations revealed how the children used technology to solve problems or achieve self-identified goals. Additionally, five emerging play effects from children’s play with apps can be observed: imaginative play, interactions, language development, motivation and merge of on-screen and off-screen play.

For example, the observations revealed how a child’s interest in trains and play with a toy train set was extended by following YouTube channels of train aficionados. The child’s growing interest in trains offered an opportunity for joint meaning-making between parent and child. His interactions expanded to include a network of online “friends”,
validating the child’s interests. These experiences influenced the child’s digital play experiences with a train app and demonstrated how the children’s real-life experiences influence their digital play experiences and vice versa. The play effects observed in this instance demonstrated how the interactions between the parent and the child enabled the child to engage with the technology to merge off-screen play with train sets and on-screen play with a train app. The child’s motivation and interest in the topic meant that he played for a sustained period of time as he engaged in imaginative play by assuming the role of the train driver and manoeuvring the train to different stops to collect passengers or cargo.

In another example, another child engaged in the development of a narrative using characters and images that he drew. He was able to manipulate these objects, move them around, record his voice to narrate the story within a flexible app environment that permitted him to explore, restart and change the components until he was happy with the digital story he produced. The analysis of this child’s digital play experiences revealed how he could incorporate his voice as a component of his digital play with apps. His interactions with the device motivated his play as the app afforded flexibility with no time limits or set goals, allowing him to fully engage in pretend play to develop the narrative he was creating. These two examples demonstrate the type of meaningful digital play that emerges as a result of the intersection of the five play effects, noting that a single play effect on its own is not an adequate indicator of quality digital experiences in apps for young children (Kervin & Verenikina, 2018).

Children’s interactions with apps were also explored within weekly Digital Playgroup sessions wherein children’s responses to apps were observed and the expression of their views was encouraged through adult scaffolding. Their involvement in decision-making was also enabled by inviting them to share their digital play experiences with their favourite apps and to select apps from the App Store in a research setting (Verenikina,
The analysis of children’s digital play with apps revealed that interaction among children was cultivated through the act of playing together and doing similar things to coordinate their actions. For example, peer-to-peer play among two children motivated both their private and social speech as they planned their actions when playing the same app. In another example, siblings engaged in pretend play of being hairdressers. Their play involved the additional personal element of inserting a photograph of each other and their talk involved making connections to their real-life experiences when their dad’s hair was mentioned. In both these digital play experiences, the children engaged in self-motivated pretend play with discovery-oriented apps that featured multiple paths of play.

A deeper exploration of app design features that promote children’s off-screen and on-screen play described how children’s engagement with digital technologies functions as a tool or resource for the development of meaning-making (Kervin, Verenikina & Rivera, 2015). An instance of digital play in the home demonstrated two children’s simultaneous recreation of an on-screen Minecraft™ world and a real-life construction using LEGO™ bricks. The children negotiated the construction of the structures using silences to give each other space to build and moments of supporting each other in the co-construction of the two creations. These different types of interactions between the children demonstrate how their digital play experiences took place over sustained periods of play. The design features of the apps they played with easily afforded opportunities for children to blend their off-screen and on-screen play as they collaboratively planned their paths of play; children engaged in meaningful interactions with the app and with others, engaging in talk during instances of pretend play.

Finally, the role of adults in extending children’s language and thinking through digital play is critical (Verenikina, Siraj & Kervin, 2018). An analysis of children’s digital play between two children and another instance between a parent and child was conducted.
The interactions between the two children encouraged the children to engage in self-talk and social speech as they planned their own rules for playing, checked with each other and deviated from the defined script of the app as they engaged in imaginative play. The interactions between the parent and child demonstrated how adults use a range of experiences and resources to engage in meaningful dialogue to extend a child’s knowledge and thinking. In this instance, the mother engaged in modelling to act out a character, demonstrate features of the app and make suggestions to support the child in creating a story using the characters, sceneries and objects offered as part of the app design. The mother’s response to the child’s interests and her taking the child’s lead were key in the interactions between the mother and the child.

These observations of instances of children’s digital play experiences trace the evolution of imaginative play in the context of digital technologies in young children’s lives. They demonstrate how children make connections and make sense of the real world from their digital play experiences, and how they engage in sustained interaction with apps while they collaborate with peers or an extended virtual network. These meaningful interactions with the apps, siblings, peers and adults encourage children’s talk during instances of pretend play and establish that quality digital resources offer quality digital play experiences for children.

The above research laid the foundation for the current study. However, it is important to note that these studies were focused on criteria derived from literature and their implementation by observing children’s play. While some attempts were made to incorporate children’s perspectives through their active participation in play within the affordances of the app design, these studies are limited to criteria designed from the perspective of adult researchers. Yet, children’s perspectives were under-explored. The aim of this current doctoral study, therefore, was to add children’s perspectives to the design criteria through their active involvement in the design of an app.
Summary of the Design Principles and Implications for this Research

Both the software design and education fields of research emphasise the positive effects of technology on children’s development and play. The guidelines, frameworks and design principles presented in the literature review reveal the design features of technology that promote learning, play and — overall — children’s development. This section summarises the criteria for design of apps for young children derived from the reviewed literature. In doing so, it attempts to group these criteria. As the reviewed literature is multidisciplinary in nature and is underpinned various conceptual frameworks, the criteria are interrelated and overlap. For this reason, the applied grouping is primarily for the purpose of structuring the presentation of the information. Therefore, the summary of design principles derived from the multidisciplinary review of literature is presented in this section in relation to characteristics of children’s play and software design features.

The findings from the literature review are compared and contrasted with the empirical findings from this study — that is, young children’s perspectives on the principles for design of apps for children, with the aim of consolidating children’s perspectives into a proposed set of design principles for the design of quality apps for preschoolers.

Notably, some guidelines and frameworks found in the literature were developed in relation to computer games (Alsumait & Al-Osaimi, 2009; Peterson, et al., 2008; Verenikina, et al., 2010). Guiding principles developed for e-learning software (Alsumait & Al-Osaimi, 2009) and children’s engagement with interactive media and toys, including but not limited to screen-based interactive computer software, (Vanden Abeele & Zaman, 2008; Zaman & Vanden Abeele, 2007) have influenced a set of design criteria for educational apps (Shoukry, et al., 2015). Likewise, the design principles identified for computer software used by children for play (Peterson, et al, 2008; Verenikina, et al.
2010) have been applied to preschooler’s use of mobile technologies for play (Verenikina & Kervin, 2011).

**Design Principles Related to the Characteristics of Children’s Play**

In this review, it was important that the design criteria for apps were aligned with the developmental characteristics of young children’s imaginative play. Vygostky’s sociocultural understanding of young children’s play influenced the description of factors that contribute to “play effects” observed during children’s digital play; it also influenced the presentation of a set of design principles to guide the development of play in preschool children’s use of apps (Peterson, et al, 2008; Verenikina, et al. 2010; Verenikina & Kervin, 2011). Imaginative play in children’s use of technologies is evident when children’s engagement in digital play makes use of design features that enable self-initiated play, discovery and exploration through play, opportunities for making connections between relatable situations and characters, engagement in collaboration and social interactions, and opportunities for assigning symbolic meaning in pretend. The manifestation of play is further supported by design features that support the development of creative skills and creative thinking during children’s digital play with apps (Marsh, et al., 2015). While intuitive navigation and consistent touch experiences motivate children and help to avoid confusion, opportunities for experimentation and exploration nurture curiosity and wonder as children play. Interactions with peers and adults provide opportunities to scaffold children’s play and offer positive feedback. This section explores how the different design principles relate to the development of children’s digital play experiences.

**Self-initiated play, discovery and exploration.** Children’s motivation to play should direct their engagement with apps (Marsh, et al., 2015; Verenikina, et al., 2010; Verenikina & Kervin, 2011). When children engage in digital play based on their
interests, they derive intrinsic fun in their engagement in this type of play. The spontaneity of these interactions offers children a selection of choices for engaging in discovery-oriented play without the objective of a learning goal. The notion of discovery allows for engagement in more than one non-linear path for play, providing children with risk-free explorations during which they can undo, restart or engage in trial and error without any time constraints. Exploration and experimentation of this type are common in open-ended apps (Marsh, et al., 2015; Verenikina & Kervin, 2011).

Relatable situations and characters. The context of children’s digital play should represent and relate to children’s real-life experiences, allowing them to explore the roles and rules of adult society (Marsh, 2010; Verenikina & Kervin, 2011). Design features such as objects, sounds, situations and actions of characters should be relevant to children’s lives so that children can make connections between digital play and the world around them (Marsh, et al., 2015; Verenikina, et al., 2010). Therefore, the choices made available to children and the actions expected from children’s interactions with apps should be age-appropriate to ensure that children are engaged in meaningful explorations of apps. The connections of digital play to children’s lived experiences can be related to the characters in apps, the use of narratives in apps and connections to popular culture and media to which children have access.

Characters in apps. The use of characters in apps is influenced by the associations that children make between digital play and their lived experiences (Verenikina & Kervin, 2011). Children interact with or respond to the characters in the app as if they were real or as if they were human beings. Utterances such as “I am” or instances of speaking from the perspective of the screen character demonstrate how a child momentarily takes on the role of that screen character (Gerkushenko, Sokolova, Meshcheryakova & Meshcheryakova, 2013). Referring to pets in apps as real animals that they can look after (Marsh, et al., 2016) is another instance of children’s engagement
in make-believe situations during play with apps. In some imaginary situations in digital play, the character is viewed as a representation of the child which interacts with others (Marsh, 2010).

**Narratives in apps.** Likewise, the use of a story or a narrative that has relevance to children’s realities allows children to engage in fantasy and pretend situations (Marsh, et al., 2015; Kervin & Verenikina, 2018; Verenikina & Kervin, 2011). Children’s interactions with apps can support the development of literacy learning and language development (Burke, 2010; Kervin, 2016). Children’s ability to step in and out of the role of play to manage and plan extensions of their play narrative is a characteristic of imaginative play. Design features that offer support enable children to progress through their engagement with apps is an example of how children step out of the play mode to progress or develop an unfolding play scenario.

**Connection to popular culture.** Digitisation and consumerism also influence children’s digital play (Edwards, 2014; Nuttall, Edwards, Mantilla, Grieshaber, & Wood, 2015). Children’s digital play associated with brands of toys and popular media has been criticised for limiting children’s imaginative play, with recommendations established for the protection of children from advertising and commercialisation (Marsh, et al., 2015; Schuler, et al., 2012). It has been acknowledged, however, that a different type of digital play experience is generated when children construct pretend situations within the consumerist context of digital play. For example, characters, story themes and plots experienced by children through a range of media and toys influence both digital play and traditional play. Additionally, associations with popular media and toys may appeal to children (Marsh et al., 2015). In understandings based on the Digital Consumerist Context (DCC), children’s engagement in a range of media, digital technologies and products, including physical toys, is a continuum that allows children to make multiple connections. This creates a “hybridised cultural experience” wherein one medium does
not preside over another as the primary source of meaning-making (Edwards, 2014, p. 232). Rather than attributing the decline of quality in play to the digital and consumerist contexts of play, proponents of the digital consumerist context instead uphold the empowering opportunities of digital consumerist play or contemporary play for expanding children’s meaning-making and agency in their engagement with different types of play materials. Researchers in this space have acknowledged that the DCC’s role in children’s development is yet to be determined.

**Collaboration and social interactions.** Collaboration and social interactions are important facets in imaginative play and constructing knowledge. While apps tend to be controlled by an individual, the literature emphasises collaboration and social interactions during digital play (Hirsh-Pasek, et al., 2015; Marsh, et al., 2015; Van den Abeele & Zaman, 2008; Verenikina, et al., 2010; Vereninina & Kervin, 2011). Social interactions in digital play can foster collaborative participation of siblings, peers and adults (Van den Abeele & Zaman, 2008; Verenikina, Siraj & Kervin, 2018). Extended dialogues between children and adults during children’s play with apps support children’s imaginary play and build on their current understandings (Verenikina, et al., 2018). Joint digital play among children can support their actions and stimulate talk and imagination, which can encourage cooperation and turn-taking (Marsh, et al., 2015, Verenikina, et al., 2018). Face-to-face interactions and communication through devices with peers and adults can also occur (Hirsh-Pasek, et al., 2015; Marsh, et al., 2015). Further, support from on-screen characters such as agents or avatars can promote interactions between children and apps (Shoukry, et al., 2015).

**Assigning symbolic meaning.** When children assign a new meaning to objects and actions, imaginary play in digital play is said to occur. Digital objects and symbols that children recognise as having relevance to their daily life may assume new meanings in the context within which these are presented in the app (Marsh, et al., 2016). Providing
children with opportunities to digitally manipulate objects and symbols within apps can allow them to create new meanings or share a collective meaning (Kervin & Verenikina, 2018; Verenikina & Kervin, 2011). In children’s use of technologies for learning, children engage in higher-order thinking, especially when they transform knowledge into new representations. The interpretation of written information, oral language and the symbolism behind images like maps and icons illustrates abstract concepts for children (Hirsh-Pasek, et al., 2015).

**Design Principles Related to Software Design Features**

This review also revealed that some design principles contribute to children’s use of technologies both for learning and for the development of play. Guidelines for design features such as visual display and multimodal representations were identified as extrinsic design features in evaluating children’s interactions with technology (Gerkerenko, et al., 2013). The incorporation of interactive design features such as challenges and rewards affect both learning and play, as does the engagement of children as producers or creators during their digital play experiences.

**Visual design and multimodal representations.** The design of apps is principally presented as a combination of visual and multimodal elements such as speech, animation, sounds, songs, music and visual effects, all of which increase the appeal of apps to children. Careful considerations should be implemented to ensure that the inclusion of these design features is meaningful, avoiding distractions to children’s play experiences and ensuring that children are able to recognise navigational features and operate these with ease (Marsh, et al., 2015; Shoukry, et al., 2015; Verenikina & Kervin, 2011). Design considerations for the motor skills of children should be accounted for (Alsumait & Al-Osaimi, 2009; Verenikina, et al., 2010), as some children may have difficulty using functions such as tilt and identifying input locations on touch screens.
(Revelle & Reardon, 2009). Overall, what is displayed on-screen, the types of touch screen input and the design of the interface should be intuitive for children to navigate (Alsumait & Al-Osaimi, 2009; Shoukry, et al., 2015).

**Interactivity incorporating challenges and rewards.** Interactivity in digital play is the response of the app to children’s input (Shoukry, et al., 2015; Verenikina, et al., 2010; Verenikina & Kervin, 2011). At times, interactivity offers adequately designed challenges that are “not too easy” yet “not too hard”, allowing children to gain a “sense of control” (Van den Abeele & Zaman, 2008). Interactivity can enable children to move through different levels of complexity (Verenikina, et al., 2010) ultimately engaging them in achieving learning goals (Hirsh-Pasek, et al., 2015) or undertaking problem-solving tasks in play (Verenikina & Kervin, 2011). An element of challenge in digital play incorporates game-like features that are carefully balanced between exploratory discovery-oriented play experiences and goal-oriented games (Shoukry, et al., 2015). Feedback and rewards are design features that inform children of their progress through different challenges or levels (Shoukry, et al., 2015; Verenikina & Kervin, 2011). Positive feedback can consist of motivational elements like collecting badges or the presence of cheering, clapping or voice reinforcement (Marsh, et al., 2015).

**Design that allows children to be digital producers, rather than just consumers.** The potential for children to create meaning can make them producers of their digital play rather than simply consumers of the features offered by the app design. Opportunities for creating and constructing as a design feature facilitate self-expression in children (Van den Abeele & Zaman, 2008). Open-ended apps such as drawing apps, for example, offer children opportunities to explore and experiment (Marsh, et al., 2015, Verenikina & Kervin, 2011; Verenikina, Kervin, Rivera & Lidbetter, 2016). Creating new representations of content and constructing artefacts develop higher-order thinking skills in children and are, therefore, valued as design features of apps for supporting the
accomplishment of learning objectives (Cherner, et al., 2014; Goodwin & Highfield, 2013). Allowing children autonomy to create their own experience is a design feature of apps that can encourage pretend play during their use of apps. For example, the icons, symbols and actions designed within apps can serve as digital placeholders and virtual pivots that develop imaginary situations in digital play. Objects, symbols and icons can be created and modified by children, which give a new sense to digital play (Fleer, 2013; Gerkushenko, et al., 2013).

**Customisation and personalisation of the design.** Design features that allow children to create their own characters or avatars and customise the visual display by incorporating their own voices, photographs or video recordings are significant elements in developing creativity and self-expression through digital play while making the play experience adaptable (Marsh, et al., 2015; Gerkushenko, et al., 2013; Shoukry, et al., 2015). Personalised characters or avatars may be customised to reflect cultural and social representations of children. This dimension of pretend engages children in role-playing, helping them develop understandings from the perspective of others.

**Assistance and support.** The type of assistance and the mode in which support is provided are essential facets of app design. These features can include spoken directions that support preschoolers to use apps effectively and to progress or achieve their goals during play (Shoukry, et al., 2015; Verenikina & Kervin, 2011). In apps with learning objectives, these support mechanisms act as a scaffold to support children’s learning. Offering opportunities for adults to adjust the support provided within an app to suit children’s play experiences, such as by muting verbal support, is another example of extending the support offered by apps (Marsh, et al., 2015).
Conclusion

The list of app design features above is not exhaustive. While it incorporates visual design within the design criteria, it aims to deviate from the evaluation of the more extrinsic features of apps — such as the scope of content and narrative plots — to evaluate the quality of play experiences within apps. It instead focuses on elements of app design that contribute to children’s play development. The literature review imparts a set of design principles in relation to children’s digital play with apps. In summary, the design principles for children’s digital play with apps are reflected by these themes:

- Children’s digital play is self-initiated and involves discovery and exploration.
- Children’s digital play with apps involves narratives with relatable situations and characters, and connections to popular culture.
- Children’s digital play with apps encourages collaboration and social interaction.
- Children’s digital play with apps enables children to assign symbolic meaning during play.
- Children’s digital play with apps is manifested through the incorporation of visual design and multimodal representations.
- Children’s digital play with apps incorporates interactivity with challenges and rewards.
- Children’s digital play with apps enables children to become digital producers, rather than just consumers.
- Children’s digital play with apps offers opportunities for customisation and personalisation of digital play experiences.
- Children’s digital play with apps offers assistance and support during play.

The growing understanding of children’s engagement with technologies alongside their growing competence and literacy regarding digital technologies demands that the guiding
criteria for engagement with digital technologies change. The design principles presented in this review reveal that the perspectives of adults with expertise in pedagogical development and software interaction design have shaped understandings of children’s digital play. The absence of children’s perspectives in the development of design principles is the gap in the literature that this study intends to address. Obtaining children’s perspectives can offer a holistic understanding of digital play because these perspectives can offer insights into children’s interests and their interaction with devices and other children during play. It also invites a better understanding of how to support children as users of technology in meaningful and appropriate ways (Verenikina, et al., 2016).

The review conducted in this chapter is significant to the study’s formation an understanding of how quality digital play is conceptualised and informs the study as a point of comparison to children’s understandings of digital play. The themes presented in this review also influence the theoretical reflection upon the findings of this study, discussed in Chapter 6.

This chapter serves an important role in this research’s approach as it explores the problem. The next chapter presents the design-based methodological approach employed in this study. The design-oriented approach engaged young children as co-designers and co-researchers in the development of an app, employing methodological approaches in the area of children’s rights and software design. To justify the research design, the next chapter includes an additional review of literature relevant to these methodologies, which facilitate an exploration of the perspectives of children on the design of preschooler apps.
Chapter 3
Methodology

Overview and Aims of the Study

This chapter describes the methodology used to explore children’s perspectives of digital play and add children’s perspectives to the existing criteria for quality digital play. The aims and research questions are discussed alongside the study design. The study follows a DBR approach framed within a qualitative paradigm and uses two interrelated methodological approaches: children as co-researchers within a children’s rights methodology and children as design partners in the development of apps within CCI research. This chapter explains and justifies the application of these methodologies to the study of children’s perspectives on preschooler apps. The participants and methods of data collection are explained in relation to each phase of the inquiry. The data sources, data analysis methods and ethical protocols are subsequently identified in connection with the broad nature of the inquiry.

The study aims to:

- explore and describe the perspectives of children in regard to their understanding of preschooler apps
- engage children in designing a preschooler app to examine their understanding of such apps
- identify and make connections between the design ideas presented by the children and propose a set of design principles for preschooler apps based on these design ideas.
Research Questions

The overarching research question which guided the methodology for this study is:

*How are design principles for preschooler apps influenced by children as co-designers and co-researchers in the development of an app?*

The research data were analysed through the following two sub-questions:

1. How do the children’s perspectives contribute to design principles of apps for preschoolers?
2. What processes do the Children’s Research Advisory Group (CRAG) enact as they co-design and trial an app for preschool children?

These questions were carefully selected such that the aims of the inquiry could be met and the purpose achieved. These questions guided the inquiry and final research design.

Research Design

This study is situated within a qualitative paradigm. Further, it is guided by the principles of children’s rights and CCI methodologies and adopts a DBR approach. Children’s perspectives on digital play are explored as children assume the roles of co-researchers in the study and co-designers of an app for preschoolers. This section first discusses the aspects of qualitative research adopted in this study. It then demonstrates how the principles of children’s rights and CCI methodologies were implemented within the phases and discusses the iterative cycles of the DBR study.

Qualitative Research

Qualitative research is used to understand phenomena from the perspective of a particular population group (Denzin & Lincoln, 2000). Qualitative approaches have the capacity to empower their participants to share their perspectives in ways that may not be represented in literature (Creswell, 2014). This study allowed children to express their
views on their digital play, a valuable contribution to current literature, which tends to convey only the perspectives of adults. The qualitative design of the study facilitated the significant inclusion of children’s perspectives in the discourses around digital play experiences. Addressing the imbalance of power relationships between adults and children, this study used the strength of qualitative research to contribute to the development of theories based on the distinct experiences of its participants (Creswell, 2014).

The following characteristics are critical to qualitative designs and this inquiry:

**The researcher as a key instrument for data collection.** In qualitative research, the researcher is considered a key instrument of data collection (Merriam, 1998) as they engage directly with participants and observe them in their natural environment. A qualitative paradigm allows the researcher to sensitively respond to the research questions by gathering descriptive accounts from the perspectives of participants within a chosen context (Merriam, 1998). In this inquiry, the researcher engaged directly with the child participants and observed them in situ. This allowed the researcher to gain insights into the perspectives of young children’s digital play and the ways these children engaged with apps.

**Data collection within authentic/ natural environments.** In qualitative research, the researcher often collects data at the site where the participants experience the issue being studied, gathering information by observing and talking to the participants as they behave and act within their context (Creswell, 2013). In this research, the formation of a regular Digital Playgroup in a facility designed for children was critical to create an environment where the children felt comfortable, were able to express their views on their digital play experiences and could engage in play with apps while being observed.
**Multiple methods.** In qualitative research, the researcher gathers multiple forms of data from interviews, observations and documents, rather than relying on a single data source (Creswell, 2013). In this inquiry, the researcher collected data through informal conversations with the children, observations of children’s play and an analysis of the artefacts produced by the children.

**Emergent design.** In qualitative research, the research process is emergent (Merriam, 1998). This means that the initial plan for the research process may change or shift after the researcher begins to collect data. In this inquiry, DBR guided the inquiry and provided a structure within which the researcher was able to make ongoing decisions throughout the phases, collecting further data to ensure adequate information was being gathered to learn about the problem and to participate in the best practices to find that information (Creswell, 2013).

**Children’s Rights Methodologies and Children as Co-researchers**

The research of children’s perspectives on the use of technologies is relatively new, given that current understandings tend to be based on adult perspectives from educators, parents and carers, and software designers (Verenikina, Kervin, Rivera & Lidbetter, 2016). It is important to obtain children’s perspectives because they are capable members of society who can make valuable contributions from their experiences with technology (Danby, Davidson, Theobald, Houen & Thorpe, 2013; Harcourt & Einarsdottir, 2011; Plowman, 2016). Additionally, children’s perspectives of and their relationships with technologies shift as they move through the different stages of development and as technologies change (Ergler, Kearns, Witten & Porter, 2016).

Children have rights to make decisions to affect changes in matters that affect their lives. The rights of a child to provision and participation in making decisions regarding activities typical to their age is legally mandated by the 1989 UNCRC, which also asserts
that children should be protected from potential risk or harm (Alderson & Morrow, 2011). Children’s rights to express their opinions, derived from Article 12 of the UNCRC, is the foundation for the translation of these rights into rights-based research. Its implementation in combination with children’s right to choose their medium of expression (Article 13) and their right to protection from risk or harm (Article 36) give children the opportunity to make informed decisions that are given weight. In this manner, suitable and appropriate research practices are implemented to support children’s voices in influencing policies and practices that affect their lives.

Children’s involvement in decision-making is a key aspect in the application of Article 12 in research (Lundy, 2007). The facilitation of children’s involvement in decision-making is often a challenge (Beazely, Bessell, Ennew & Waterson, 2009). Without children’s influence in decision-making, their involvement in research becomes superficial or “tokenistic”, which can be alleviated by an awareness of the various levels of autonomy describing children’s involvement in decision-making (Lansdown, 2005):

1. Children are consulted by adults to obtain children’s perspectives.
2. Children are engaged in the process of designing and implementing the study.
3. Children self-initiate actions on an issue that they have identified, rather than acting in response to an adult-initiated concern.

Gaining children’s perspective is crucial and can be accomplished through the elements of the model of participation: space, voice, audience, and influence (Lundy, 2007). The four elements within the model present an interrelated order by which children’s decision-making can be supported. First, a “space” where children have the opportunity to express their views should be made available. Second, within this space, the children’s “voice” should be facilitated such that children can express their views in a medium of their own choosing. Third, the views of the children should have an “audience” committed to listening to them. The vital fourth element in the model of participation is
ensuring that the children’s views and decisions “influence” appropriate actions. Following this model, adults are obligated to actively seek children’s views and give them due weight.

Giving children’s voices due weight is a crucial element in the propagation of children’s rights methodologies, which is an application of Article 12 of the UNCRC (Lundy, 2007.) However, giving children’s views due weight is compromised by any discomfort that children may have in expressing their opinions to adults (Hanna, Risden & Alexander, 1997).

Lundy and McEvoy (2011) argued that it is essential to include process training for children as co-researchers to be truly active participants of the research process. They suggested that children should be facilitated to be aware of “the techniques of data collection and analysis so that they can conduct research themselves or work as data collectors or peer researchers in child or adult-led teams” (Lundy & McEvoy, 2011, p.131). The participation of children as co-researchers can be established through a CRAG, assisting children in developing, expressing and implementing their views. This method was adopted in this study to provide a framework for children’s active engagement as co-researchers alongside the adult researcher. However, because this approach has not been previously used in the context of children and digital technologies, several additional, context-specific procedures were developed; these are described below.

In early childhood literature, establishing children’s freedom of expression is considered significant in working with children so that they can freely express their ideas (Dockett, Einarsdottir & Perry, 2009). In this study, children’s freedom of expression was addressed by establishing the role of children as members of the CRAG within the research space, creating conditions in which children were listened to and placing
appropriate weight on the resulting effects of the children’s decisions. The children’s freedom of expression was also facilitated by allowing them different ways to express themselves through drawings, images and oral expression. These modes of expression are familiar to children and limited the reliance on written expression, which some young children are not yet familiar with (Sumption, 2003). The participants were made aware of the specific roles of that the children held as participants to the study. They were informed of the research activities and were given opportunities to discuss these with the researcher at the beginning of the session. The conscious approach of the researcher to confirm children’s expression ensured a validated understanding of the children’s perspectives.

Opportunities for decision-making was offered to participants at every step of the study, especially since initial consent does not mean a blanket consent for the variety of research data collection methodologies employed. These adopted methodologies became part of “rituals and routines” that helped the children to understand their role in the research space (Sumption, 2003). In this study, rituals and routines allowed the children freedom to move around the space as they wished, including walking around, standing up, going over to other children to see what they were doing and freely having conversations with each other. They also were offered snacks, which were available at any time during the research session; they were not required to ask for permission. Further details on these procedures are provided in the sections of this chapter where the iterative cycles of DBR is described and where the ethical considerations are discussed.

**Children as Design Partners in Application Development**

Studies within the field of HCI, and, in particular, CCI informed the interdisciplinary approach used in this study. Children’s voices in relation to the development of technology have been explored in this field over the past two decades by engaging children in testing of software (Hanna et al., 1997). Research in CCI acknowledges the
predominant influence that adults have over children’s engagement with technologies (Read & Bekker, 2011). Adults drive the design, development and distribution of technologies targeted at children. Additionally, adults have assumed authority over children’s access to technologies and the regular practices surrounding the use of these. Therefore, as expressed by Read and Markopoulos (2013), CCI research seeks to resolve these challenges by focusing on the shaping of interactive technology design to suit the specific needs of children and to develop methodologies for the design and evaluation of technology for and with children.

**Interactive technology design for children.** Children’s interactions with technology are inherently distinct from adult practices since they engage in different types of activities, have different abilities, are physically different in size and, as such, exhibit behaviours related to these characteristics when engaging with technologies (Read & Bekker, 2011). Research in CCI is concerned with how these components affect children’s engagement with technologies, with additional considerations regarding the type of involvement that children have in the process of development.

Read & Bekker (2011) revealed key understandings of children’s interactions with technology in the field of CCI. Play is the predominant activity children for which children engage with technologies and is deemed separate to using technology for learning or communicating. Further, children’s engagement with technologies for play is self-initiated. This is an important characteristic of digital play that mirrors the sociocultural definition of play. Since children’s engagement in play, whether traditional or digital, is spontaneous and initiated by the children themselves, their involvement in the development process conveys that their concerns are accordingly different to those of adults. While adult concerns revolve around the design and usability of technology, children are more interested in whether the digital play experience is “fun” and how its features facilitate “playability” (Van den Abeele & Zaman, 2008).
Methodologies in designing and evaluating products for children with children. Using methodologies that involve children in the process of designing is emphasised in CCI as a relevant approach in exploring the relationship between children and technology. These methodologies aim to inform the design, development and evaluation of technologies designed for and with children, distinguishing the increasing levels of participation children have in the design of technology (Druin, 2002; Markopoulos & Bekker, 2003). At the lowest level of participation, CCI engages children as users in usability testing to observe how children use a product that is already available in the market. At the next level of participation, CCI engages children as testers in testing a product prior its release to the public. CCI involves children as informants, at another higher level of participation, who offer design ideas regarding products, with the final decisions made by adults. At the highest level of participation, children and adults work collaboratively to co-design a product as design partners.

In both user and tester roles, there is a tendency for children to participate in the design process after a product has been designed. For example, in usability studies in which children are observed as end users of a technology product, recommendations that determine differences between adult and children’s preferences for the design of interfaces are proposed to cater for the needs of children aged three to 12 years old (Nielsen & Budiu, 2013). Involving children as testers of software, meanwhile, engages children in a range of objectives such as performing a direct comparison of two software applications, identifying functionality issues or examining their preferences between touch screen and keyboard and mouse input controls (Celis et al., 2013; Lucero, Karapanos, Arrasvuori, & Korhonen, 2014; Sim & Horton, 2012; Sim, MacFarlane, & Read, 2006). In these cases, as it is not clear how children’s perspectives influence the final design of the products, both user and tester roles imply that, while children are indeed consulted, their involvement in the overall decision-making process is “tokenistic”.

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CCI research engages children in the evaluation of technology products using child-friendly tools that measure the children’s user experiences. The Fun Toolkit (Sim, McFarlane & Read, 2006; Sim & Horton, 2012; Sim, Read, Gregory & Xu, 2015) is an evaluation tool that adopts three different measures to demonstrate children’s motivations for play: the “Smileyometer”, the “Fun Sorter” and the “Again-Again” table. The Smileyometer is a visual five-point Likert scale ranging from “awful” to “brilliant”, accompanied by an appropriate smiley face. It is used to determine children’s expectations before interacting with an app or piece of software and their reactions after interacting with the app or software (Sim & Horton, 2012; Sim et al., 2015). The Fun Sorter invites children to make comparisons between different games and apply a comparison of “best” or “worst” to selected aspects of the app or software, using terms such as “fun” or “easy to play” (Sim & Horton, 2012; Sim et al., 2015). The Again-Again table allows children to select “Yes”, “No” or “Maybe” in response to questions such as “Would you like to play this game again?” (Sim & Horton, 2012; Sim et al., 2015). These tools use visual scales and organisers to explore the feelings and opinions of children regarding the notion of fun as an application of Malone’s taxonomy (1980), which states that children’s engagement with computers and technology is driven by their intrinsic motivation.

An evaluation of the reliability of the Fun Toolkit provides evidence for obtaining children’s preferences regarding the constructs measured (Read & McFarlane, 2006; Sim & Horton, 2012) and also acknowledged the limitations of these tools. The suitability of the Smileyometer for obtaining the perspectives of children under five years old was disputed as these children tend to award the highest positive option, “Brilliant”, when evaluating products (Read & McFarlane, 2006). Further, it is also acknowledged that these tools overlap in measuring similar constructs and, as such, the design of evaluation tools should be methodically deliberated to facilitate a thorough evaluation of children’s perspectives (Read & McFarlane, 2006; Sim & Horton, 2012).
Involving children as design partners in the design and development of apps is consistent with children’s rights methodologies in the application of Article 12 of the UNCRC (Lundy, 2007.) Ensuring that children are actively engaged in the design process, as either informers or as design partners, elevates the level of children’s participation to a point at which their views have direct influence on the design of the product in question (Druin, 2009). When children are involved in the generation of ideas through to the evaluation of the design of the technology, this implements an appropriate level of engagement and ensures that children’s ideas are given due weight.

Various approaches to gaining children’s perspectives on software design are reported in the CCI literature. Paper prototypes (Bilal, 2003) have been used to engage children in usability testing of web search engines; children used drawing materials such as paper and coloured markers to generate their own interface design for a hypothetical web search engine. Brown et al. (2010) used clear transparencies set on top of mobile devices to engage children in expressing their preferences for navigational touch screen gestures in the design of mobile applications. A range of tangible objects and arts and crafts materials were used to engage children in “low-tech” prototyping to generate ideas for technologies that did exist or did not exist at the time of the study (Druin, 2009). Additionally, children evaluated these ideas collaboratively by indicating their “likes”, “dislikes” and “suggestions” for the improvement of the design. Further, Guha et al. (2005) proposed the incorporation of intergenerational partnerships between adults and children in developing and evaluating children’s ideas for technology designs. In this methodology, the analogy of baking with separate ingredients that combine to produce an appealing product was used to develop a sense of collaboration among the adults and children involved in the design process.

Evident in these studies are the rapid changes in the types of technology that have occurred over the last two decades, accompanied by the shift in children’s expertise in
and expectations of technology. These changes indicate the pertinent role of CCI in informing the future design of children’s interactions with technologies that may not yet be defined. CCI research can inform the future design of children’s interactions with technologies by:

- defining models and guidelines for the design of interactive experiences for children
- conducting empirical research to inform these models and guidelines
- facilitating further research into children’s participation as designers and users of technology (Read & Markopoulos, 2013).

In summary, this thesis employed CCI methodologies to engage children as design partners in co-designing an app for preschoolers to facilitate an understanding of children’s perspectives of digital play. The children’s design ideas offered empirical evidence to contribute to existing criteria or models for quality digital play, guide the design and implementation of digital play experiences for children and contribute to the research on methodologies in which children participate as co-designers of technology.

**Design-Based Research**

DBR is not a research methodology but an approach best suited to addressing a practical problem through an innovative solution with a long-range goal of informing future practice (Kervin, Vialle, Herrington, & Okely, 2006). DBR is also referred to in the literature as “educational design research” (McKenney & Reeves, 2012, 2019), “design research” (Bakker, 2019) or “development research” (van den Akker, 1999); in this study, “design-based research” (Bakker & van Eerde, 2013) is preferred.

DBR sits within the qualitative paradigm as it aims to articulate clear theoretical perspectives that emerge from rigorous, prolonged data collection periods and deep analysis that builds the credibility of findings (Creswell, 2014; Reeves, 2000, 2006). The
blend of theory and practice is a fundamental element of DBR that distinguishes it from other methodological approaches. A typical application of educational DBR is the design, development and evaluation of programs, teaching materials and products including technology products.

Joseph (2004) argued that the goal of DBR is to contribute to “research, design and pedagogical practice” (p. 235). This enables a practical research design; a challenge or “problem” is first identified and then a “solution” is found through research and discussion with those affected by the problem. Using iterative cycles of data collection and analysis, the solution is tested and its principles modified at each iteration in response to data analysis. The aim is twofold: to refine theory and to refine practice (Collins, Joseph & Bielaczy, 2004). The researcher uses the findings to identify principles that contribute to a deeper understanding of the problem, which will advance knowledge of theoretical methodologies and present practical applications for the field.

The following characteristics of the DBR approach signify its suitability to the current study’s research design. DBR is theoretically grounded (Bakker, 2019; McKenney & Reeves, 2019). The study’s objective of elaborating on current theoretical understandings of children’s digital play is founded on theories of play and builds on the current criteria for developmentally appropriate design of apps for children. These theories informed the design-oriented solution of collaboratively designing an app with children so that they could share their perspectives regarding preschooler apps. DBR solutions are intended to be interventionist, affirming conjectures through empirical testing to develop theoretical understandings (McKenney & Reeves, 2019). The development of theory is accomplished through reflective practices and iterative cycles, which are characteristics of DBR studies (Bakker, 2019; McKenney & Reeves, 2019). The multiple iterations of the design of the app permitted the development of design principles for preschooler apps, which are presented as the theoretical outcomes of this study. The strength of DBR
in forming theoretical understandings is derived from the three phases of identifying a problem, proposing a solution and conducting an evaluation. These phases of DBR in relation to the study’s research design are discussed below.

**Phases of design-based research.** Typical to a DBR approach, this qualitative study has both practical and theoretical goals that informed the research design sequence (Kervin et al., 2006; McKenney & Reeves, 2012; van den Akker, Gravemeijer, McKenney, & Nieveen, 2006). It aims to implement a systematic process of co-designing an app as conceptualised by children, with the aim of disseminating design principles that contribute to theoretical understandings of the developmental benefits of digital play for young children. The dual outcomes of the study were realised through the three core phases of DBR, as follows:

- **Phase I** involved the identification of the problem, which was researched through analysis and exploration.
- **Phase II** focused on the design and construction of a solution.
- **Phase III** involved the evaluation of the solution and a reflection on the research process.

Figure 3.1 depicts the three core phases of DBR. The development of a practical innovation is represented in the white boxes and is where the design and development of an app for preschoolers occurred. The development of a theoretical understanding of children’s play experiences is represented in gray. Each phase of the DBR study produces a theoretical outcome — in the form of design principles for preschooler apps — and a practical contribution to design methodologies for obtaining children’s perspectives. The arrows between each core phase and within the core phases in Figure 3.1 indicate the iterative nature of the DBR process adopted in this study. The iterative cycles enabled the formulation of a set of initial design principles between Phases I and II, which were further refined at the end of Phase III. Details of the research activities within the separate
cycles are discussed after a description of how the three core phases of DBR were implemented in this study.

![Design-based Research Process]

*Figure 3.1. The design-based research process. Adapted from McKenney and Reeves, (2019, p.83).*

**Phase 1: Analysis and exploration of the problem.** The first step, exploring and identifying the problem, is key to addressing the gap between a desired outcome and actual practice (McKenney & Reeves, 2012; McKenney & Reeves, 2019). The objective of the first phase in the current research was to define the problem and identify the scope and design of the research to be conducted. The analysis and exploration phase for this study involved two activities to identify the research problem:

1. A review of empirical and theoretical literature on children’s engagement with digital technologies was conducted as a theoretical analysis to identify the research issue and its scope.

2. An exploration of the current practices of children’s digital play further determined how children perceive their digital play experiences.
The outcomes of the analysis and exploration of the problem formed the basis for a set of initial design principles for the design of preschooler apps, which was explored as a component of Phase III of the study. Table 3.1 outlines how the research activities, collected data and processes involved in the analysis of the data in Phase I correlated with the research questions.
Table 3.1
*Data Collection Procedures for Phase I of the Design-Based Research Study*

<table>
<thead>
<tr>
<th>Research activities</th>
<th>Participants</th>
<th>Data collection</th>
<th>Data analysis for the development of initial design principles (RQ1)</th>
<th>Data analysis for obtaining the perspectives of children (RQ2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review of literature</td>
<td>No participants. Conducted by the researcher</td>
<td>Literature regarding:</td>
<td>Thematic analysis of literature to identify:</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• childhood development in the field of education</td>
<td>• design features of technologies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• computer-child interaction regarding the design and evaluation of technology for children</td>
<td>• design principles that promote quality digital play experiences for children</td>
<td></td>
</tr>
<tr>
<td>Understanding children’s digital play</td>
<td>CRAG, as co-researchers</td>
<td>• photographs of spaces for digital play to stimulate discussion about spaces for and practices of digital play</td>
<td>Thematic analysis of:</td>
<td>Identification of design processes which engaged children in decision-making</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• screenshots of selected apps to stimulate discussion around features of apps</td>
<td>• children’s reflections on their own digital play practices</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• group discussion of features of preschooler apps</td>
<td>• the perspectives of children regarding features of apps for preschoolers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• recorded conversations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Phase II: Design and construction of the solution.** The objective of Phase II in DBR approaches is to explore and map out practical solutions to a research problem. The processes undertaken in the design and construction of solutions are systematic despite the diverse nature of research problems and the solutions designed to resolve these (McKenney & Reeves, 2019). This study facilitated an approach that made it possible to obtain the perspectives of children and give them a voice in influencing their own digital play experiences. The study resolved this issue of gathering children’s views by drawing on CCI methodologies in incorporating children’s perspectives as design partners in the co-design process of app development for young children.

During Phase II, the CRAG generated and developed design ideas for the co-design of an app with preschool children as its target audience. The researcher developed prototypes of the co-designed app based on the children’s ideas as stimulus for further refinement of the children’s ideas. The generation and checking of ideas are typical processes employed in the exploration of solutions, just as the development of prototypes is a typical method for constructing solutions to the research problem (McKenney & Reeves, 2019). The data collection strategies employed within this phase are detailed alongside the discussion of the iterative cycles of the research design.

The outcomes of the design and construction phase informed the activities of Phase III, which conducted an evaluation and reflection of the practical activities of Phase II. Table 3.2 outlines how the research activities with the CRAG, the collected data and the process of data analysis correlated with the study’s research questions.
<table>
<thead>
<tr>
<th>Research activities</th>
<th>Participants</th>
<th>Data collection</th>
<th>Data analysis for the development of initial design principles (RQ1)</th>
<th>Data analysis for obtaining the perspectives of children (RQ2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-design of app with the researcher</td>
<td>CRAG, as co-designers</td>
<td>• app icon drawings</td>
<td>Thematic analysis of: • the perspectives of design ideas presented by the children</td>
<td>Identification of design processes which engaged children in decision-making</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• low-tech prototyping using arts and crafts and laminated drawings</td>
<td>• the perspectives of children regarding interactive features of preschooler apps</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• screen-based prototype displayed on an iPad</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• recorded conversations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prototype development by the researcher</td>
<td>No participants Conducted by the researcher</td>
<td>Not applicable. These were presented to the children for feedback in the co-design stages of the research.</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
Phase III: Practical evaluation and theoretical reflection. Phase III is two-fold: it concerns the systematic evaluation of the data collection followed by a retrospective reflection of the findings from the evaluation (McKenney & Reeves, 2019). For this study, an evaluation of the methodological approaches employed to obtain the perspectives of children is reviewed by the researcher. Additionally, the formulation of theoretical understandings was undertaken. In DBR studies, theoretical contributions are intended to be “actionable” in that the purpose of the study is to inform current practices. Theoretical outcomes from DBR studies include conjecture maps or learning trajectories resulting from the lesson design intervention or solution (Bakker, 2019). In this study, the theoretical reflections allowed the researcher to identify, refine and develop a set of design principles for the preschooler apps based on the collected perspectives of children to inform understandings of quality design of apps.

Bakker (2019) described design principles as criteria or guidelines accompanied by reasons or goals that are intended to be achieved. Design principles can have concrete and specific requirements rather than simply providing general directions. In this study, the design principles evolved and were refined during the iterative cycles of DBR. The formulation of the design principles in the iterative cycles validated the findings and indicate their robustness as a theoretical result of the study. In this case, generalisation of results is defined by the inclusion of design principles as they evolved throughout the phases of the DBR (Bakker, 2019).

Table 3.3 outlines how the practical evaluation and the theoretical reflections correlated with the study’s research questions, which types of data collection procedures were conducted and the process of data analysis, which allowed the proposition of a set of design principles that were developed over the iterative cycles of this study.
Table 3.3
Data Collection Procedures for Phase III of the Design-Based Research Study

<table>
<thead>
<tr>
<th>Research activities</th>
<th>Participants</th>
<th>Data collection</th>
<th>Data analysis for the development of initial design principles (RQ1)</th>
<th>Data analysis for obtaining the perspectives of children (RQ2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structured reflections</td>
<td>CRAG, as co-researchers</td>
<td>• Recorded conversations</td>
<td>Thematic analysis of:</td>
<td>Identification of design processes that engaged children in decision-making</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• the perspectives of children regarding design features of preschooler apps</td>
<td></td>
</tr>
<tr>
<td>Digital Playgroup with</td>
<td>CRAG, as co-researchers and preschoolers</td>
<td>• Screen-based prototype displayed on iPads as stimulus for conversations</td>
<td>As above</td>
<td>As above</td>
</tr>
<tr>
<td>preschoolers</td>
<td></td>
<td>• Recorded conversations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theoretical reflection</td>
<td>No participants, conducted by the researcher</td>
<td>No additional data collected during theoretical reflections</td>
<td>As above</td>
<td>As above</td>
</tr>
<tr>
<td>by the researcher</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design-Based Research Sequence

This section presents the design sequence adopted in the implementation of the DBR approach to co-design of the app. The phases of DBR is iterative. These cycles of iteration, distinct to the DBR approach, denote that the research activities can inform both the succeeding phases and, retrospectively, inform prior phases of the inquiry (Bakker, 2019; Reeves, 2006). In DBR, the cycles of iteration do not necessarily occur over the three core phases but can also occur as a micro-cycle (Bakker, 2019; McKenney & Reeves, 2018). In this study, the design sequence followed the iterative cycles of the theoretical and product development processes involved in co-designing an app.

Figure 3.2 demonstrates how the study’s design sequence centres around the facilitation of iterative cycles within the study, rather than the different phases of DBR. Data collection involving the CRAG and preschoolers as participants is indicated in yellow and green respectively. Each cycle ends with a theoretical reflection conducted by the researcher. These theoretical reflections, indicated in red in Figure 3.2, enabled the researcher to review the development of design principles based on the perspectives of children regarding preschooler apps. The remaining activities, in gray, refer to activities undertaken by the researcher in response to the preceding activity or in preparation for the succeeding activity within the cycle. Appendix A offers an overview of the research activities employed at each cycle of the design sequence. The details of each research activity are presented in the subsequent discussions of the first cycle, subsequent cycles and the last cycle.
First Cycle: Gathering the Children’s Research Advisory Group’s Perspectives of Digital Play with Apps

The focus of the first cycle in the study design was gaining a better understanding of children’s experiences of digital play with apps. In this cycle, the research activities included a review of literature regarding children’s use of technologies, the participation of the CRAG in activities to share their perspectives of digital play and the development of initial design principles conducted by the researcher.

Table 3.1 demonstrates the correspondence of each activity in the first cycle with Phase I and Phase III of the research design. The literature review presented in Chapter 2 and the activities in which the CRAG participated to demonstrate their understanding of children’s digital play relate to Phase I of the DBR study, in which the problem of children’s perspectives of digital play was analysed. The development of initial design principles was the result of the first stage of theoretical reflection conducted by the researcher.
researcher. This corresponds with Phase III of the study, in which the evaluation of the design-oriented process and a reflection of findings occurred.

The purpose of engaging the CRAG as co-researchers was to offer opportunities for the CRAG to share their understandings of digital play environments and preschooler apps.

The activities in this cycle required the CRAG to:

1. take photographs of the physical spaces where digital play took place in their home settings. These photographs were shared with the researcher and the other CRAG members.

2. use their own devices to play with an app selected by them. Each CRAG took screenshots of two to three screens from their selected apps. The screenshots were used as a guide by members of the CRAG to share with the group their perspective of what was occurring in the app.

3. participate in a group discussion to share their understanding of design features of preschooler apps.

Taking photographs and engaging with selected apps contributed to the CRAG’s understanding of preschool children’s digital play environments, addressing the requirement that the CRAG should understand preschool children’s digital play experiences before generating ideas for a co-designed app.

Subsequent Iterative Cycles: Development of a Co-designed App for Preschoolers with the CRAG

The focus of the subsequent cycles of the study was to obtain the shared perspectives of the CRAG of preschooler apps. The subsequent cycles of the study engaged the CRAG in generating and developing their ideas for an app for preschoolers while the researcher developed prototypes of the app in response to the children’s design ideas. A theoretical reflection by the researcher to refine the design principles at the end of each cycle was
also conducted. The three iterative cycles supported the development of individual design ideas into a shared understanding of preschooler apps among the members of the CRAG.

Table 3.2 demonstrates the correspondence of each activity in the subsequent cycles with Phase II and Phase III of the research design. The CRAG’s engagement in the co-design of the app and the prototype development conducted by the researcher both relate to Phase II of the DBR study, where the design and construction of a solution to address the lack of children’s perspectives was proposed and implemented. The reciprocal exchange between the children’s design ideas and the prototype developed by the researcher informed the ongoing refinement of the design principles for preschooler apps. This theoretical reflection conducted by the researcher corresponds with Phase III of the study, wherein the evaluation of the design-oriented process and a reflection of findings took place.

Children’s Research Advisory Group shares design ideas for the co-design of an app. The CRAG was involved from the early stages of designing and redesigning ideas for the app through their participation in several design-oriented activities adapted from CCI methodologies for the co-design of technology with children (Brown et al., 2010; Druin, 2009). To generate design ideas for the app, the CRAG engaged in a drawing activity to create an app, accompanied by a small piece of text explaining the app, then used arts and crafts materials to represent their ideas in detail, accompanied by conversations about how their app worked. The children’s design ideas were further elaborated through the CRAG’s engagement in the following design activities: a) presenting their ideas to the rest of the CRAG and mixing their design ideas to form one design to establish a shared understanding; b) exploring interactivity through manipulation of paper prototypes of the app design; and c) trialling a screen-based prototype of the app. Conversations with the CRAG regarding suggested detailed designs were recorded, transcribed and thematically analysed to identify the unique perspective
that children had regarding generating ideas for an app for preschool children.

**Researcher develops prototype based on children’s ideas.** The design propositions co-formulated by the CRAG in the iterative cycles were transformed by the researcher into varying stages of prototypes by the researcher with partial components and semi-working functionality (Druin, 2009). The varied formats of prototyping employed by the researcher were developed in response to the data collected from the children’s design ideas. These included the development of a mock App Store to showcase the app icons designed by the children, laminated paper prototypes of the children’s design ideas to initiate an exploration of interactivity and a screen prototype of the children’s design ideas using the Adobe Creative Suite. The prototype development involved the creation of digitised vector images of the laminated paper prototypes using Adobe Illustrator and the scripting of interactive and animated elements of the app using Adobe Animate. Coding of the prototype involved the use of ActionScript 2, an action-oriented programming language native to Adobe Animate. Adobe Animate was selected by the researcher for its capacity to publish applications for the iPad’s iOS operating system. The researcher obtained an Apple Developer license, which allowed the different versions of the prototype to be uploaded on devices for testing.

**Last Iterative Cycle: Observing Preschoolers Engaging with the Co-Designed App**
The focus of the last cycle of iterations was to obtain the perspectives of preschoolers regarding the co-designed app as an evaluation of the design-oriented study. The last cycle of the co-design process engaged the CRAG as co-researchers in observing preschoolers playing with the app while the researcher continued to develop the prototype of the app design in response to the children’s design ideas. A final theoretical reflection was also conducted by the researcher at the end of the last cycle to propose a set of design principles for preschooler apps as a theoretical contribution of the study.
Table 3.3 demonstrates the correspondence of each activity in the last cycle with Phase III of the research design. The CRAG’s role as co-researchers in observing the engagement of preschoolers with the co-designed app served as an evaluation of the design methodologies employed to obtain the perspectives of children. In this activity, the CRAG shared and modelled their interactions with the co-designed app and also gathered the views of the preschoolers regarding their engagement with the co-designed app. These methodologies, employed by the CRAG during the Digital Playgroup sessions, were selected and enacted by the CRAG as the suitable approach for employment during the Digital Playgroup sessions. In the CRAG’s role as observers, the methodological decisions that guided their inquiry is typical of the emergent characteristic of qualitative research (Creswell, 2013) and also matches the reflective characteristic of DBR, wherein the next step of the study is informed or adjusted in response to data collection (Bakker, 2019; McKenney & Reeves, 2019).

The theoretical reflection conducted by the researcher consolidated the design principles presented in the children’s design ideas over the different cycles of the study. The analysis of these findings indicated how observations of preschoolers engaging with the co-designed app contributed to the proposed design principles for preschooler apps.

**Recruitment and Overview of Participants**

Two distinct groups of participants, the Digital Playgroup and the CRAG were involved in the study. The participants were recruited from a group of 17 children and their six older siblings, based on their previous participation in the ARC Discovery Project (ARC DP140200328). The younger cohort of children were four preschoolers aged between three and five years old who had regular access to the use of mobile technology, specifically an iPad. These children attended the Digital Playgroup, where they were observed as they engaged in digital play. The CRAG comprised of six primary school-aged children aged between five and seven years old who were previously participants of
the Digital Playgroup or who were the older siblings of a preschooler from the Digital Playgroup. The CRAG assumed multiple roles as co-designers of an app and co-researchers of the study.

The homogenous sampling of the participants of the CRAG and the Digital Playgroup who had prior engagement in the ARC Digital Playgroup was purposeful. The researcher had already established a rapport with the families and young children who were participants in the research study. The sampling procedure also established that the participants met the criteria of having regular engagement with mobile technology for play. The time invested by the researcher in establishing these relationships with the participants is a characteristic of qualitative research that increased the opportunities for acquiring information-rich data (Creswell, 2013). It is also recommended in children’s rights methodologies as an ideal method for gaining a true understanding of children’s experiences (Dalli & Te One, 2012). Appendix B provides an overview of the children who participated in this inquiry. This overview offers further details regarding each participant’s involvement in the Digital Playgroup associated with the study.

The study was conducted within the Playful Learning Space, an Early Start facility at the main campus of the University of Wollongong. The Playful Learning Space is a dedicated early childhood facility that is furnished to resemble a preschool, complete with child-friendly furniture. The Digital Playgroup had been facilitated in the same venue for two years as part of the larger ARC project at the time of data collection. Maintaining a familiar venue that families and participants already associated with previous research on digital play established continuity and ascertained the comfort of the participants, allowing the research to be conducted in an environment conducive to qualitative research designs (Creswell, 2013).
Data Sources

The data collected from a range of sources throughout the inquiry are described and justified here in connection with the research questions and participant groups within each phase. Some of these were presented in Tables 3.1 to 3.3. This section provides an overview of all the methods used for data collection.

Listening to children can involve a range of methodologies which create opportunities for the expression of children’s thinking (Conroy & Harcourt, 2009). Each child comes from a variety of backgrounds; therefore, using a variety of methods facilitates different ways of understanding children and their perspectives (Alderson & Morrow, 2011; Docket, Einarsdottir & Perry, 2009; Lundy, 2007). Such methods can include:

- conducting informal conversations with children
- encouraging children to keep journals
- providing opportunities to draw
- incorporating photo and video tours
- using arts and crafts.

These methods were all incorporated in the design of the current study. The use of qualitative audio and visual materials such as photographs, video footage and art objects is classified as visual ethnography. In visual ethnography, the different types of data represent the context in which they are situated in and are open to interpretation; the researcher’s understanding and awareness of the participants and their experiences is the basis for decision on which specific visual methods are appropriate to the study design (Pink, 2001).

In this study, the CRAG had multiple opportunities to directly share their realities through audio-visual materials, such as photographs of spaces in their homes where digital play occurred and the apps that they selected to play on their personal devices. The
use of audio-visual materials offers an advantage because they were unobtrusive in that the researcher did not need to enter the homes of the participants to gain the valuable insights shared by the children. The researcher ensured a valid interpretation of the data by enabling the children to use the audio-visual materials as stimuli for sharing their perspectives.

The study also employed the use of arts and crafts, opportunities for the children to draw and keep journals. With these types of data collection, the researcher supported the children in expressing their perspectives through the use of their own words and images. The advantage of these types of data is that they have been identified by the participants as significant; the limitation, however, is that not all children are articulate, perceptive or consistently willing to share their ideas (Creswell, 2013).

Throughout the data collection phases of the research study, observations of the children’s participation and interactions were conducted by the researcher, both as an observer and as a participant in the research study. Researcher’s keen awareness of developing rapport is key, especially when young children are involved as participants in a study (Creswell, 2013). The children’s familiarity with the Digital Playgroup site, their co-participants and the researcher ensured that they were comfortable and willing to participate and share their views within the space.

All data collection sessions were recorded on two to three video cameras set on tripods and three audio recording devices to capture the different conversations and interactions taking place. A total of 38 hours and 27 minutes of video footage and 32 hours and 8 minutes of audio recordings was collected over the duration of the study. This precaution improved reliability by avoided bias based on what the researcher could remember from the data collection sessions (Bakker, 2019). The observations conducted by the researcher enabled the researcher to make notes and record key information as these occurred.
Audio footage and video recordings were stored in an external hard drive with a back-up on a password-encrypted network server. Other types of data such as images, artworks and journal entries produced by the children were digitised and filed, as were the prototypes created by the researcher. These were stored securely in the same storage system as the video and audio data. (See Appendix C to view how an audit of the range of data collection types was documented.)

The use of multiple methods offered children a sense of control in their participation in the research study. Additionally, employing a range of methods offer children a choice in how to participate in the research, complying with Article 13 of the UNCRC, which indicates that it is the right of a child to express their views in a medium of their own choosing (Docket et al., 2009). Both the structured and unstructured recording of activities in this qualitative study continued until the point of saturation, at which the gathering fresh data no longer revealed new insights (Guest, Bunce & Johnson, 2006).

**Data Analysis**

Researchers’ awareness of the assumed authority of an adult is a crucial consideration in ensuring that children’s views are listened to. Therefore, the exchange of information between researchers and the children should allow open communication and discussion to achieve a mutual understanding of the experiences shared by the children (Alderson & Morrow, 2011). Further, children should also be represented in the analysis of the research data to ensure that the data is interpreted from a children’s perspective, rather than through an adult’s interpretation of children’s perspectives (Dockett et al., 2009).

**Data Analysis Approach**

The iterative cycles of data collection formed part of the DBR approach employed in the study and informed the process of data analysis which took place at the end of each cycle. The data analysis for this inquiry used the constant comparison method (Glaser & Strauss, 1967). This is an ideal method for a systemic analysis of data from multiple
sources (Bogdan & Biklen, 1998), which fits the inductive process of data analysis typical of qualitative research (Creswell, 2013).

Using the constant comparison method permits the researcher to conduct analysis from the early stages of data collection (i.e., the first cycle of iteration). The emergent nature of qualitative research permits the researcher to make considerations for the succeeding research activities based on this analysis (Creswell, 2013). The constant comparative method was appropriate for this inquiry because it allowed the data to be considered throughout the collection process, informing subsequent data collection decisions and direction. The constant comparative method is non-linear in design as the researcher moves between data collection, analysis and further collection driven by emerging understandings from codes and memos (Boeije, 2002; Bogdan & Biklen, 1998). The cyclical nature of the analysis suited the underpinning design of action research, self-study and the DBR approach.

Figure 3.3 illustrates how the analysis of the data collected from each cycle occurred at the end of each cycle. These theoretical reflections contributed to the identification and redefinition of a set of design principles for the design of preschooler apps. The comparison of newly collected data with existing data examined the fit between the data and categories, directing reconsideration and modification of emerging theory in light of this analysis (Cohen, Manion, Morrison & Morrison, 2007). This process continued with the aim to achieve “theoretical completeness, when the theory is able to explain the data fully and satisfactorily” (Cohen et al., 2007, p. 494).
Figure 3.3. Data analysis within the iterative cycles of the design-based research study.

The initial stages of data analysis commenced with the organisation and preparation of large amounts of data typical of qualitative research (Creswell, 2013). The artwork and images produced by the CRAG were catalogued, sorted and organised. Likewise, the video footage and audio recordings were transcribed, catalogued and organised. (See Appendix C to view the audit of the data types collected in this inquiry.)

In qualitative research, inductive data analysis involves segmenting large amounts of data by reducing them into themes to make sense of the findings and develop theoretical understandings (Creswell, 2013). Similarly, the constant comparison method involves two complementary activities — fragmenting and connecting (Dey, 1993, in Boeije, 2002). The fragmentation of data considers individual pieces of data detached from the overall context of the research process, after which connections are made among the discrete pieces of data to form a complex and rich interpretation of findings derived from
the analysis (Boeije, 2002). Theoretical perspectives played a key role in guiding the analysis.

The analysis of data using the constant comparison method is achieved in three stages (Glaser & Strauss, 1967). These three stages are described below in relation to the process of data analysis adopted for this inquiry.

1. **Comparison of incidents and data to a category**: First, incidents and data are coded as fragmented pieces of information and then connected with either similar incidents or data from the same participant and also from other participants (Boeije, 2002; Cohen et al., 2007). For this inquiry, the coding of the collected data was based on specific attributes, characteristics and design features of apps referenced by the children while they played with apps, during their reflections on the design of apps for preschoolers and as they engaged in the process of co-designing an app for preschoolers. The coding of the data isolated design features that were identified by the children as significant and also included design features that emerged from the children’s conversations and design ideas. The themes presented in the analysis of these isolated fragments were then connected to the development of initial design principles for preschooler apps. Table 3.4 demonstrates an example of how design features were identified and isolated from the overall data. Figure 3.4 exemplifies how identified design features were connected to form an initial set of design principles for preschooler apps. The process of making these connections is detailed in Chapter 4.

<table>
<thead>
<tr>
<th>Coding of design features from transcripts in the first cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apps allow children to assume “roles of the characters” in the app as they play.</strong></td>
</tr>
<tr>
<td>• Ava: Get some corn and you need to stay on the track so you go on this. And you need to quickly turn. Then you go up here and you can bounce…(CST06.08)</td>
</tr>
<tr>
<td>• Henry: I’m trying to get all the coins. I’m really trying to run from the guy. (CST06.08)</td>
</tr>
<tr>
<td><strong>Apps allow children to gain a “sense of being in control” through a “range of choices”</strong>.</td>
</tr>
</tbody>
</table>

Table 3.4
Example of Coding Design Features of Apps in Transcripts
• Henry: I can show you what the different characters, what they do for different abilities. (CST06.08)
• Marnie: Well you can choose a character, if it’s not locked. So if I want to be her, I can be her. (CST06.08)

Apps enable children to make adjustments through “personalisation or customisation”.
• Researcher: ... how did you change the team name or does it change it for you?
  Owen: You get to... It starts out with “Vaughn” your last name “FC” and you can change it. (CST06.08)

---

**DESIGN FEATURES OF APPS**

<table>
<thead>
<tr>
<th>Identified while playing with apps</th>
<th>Identified while reflecting on preschooler apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apps offer indicators of progress as children play.</td>
<td>Preschooler apps motivate through rewards or points.</td>
</tr>
</tbody>
</table>

**INITIAL DESIGN PRINCIPLE**

Preschooler apps motivate through rewards or points and provide children with an indicator of progress during play.

*Figure 3.4. Example of how an initial design principle for preschooler apps is developed.*

2. *Integration of categories and properties within these categories:* This stage of the data analysis process slightly differs from that of the previous stage in that the incidents are not compared with other incidents of the same code. The comparison of incidents and data, in this stage, is focused on the properties within each category (Cohen et al., 2007). The comparison of the initial set of design principles from the first cycle with the data collected from the subsequent cycles enabled the confirmation and adjustment of design principles, as well as the identification of emerging design principles. Table 3.5 demonstrates how the data collected from the subsequent cycles confirmed and adjusted Design Principle 8. The process of identifying and defining the specific properties of
each design principle is reported in detail in Chapter 5. (See Appendix D to view how each cycle in this phase of the inquiry confirmed, expanded or identified a new design principle.)

Table 3.5
Example of Development of Design Principle 8 through Cycles 2 to 4

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
</table>
| Cycle 2 | The CRAG often used “I” or “you” to describe how the app design functioned, indicating they felt as if they were characters acting in the app:  
  - *Owen*: *If I went to the fire station and then if the bell rings, I would get into a fire truck then it will tell me which way to go.* (PPD20.08)  
  - *Henry*: *... you can draw with shapes and colours. You can make a smiley face with stars and shapes.* (PPD20.08) |
| Cycle 3 | The option to choose a character based on a popular athlete is an example of how the CRAG perceived that assuming a role of a character is a key feature of preschooler apps.  
  - *Ruben*: *This is where you choose a character in the sports stadium. There’s Usain Bolt, Steven Gerrard and Messi.* (CST03.09) |
| Cycle 4 | The CRAG described how the characters could be created to be a representation of themselves.  
  - *Owen*: *... you can take a picture of yourself then tap on the picture, then you go up to photos ... and the character who looks like you goes up on the street then you can move yourself around*  
  - *Ava*: *Or you can make your own body and then put your head stuck on it* (CST17.09)  
  The CRAG playfully switched gender stereotypes as they played in the character section. This is an example of emerging play which was not intended by the design. However, the analysis of this data is relevant in understanding the CRAG’s reflections regarding the adjustment of their representations.  
  - *Owen*: *I’m going to put Henry on this one. (He turns his iPAD to show the girls.) ... Look at Henry.*  
  - *London*: *(Turns her iPAD to Ava and Owen.) Look at Henry. (squealing and laughing) Look at Henry. He’s a beautiful lovely person girl.*  
  - *Owen*: *Look at Ruben. He’s the same thing as Henry.* (CST29.10) |

Extended Principle

#8: Preschooler apps allow children to assume the roles of characters that enable them to adjust the representation of themselves.

3. Development of theory: This stage achieves a theoretical analysis of findings wherein the findings from the data are justified and the underlying results of the study are identified (Cohen et al., 2007). The themes within this refined set of
Design principles were further connected with the criteria for quality digital play derived from the review of literature review to form a holistic understanding of children’s digital play with apps. The note-taking conducted by the researcher supported this process through the exploration of relationships and identification of themes within the data (Ryan & Bernard, 2000). A comparison between the theoretical understandings derived from the data and the themes derived from literature acknowledged and extended these themes and also provided an opportunity for identifying new concepts. This comparison is discussed and presented in Chapter 6, wherein the relationships between and among the themes are demonstrated and explained (Ryan & Bernard, 2000). Table 3.6 demonstrates how the design principles corresponded with the themes and design criteria identified in the review of literature that lead to quality digital play. The discussion in Chapter 6 reveals how the design principles from the children’s perspectives confirmed or expanded on the themes and design criteria derived from the literature. The results are then presented as model of design principles for preschooler apps.

Table 3.6
Example of Corresponding Design Principles from Children’s Perspectives with Themes and Design Criteria from the Literature Review

<table>
<thead>
<tr>
<th>Themes and design criteria From literature review (Chapter 2)</th>
<th>Design principles for preschooler apps Children’s perspectives presented in findings (Chapters 4 and 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-initiated play, discovery and exploration (C)* (E)**</td>
<td>• #2. Preschooler apps should offer children a range of age-appropriate choices.</td>
</tr>
<tr>
<td></td>
<td>• #12. Preschooler apps allow risk-free exploration by enabling children to undo, delete or restart actions.</td>
</tr>
<tr>
<td></td>
<td>• #6. Preschooler apps include references to popular culture and media.</td>
</tr>
<tr>
<td>Relatable situations and characters, including narratives and connection to popular culture (C) (E)</td>
<td>• #8. Preschooler apps allow children to assume the roles of characters that enable them to adjust the representation of themselves.</td>
</tr>
<tr>
<td></td>
<td>• #10. Preschooler apps should relate and connect to the children’s real-life experiences.</td>
</tr>
</tbody>
</table>

Note: *(C) refers to a confirmed design principle. **(E) refers to an expanded design principle.
Validity and Reliability

The rigour of the research process is different in qualitative research in comparison to quantitative or mixed-methods studies. In particular, DBR approaches tend to be judged on their innovativeness and usefulness based on technical criteria, validity and reliability (Bakker, 2019). The technical components of the current inquiry correspond with DBR approaches in facilitating a design-oriented approach with relevance to both theory and practice. The study’s contributions to theory are presented as a set of design principles for preschooler apps; its methodological contributions in obtaining children’s perspectives of digital play are significant towards a holistic understanding of children’s digital play and its role in policies and practices surrounding children’s development in the field of education. The literature review in the fields of education and software design clearly positions the study and identifies what is known about children’s digital play experiences. The methodological approach of the study is consistent in its endeavour to gather and report on children’s understandings of digital play experiences throughout the different cycles of the design-oriented approach undertaken.

Reviewing the data for overall depth and credibility is an essential step in the process of data analysis (Creswell, 2013). This study engaged in triangulation and member-checking to ensure the validity of the study’s findings. Triangulation of the study’s findings compared, contrasted and identified new themes that were presented across the multiple data sources and the different cycles of data collection. The process of triangulation was supported by the constant member-checking, which was facilitated by the design-oriented approach employed in the co-design process of the app. Each iterative cycle of the design process was informed by the children’s perspectives expressed in a range of data sources. Each cycle involved the creation of a range of materials produced by the researcher, which were re-presented back to the children to verify that their design ideas were reflected accordingly.
Finally, the reliability of the study’s findings was ensured by establishing a consistent scheme for collecting, analysing and reporting the findings to the participating children. The consistent and transparent cycle of co-design and redesign of the app for preschoolers ensured a robust methodology for reporting on children’s perspectives regarding the design of quality preschooler apps.

For example, when the children drew app icons, the researcher presented these icons in a pretend “App Store” in which the children could click on the icons they drew, view images of the artworks they created associated with each icon and see how their descriptions were transcribed. This process was also exemplified when the children drew characters and described how they wanted a photograph to be placed on the drawings of the characters to represent themselves. The researcher produced a screen-based prototype that the children could interact with to create their on-screen characters. Table 3.7 exhibits these two examples and how they were reported back to the children for them to provide feedback. This consistent approach was used throughout the study; the children became accustomed to it and relied on it for sharing their views.

Table 3.7
Examples of Reporting Back to the Children for their Feedback

<table>
<thead>
<tr>
<th>App icon drawings into the “App Store”</th>
</tr>
</thead>
<tbody>
<tr>
<td>![App icon drawings image]</td>
</tr>
<tr>
<td>Character drawings into a screen-based prototype</td>
</tr>
<tr>
<td>![Character drawings image]</td>
</tr>
</tbody>
</table>
Likewise, a consistent approach to the development of design principles was adopted during the process of theoretical analysis conducted by the researcher. A description of each design principle is included in the findings presented in Chapters 4 and 5. Each description defines how each of the design principles was identified, confirmed or extended. Figure 3.5 presents an example of how Design Principle 8 is described in Chapter 5.

Design Principle 8 recognises the role of characters assumed by children during play. “Assuming the role of a character” was a key feature of apps identified in Cycle 1 during the CRAG’s demonstration of apps which they played with. The CRAG’s demonstration of their play in Cycle 1 involved the use of “I” or “you” as they projected the role of the character in the app as themselves or onto the person they were speaking to. The CRAG integrated “you” or “I” as they described the key features of their app design ideas in Cycle 2.

Figure 3.5. Example of a description of a design principle.

**Ethical Considerations**

Ethical approval was granted by the University of Wollongong’s Human Research Ethics Commission to ensure that the study complied with the National Statement on Ethical
Conduct in Research Involving Humans (HE15/090) (Appendix E). In particular, regulations on working with children guided the process of inquiry. As such, the recruitment of participants involved two levels of informed consent: from the parents/caregivers of each child participant and from the children themselves. Families of potential participants were invited to participate in the inquiry and were offered detailed information (Appendices F & G). All the parents/caregivers of each participating child in this inquiry gave informed consent for their children to participate (Appendix H). All of the participating children also gave their informed consent to participate in the study (Appendices I & J).

**Consent of Children**

Opportunities for children to confirm their participation at different stages of the study were a key consideration in planning and facilitating the study. Each child is different; therefore, it is not possible to determine the willingness of a child to participate across the different stages of the study (Alderson & Morrow, 2011). Children must be fully informed and consulted with respect to their decisions to participate or withdraw from the study at any time (Alderson & Morrow, 2011; Harcourt & Conroy, 2005; Lundy, 2007). Ideally, children should be involved in discussing how the data will be collected, analysed and disseminated (Conroy & Harcourt, 2009). The researcher’s role requires an awareness of verbal and non-verbal cues and gestures that may indicate a child’s willingness to participate (Docket et al, 2009). Additionally, a researcher can scaffold the research process by reminding children what activities have occurred and what is yet to occur (Harcourt & Conroy, 2005). To orient the CRAG members in their role as co-researchers, the CRAG members were informed of the objectives and methodologies by the researcher. The researcher also sought their individual consent (which children provided by writing their names on a sign-in sheet) and identified their roles by giving them badges to wear. Finally, all CRAG members received a journal, which they took
from session to session with open invitation to work on this at times external to the formal CRAG sessions and Digital Playgroup meetings. These consent sheets, badges and journals are exhibited in Figure 3.6.

![CRAG consent sheet, badges and journals](image)

**Figure 3.6.** CRAG consent sheet, badges and journals.

**Respecting Children’s Intellectual Property**

The power imbalance between adults and children was addressed throughout the study in regard to informed consent, how the data were collected and how the data were represented. While information sheets were disseminated to parents and their written consent sought, the study also ensured each child was informed of the methodologies and the purpose of the study and was happy to participate in and contribute to the research. Children were assured that they could choose which activities they would like to participate in and had the right to withdraw from the study at any time. Likewise, the group dynamics between the CRAG and the Digital Playgroup were monitored. Fostering a collaborative environment of working together alleviated any potential tensions among children.

In collecting data, the researcher ensured that it was the children’s “voice” that was being listened to. Ownership issues of collected data were addressed, especially since the children were the authors and creators of drawings, reflective journals, images and app
prototypes. In accordance with the University’s intellectual property policies, the children retained ownership of these materials and their permission will be sought to make copies for research purposes. The co-designed app is attributed to the collective group of children — the CRAG — who were involved in co-designing the app. While the anonymity of participants cannot be guaranteed, especially in regard to photographs and video footage, confidential information was guarded for the safety and protection of the research participants.

It was anticipated that all the participants benefited from participating in the study. The CRAG was empowered in participating in the co-design and co-creation of an app. The children from the Digital Playgroup benefited from the iterative cycles of digital play. All children in general will benefit from the design principles, which aim to positively influence the quality of apps and the design of digital play experiences that children will engage with in the future.

**Chapter Conclusion**

This chapter has highlighted the significance of certain methodological approaches when engaging children as participants to understand their perspectives of digital play. It introduced the study’s aims and the research questions, then situated the study within a qualitative paradigm. A review of children’s rights methodologies and children’s role as design partners in the development of apps and software supported the DBR approach adopted. The participants were introduced, accompanied by a justification of the data collection process that occurred over the different phases of the DBR approach and the iterative cycles of the research sequence. Likewise, a justification of the data sources and data analysis was presented, alongside ethical considerations regarding the participation of young children.

The next chapter reports on the findings from the first cycle of the research study, which
focused on the analysis and exploration of the research issues surrounding children’s perspectives of digital play. The findings from this chapter inform the design and solution for engaging children as co-designers and co-researchers in the development of an app.
Chapter 4
First Cycle — Gathering the CRAG’s Perspectives of Digital Play with Apps

Chapter Overview

The aim of the research is to extend our understandings of children’s digital play through exploring their perspectives with the following overarching question:

How are design principles for preschooler apps influenced by children as co-designers and co-researchers in the development of an app?

This research question is explored through two sub-questions:

1. How do the children’s perspectives contribute to design principles of apps for preschoolers?
2. What processes do the CRAG enact as they co-design and trial an app for preschool children?

The data presented in this chapter relate to the first iterative cycle of the DBR approach employed in this study (detailed in Chapter 3). Figure 4.1 provides a visual representation of how the sequence of the iterative cycles was applied in this study and how it guided the data collection process.
Figure 4.1: Iterative cycles of the co-design of an app for preschoolers.

The data gathered in these research cycles are examined in two separate chapters in relation to the processes enacted by the children in co-designing the app, as follows:

- Chapter 4: First cycle — Gathering the CRAG’s Perspectives of Digital Play with Apps
- Chapter 5: Subsequent cycles — Development of a Co-designed App for Preschoolers with the CRAG

The inclusion of children’s perceptions of software design was an essential component of the data collection process. Therefore, children’s rights methodologies were interwoven within the iterative cycles to ensure that appropriate avenues for voicing children’s thoughts and perspectives were made available. Two distinct groups of children, the CRAG and the Digital Playgroup (preschoolers), participated in the study. Six children
assumed the roles of co-designers and co-researchers and participated in the CRAG sessions to generate ideas for a preschooer app from which the researcher built a prototype of the co-designed app. Four preschoolers attended the Digital Playgroup sessions, in which the CRAG observed the preschoolers as they engaged in digital play with the co-designed app.

This chapter reports on the findings of the first cycle of gathering the CRAG’s perspectives of digital play with apps. It describes the context of the CRAG’s digital play experiences, the CRAG’s descriptions of their digital play with selected apps and the CRAG’s perspectives of preschooler apps. The findings from these are analysed to present an emerging set of criteria for preschooler apps. The chapter concludes with the development of initial design principles based on a comparison of the emerging criteria for preschooler apps and the findings identified from the CRAG’s digital play experiences.

**Gathering the CRAG’s Perspectives of Digital Play with Apps**

A general overview of the research sessions in the first cycle, conducted with the CRAG as participants, is presented in Table 4.1. These comprise of Sessions 1 and 2 (CS1 and CS2), which involved the CRAG in two distinct processes: exploring the CRAG’s perceptions of their own digital play with apps and exploring their perspectives of apps designed for preschoolers.

<table>
<thead>
<tr>
<th>Table 4.1</th>
<th>Summary of Sessions for the First Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First cycle: Gathering the CRAG’s perspectives of digital play with apps</strong></td>
<td><strong>Overview of activities</strong></td>
</tr>
<tr>
<td>Session</td>
<td>Date</td>
</tr>
<tr>
<td>CS1</td>
<td>6 August</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>CS2</td>
<td>20 August</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This section presents the data from CRAG Sessions 1 and 2, which demonstrate the CRAG’s perceptions of digital play environments. In CRAG Session 1, the researcher guided the CRAG to consider the spaces where their own digital play regularly occurred and the typical apps they played with as a first step in gathering the children’s perspectives of their digital play experiences. CRAG Session 2 extended on this process by exploring the CRAG’s perspectives of apps designed for preschoolers.

The initial process of scoping the field of digital play experiences from the perspective of the CRAG attempted to establish the background for the co-design cycles. This was the first step taken by the CRAG in their role as co-designers of an app and also established the environment wherein the CRAG listened to each other and worked together as a group. The extension of their discussions around preschooler apps helped establish the role of the researcher as a facilitator in revealing the CRAG’s understanding and ideas regarding children’s digital play.

**Context of the CRAG’s Digital Play Experiences**

All CRAG members were invited by the researcher to bring the device that they regularly played with in their homes. Before the first session, they were invited to take photos of spaces in the home where digital play occurred. The CRAG were also invited to share some of their favourite apps with the group during the session. Four children brought an iPad with photos of digital play spaces from home. These children used their devices and photographs for talking about their digital play and some typical apps that they played with, and the researcher was able to use these as prompts to encourage the discussion. The child who did not bring a device was able to respond to the researcher’s request to talk about their digital play experiences. Despite not having tangible prompts such as her own iPad or photos of where digital play took place in her home, the child was able to join in the discussion as the researcher guided the CRAG’s conversations around their
habits of practice and issues of access.

The CRAG’s discussion revealed that there were multiple spaces in their home settings where digital play typically took place. These places include the lounge in the living room, at the kitchen bench where a parent was nearby and, sometimes, on the bed. Four of the children indicated they “usually” or “normally” played on the lounge, although one child mentioned that “we only did that on the weekends”, in reference to the photo of his brother and him on the sofa. The CRAG’s conversations expressed the significance of the lounge in their digital play experiences.

Researcher: So this is a picture of…
Henry: The lounge, in the corner, where I usually sit. I usually sit in the corner of my lounge in my house (CST06.08).

Researcher: Does anybody else sit on the lounge too?
Ava: I sit… on the corner of my lounge too. So you walk up the stairs and you turn that way then you see the lounge (CST06.08).

London: I have heaps of play spaces. Okay, I’ll show you my first space, my bed. The next one I think is my front room.
Researcher: Your front room.
London: This is my front room where I normally sit.
Researcher: [Nods in agreement.]
London: And this is the kitchen bench where I normally sit on a chair to play on my iPad. And this is the rocking chair that I sit on while I play on my iPad. And I sit on that spot (pointing at the photo of the lounge in the front room) when I play on my iPad (CST06.08).

While “sometimes” some of the children had access to their iPad’s in the car or sitting at their beds, the kitchen bench and the dining room were the second-most common areas for digital play for four of the five children. Owen’s photo of the kitchen bench drawer
opened a new discussion around children’s access to their devices.

Owen: This is where we keep the iPads.
Researcher: Can you pick it up anytime?
Owen: Yeah, we can do it sometimes but not all the time.
Researcher: Is that the same for everybody?
Henry: [Shakes his head.]
Researcher: No? Can you pick up your iPads anytime?
Ava: I don’t have to ask. Sometimes I’m banned from it.
Researcher: How come?
Ava: Sometimes I’m naughty.
Researcher: What about you London?
London: I get banned from my iPad if I play it too much (CST06.08).

During the discussion, most within the group mentioned their parent’s control over their access to digital play. The children spoke of the parental controls over access to the devices and the conditions that permitted access to them. The CRAG recalled that their access to the digital devices was influenced by what their parents defined as acceptable behaviour and whether or not they have not spent too much time on digital play. Three children spoke of having access to the devices “sometimes but not all the time” and indicated how behavior such as being “naughty” or playing “too much” could influence their access to digital play. The CRAG’s discussion reflected the concerns raised by families about the negative connotations around the use of digital devices, with one child exclaiming “I’m nearly addicted to it!”

The above data regarding digital play spaces verified that the CRAG members had regularly engaged with digital play in their home contexts. The discussions facilitated by the researcher positions the children as “experts” sharing their own digital play experiences with the researcher. At home, parental controls limited their access to digital play, implying that their expertise might not have been explicitly recognised. In contrast, the CRAG were experts of their own digital play experiences within the research space,
which established their position to discuss the design of apps for preschoolers.

**CRAG’s Digital Play with Selected Apps**

The researcher offered the CRAG an opportunity to share some of their favourite apps (see Figure 4.2). The researcher provided the CRAG members with choices about how they could share their digital play experiences and their favourite apps with each other, encouraging them to use two formats: screenshots from the apps or a demonstration of actual play. In the first method, the researcher asked the children to take screenshots of their favourite apps then provided the children with clear transparencies to set over the images they captured of their screens. The children drew circles around what they considered were important features of the app with a marker. Four of the CRAG members set these clear transparencies on top of the screenshots of their iPad screen and engaged in conversations with the researcher as they spoke about the important features they have marked on the clear transparencies. For the second method, three children chose to demonstrate their chosen app to a partner while one child opted to demonstrate their chosen app to the researcher only.

*Figure 4.2. Sharing photos of digital play spaces and playing with favourite apps (CSV06.08).*

Offering the CRAG two different choices through which to express themselves had the concurrent objective of providing them with practical ways of talking about and
observing other children’s engagement in digital play. These experiences were of significance to the CRAG, who in the later stages of the research process, participated in observations of preschoolers engaging with the co-designed app during the Digital Playgroup sessions. Additionally, sharing their favourite apps with each other was a process that initiated conversations about features of apps that the CRAG deemed were important to their play experiences.

**Apps played by the CRAG.** The different apps that were identified by the CRAG as their current favourite apps (see Table 4.2) all featured game-like elements. The element of winning was common among the majority of the apps played by the CRAG, with the theme of play dictating the varied objectives that a child needed to accomplish to win.

### Table 4.2

<table>
<thead>
<tr>
<th>App title</th>
<th>Game-like objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slither.io</td>
<td>To grow the longest snake. The app is a re-make of a 1980s arcade game.</td>
</tr>
<tr>
<td>Cooking Fever</td>
<td>To cook dishes and serve drinks to customers with the purpose of accruing income from managing restaurants.</td>
</tr>
<tr>
<td>Subway Surfers</td>
<td>To collect coins as the player runs through a rail system. The player must evade being caught by the train inspector.</td>
</tr>
<tr>
<td>Bloons Tower Defense 5</td>
<td>To prevent balloons (“bloons”) from completing their course. Players earn currency that allow them to purchase upgrades within the game.</td>
</tr>
<tr>
<td>Dream League</td>
<td>To create a dream football club. The players can customise the team name and players’ kits. Upgrades can be purchased within the game.</td>
</tr>
<tr>
<td>Mermaid Twins</td>
<td>To take care of Princess Mermaid before and after the birth of twin babies.</td>
</tr>
<tr>
<td>Minecraft</td>
<td>To build worlds using 3D blocks representing different materials. The app allows players to network and visit each other’s worlds.</td>
</tr>
<tr>
<td>Animal Escape</td>
<td>To avoid being caught by the angry farmer by running across a farm. Players collects corn along the way and unlock levels as they proceed in the game. Upgrades can be purchased within the game.</td>
</tr>
</tbody>
</table>

Analysis of the apps played by the CRAG allowed the researcher to identify several features exhibited by these apps:

1. **Open-ended exploration:** Minecraft is unique to the other apps mentioned by
the CRAG in that its creative mode promotes creativity and problem-solving skills with the open-ended goal that children can build a world with no limitations.

2. **Ability to network with others during play:** Both Minecraft and Snake.io enable players to connect with others to play.

3. **In-app purchases:** Subway Surfers, Cooking Fever, Snake.io, Bloons Tower Defense 5, Animal Escape and Dream League offer in-app purchases to extend the features of the gameplay experiences.

4. **Reference to popular culture:** Dream League relies on popular culture as a premise for the play experience wherein children can choose from famous soccer personas and soccer clubs to play within the app.

5. **Personalisation and customisation:** A variety of customisation options are available in different apps. Dream League allows players to customise the team names and the uniform kits while Animal Escape allows players to choose from a chicken or a cow.

6. **Collection of points, scores and other items:** Subway Surfers, Animal Escape and Cooking Fever allow players to collect “coins” or “gems”, while Dream League and Snake.io keep records of highest scores.

The purpose of presenting the type of apps that the CRAG played and their features is to provide context to the digital play experiences discussed in this chapter. During this activity, the CRAG members discovered common apps that they have played: Subway Surfer, Minecraft, Slither.io and Cooking Fever were all mentioned by at least two children in the CRAG. This helped to establish connections between the members of the CRAG as they recognised apps that the other members were playing:

London: [Looking at Henry’s iPad screen.] Do you have Subway Surfer?

Henry: Yeah.
London: I love it! (CST06.08)

Ava: Do you want to tell me about it?
Marnie: Oh, yes…This game’s called Minecraft and…
Ava: Yeah, I know about Minecraft.
Marnie: I’m just building a rollercoaster (CST06.08).

London: Excuse me, can you help me with Cooking Fever?
Ava: Oh, my sister has that. It’s hard isn’t it? Cooking Fever is quite hard. You have to see what they order and then time can run out (CST06.08).

As the activity unfolded, the CRAG’s expertise in digital play was reaffirmed as they engaged in self-directed play. The conversations regarding favourite apps demonstrated the children’s confidence and skills when engaging in digital play.

Marnie: My roller coaster is going to be the best!
Marnie: How do I get this here? Oh, I’m good. I just did that. [as she demonstrated her play to Ava] (CST06.08)

Owen: Oh, yes, a corner kick to me. I love corner kicks… Yes! [He chants “I scored”, accompanied by a little tune.] (CST06.08)

Attributes of apps identified by the CRAG. The analysis of the conversations between the CRAG and the researcher revealed that the CRAG had an awareness and appreciation of specific attributes of apps that contributed to their digital play experiences. These are explained and exemplified below.

Roles of characters. Instances during the CRAG’s play demonstrate how two CRAG members assumed the role of the characters within the app. For example, when Ava demonstrated Animal Escape to Marnie, she provided Marnie with directions of what “you”, the cow (the main character), should do throughout the game. Ava
interchanged “you” and “I” during her explanation.

Ava: Get some corn and you need to stay on the track so you go on this. And you need to quickly turn. Then you go up here and you can bounce. And then I’m going to walk up… You can’t get up there. You gotta bounce up there. And um… they did it that’s why I can use my bounces and I didn’t want to (CST06.08).

Likewise, Henry identified himself as the main character in Subway Surfer as exemplified in Figure 4.3. He wrote, “I’m trying to get all the coins” and “I’m really trying to run from the guy” (CST06.08).

*Figure 4.3. Use of clear transparencies to indicate important elements of the app (CSV06.08).*

*The rules of play.* The CRAG’s description of their own digital play with apps revealed that the CRAG were aware that they needed to perform specific actions predetermined by the app to progress and gain a sense of fulfilment in playing the apps. The children engaged in problem-solving strategies when these were required by the app. Both Ava and Henry spoke of tactics and strategies in describing their digital play experiences in response to the app’s automated decisions. The children’s conversations indicated their awareness of “rules” pre-determined by the app, which dictated the range of actions that were available to them. For example, Ava explained to Marnie, “You got
to walk up there”, then corrected her explanation to, “You got to bounce up there”, further indicating that she did not want “to use… bounces but I have to.” Marnie also explained that “you can choose a character” only “if it’s not locked”, indicating that the freedom to choose also had limitations.

A range of choices: Sense of being in control. The CRAG demonstrated a sense of being in control over the range of actions available to them as they played with the apps. They also indicated that the range of options to choose from was an important aspect of their play. For example, Marnie demonstrated that she could choose different characters (see Figure 4.4). Likewise, Henry indicated how the options for different characters allowed him to “control” his play based on the different abilities of the characters selected for play.

Henry: I can show you what the different characters, what they do for different abilities (CST06.08).

Figure 4.4. Marnie chooses a character to play in Minecraft (CSV06.08).

Personalisation or customisation. Another distinct feature mentioned by the children was the ability to adjust the app through the personalisation or customisation of elements within the app. In the excerpt below, Owen directed the researcher’s attention to his team name, which displayed his last name “Vaughn FC”.

Researcher: Have you taken photographs, Owen?
Owen: Yeah, do you want me to show you?
Researcher: Okay, so tell me about each one.
Owen: That was the score for my team.
Researcher: And what else is happening on that screen?
Owen: I had this… that's the player that I put. That's my team name.
Researcher: Oh. How did you change the team name or does it change it for you?
Owen: You get to … It starts out with “Vaughn”, your last name “FC” and you change it (CST06.08).

*Indicators of progress.* The children’s conversations portrayed a sense of achievement or failure, as demonstrated in the excerpts below. Additionally, Figure 4.5 demonstrates how both Ava and London identified the screenshots with their scores as indicators of their progress within the app, as Owen does in the excerpt above.

Marnie: Yay, I did it! (CST06.08).
Owen: Yes! [as he successfully manipulates his team to win in Dream League] (CST06.08).
Ava: And you win it! (CST06.08).
Henry: I’m dead (CST06.08).

*Figure 4.5.* Ava and London both choose these screens as significant during digital play. (CSV06.08)

In summary, scoping the field of digital play through the exploration of the CRAG’s experiences uncovered a widening understanding of children’s digital play. The process revealed how the CRAG possess expertise and knowledge of digital play and that their digital experiences in the home revolve around the use of iPads for play, leisure and entertainment rather than for educational purposes. The process also enabled the children
to express their awareness of features of digital play inherent in app design.

Overall, the process of obtaining the CRAG’s perspectives of their own digital play experiences with apps demonstrates the motivation and engagement that the children had regarding the subject of digital play. Through this process, the CRAG identified the following features of apps during their play experiences:

1. Apps allow children to assume “roles of the characters” in the app as they play.
2. Apps enable children to gain an awareness of “the rules of play” predetermined by the app.
3. Apps allow children to gain a “sense of being in control” through a “range of choices”.
4. Apps allow children to adjust the app through “personalisation or customisation”.
5. Apps offer “indicators of progress” as children play.

CRAG’s Perspectives of Preschooler Apps

The second step in the process of gathering CRAG’s perspectives of digital play occurred in CRAG Session 2. In this process, the CRAG articulated their understandings of the features of apps designed specifically for preschoolers (typically aged between two and five years old). The data presented here are drawn from the following experiences facilitated by researcher:

- the CRAG’s discussion regarding the different features of preschooler apps
- the CRAG’s criteria for preschooler apps, recorded by one of the CRAG members on behalf of the group (see Figure 4.6)
- and the journal entry of an interview conducted by a CRAG member with a younger sibling who was a preschooler.
Figure 4.6. The CRAG’s criteria for preschooler apps (PPD20.08).

The researcher engaged the CRAG members in a brainstorming activity in which they listed features of an app that they considered appropriate for preschoolers. It was evident that in their discussion, the CRAG drew on their personal experiences with preschoolers (e.g., younger siblings or friends) and recalled their own preschooler experiences. Below is an excerpt from a discussion among the CRAG members as they consolidated their ideas and compiled their criteria for preschooler apps. During the discussion, the researcher was mindful to validate the children’s ideas by repeating their words and ensuring that the criteria listed in Figure 4.6 were formulated in exact words used by the CRAG members.

Researcher: Does anybody have an idea of what preschooler apps should have?
Ruben: Fun games and not scary stuff. [Repeats.]
Henry: [Writes Ruben’s suggestions.]
Researcher: Yes, Ava.
[Ava had her hand up.]
Ava: Arts and crafts because some kids like arts and craft when they’re young.
While the CRAG’s discussion around their criteria for preschooler apps occurred in CRAG Session 2, this conversation was extended to the home setting by a CRAG member. Figure 4.7 depicts how Owen interviewed his younger brother, who was a preschooler, regarding his perceptions of what preschooler apps are like. Owen recorded this in his journal, the page of which is also included in Figure 4.7. This interview presents a specific source of data which contributes to the CRAG’s criteria for preschooler apps.

![Image of Owen and his younger brother writing](image)

*Figure 4.7. CRAG member interviews younger sibling in the home (CJ1).*

**Emerging Criteria for Preschooler Apps**

To consolidate the emerging criteria for preschooler apps, the researcher conducted open-ended coding to thematically analyse the CRAG’s discussion of preschooler apps, the handwritten criteria (see Figure 4.6) and the criteria for preschooler apps listed in Owen’s journal entry (see Figure 4.7). The emerging themes specific to the descriptions of preschooler apps formed a preliminary list of the CRAG’s criteria; these are listed in
Table 4.3. The themes identified in the table are categorised based on children’s utterances during the CRAG’s discussion of preschooler apps. Utterances are presented under each theme to which they relate, in the sequence in which they were uttered during their discussion. The items listed in bold also appear in Figure 4.6 and Figure 4.7.

Table 4.3
The Emerging Criteria for Preschooler Apps

<table>
<thead>
<tr>
<th>Children’s utterances relevant to emerging criteria for preschooler apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preschooler apps should have choices of content based on children’s interests.</td>
</tr>
</tbody>
</table>
| Ruben: **Not scary stuff**  
  Ava: some kids like *arts and craft* when they’re young  
  Henry: baby-type stuff… **toddler-type** thingies, blankets and stuff  
  Ruben: **ponies**  
  Henry: **teddies**  
  Ruben: **unicorns**  
  London: It has stuff that they want to do.  
  Owen: **Nothing scary.** |
| 2. Preschooler apps should have choices of age-appropriate levels of difficulty that allow children to play on their own. |
| Ruben: [Apps should] have easy things for preschoolers.  
  London: [Apps] shouldn’t have hard things that are too hard for preschoolers.  
  London: They can play and do everything |
| 3. Preschooler apps motivate through interactivity. |
| Owen: **lots to touch** … Lochie like lots to touch  
  Ruben: **lots to touch**  
  Owen: **lots to do** |
| 4. *Preschooler apps motivate through rewards or points.* |
| London: They can move up stuff, move up numbers. |
| 5. Preschooler apps are fun. |
| Ruben: **fun games**  
  Owen: **like a story**  
  Owen: **exciting music** |
| 6. *Preschooler apps motivate through its connections with popular culture and media.* |
| Owen: **like ABC kids** |
| 7. *Preschooler apps offer opportunities for preschoolers to make their own content.* |
| Owen: **lots to draw** |

*Note: Items 5, 6 and 7 each appear as a criterion in Table 4.3 Emerging Criteria for Preschooler Apps despite having only one related utterance from a CRAG member relating to it. Inclusion of these items in the criteria is justified as each of these items identify features of play with apps which were already observed during the CRAG’s Digital Play with Apps (CS1).*

As such, the themes derived from the CRAG’s perspectives on preschooler apps provided
some emerging criteria for preschooler apps (see Table 4.3), which was revisited by the CRAG within the duration of the study.

Developing Initial Design Principles for Preschooler Apps

An analysis of the CRAG’s formulation of the aforementioned criteria for preschooler apps reveals that the criteria are consistent with the characteristics of their own digital play. The analysis presented in this section compares the CRAG’s emerging criteria for preschooler apps with the five attributes identified during the CRAG’s Digital Play. The development of the initial design principles for preschooler apps in this phase of the design-based study is presented in Figure 4.8.

![Figure 4.8. Development of initial design principles in Phase I of the study.](image)

To reiterate, the five attributes identified during the CRAG’s digital play with apps (CS1) are:

1. Apps allow children to assume “roles of the characters” in the app as they play.
2. Apps enable children to gain an awareness of “the rules of play” predetermined by the app.
3. Apps allow children to gain a “sense of being in control” through a “range of
4. Apps allow children to adjust the app through “personalisation or customisation”.
5. Apps offer “indicators of progress” as children play.

Three items within these five significant attributes of the CRAG’s digital play are consistent with the emerging criteria for preschooler apps (CS2):

**Connections to Item 2: “Apps enable children to gain an awareness of ‘the rules of play’ predetermined by the app”**. Item 2, “Apps enable children to gain an awareness of ‘the rules of play’ predetermined by the app” is consistent with Item 3 of the emerging criteria for preschooler apps, “Preschooler apps motivate through interactivity”. Understandings of apps’ predetermined rules of play are extended by the implication that these “rules” generate interactivity. The predetermined rules of play in apps anticipate and trigger user input by engaging preschoolers in “lots to touch” and “lots to do”.

Therefore, the connections between the two items reveal the first design principle for preschooler apps:

1. Preschooler apps motivate through predetermined rules that promote interactivity providing opportunities for “lots to touch”.

**Connections to Item 3: “Apps allow children to gain a ‘sense of being in control’ through a ‘range of choices’”**. Item 3, “Apps allow children to gain a ‘sense of being in control’ through a ‘range of choices’” is consistent with Item 1 of the emerging criteria for preschooler apps, “Preschooler apps should have choices of content based on children’s interests”. The CRAG’s criteria affirm the concept that apps should offer children a “range of choices”. This criterion is further broadened to accommodate that these range of choices should include age appropriate content that:
• Is based on the different interests of preschoolers (e.g., arts and crafts, toys, teddies and unicorns)

• should have “nothing scary”.

Additionally, Item 3, “Apps allow children to gain a ‘sense of being in control’ through a ‘range of choices’” draws attention to age-appropriate content that allows preschoolers to engage in independent play. This is consistent with Item 2 of the emerging criteria for preschooler apps, “Preschooler apps should have choices of age-appropriate levels of difficulty that allow children to play on their own”, which states that preschooler apps “should be easy” for preschoolers and “not too hard” to ensure “they can play and do everything.” Therefore, the connections between the two items reveal the second design principle for preschooler apps:

2. Preschooler apps should offer children a range of age-appropriate choices that:
   a. are based on a range of topics and interests that preschoolers like
   b. promote positive experiences that are not “scary”
   c. promote a sense of being in control and independent play: “easy” and “not too hard”

**Connections to Item 5: “Apps offer ‘indicators of progress’ as children play.”** Item 5 of the significant attributes, “Apps offer ‘indicators of progress’ as children play” is consistent with Item 4 of the emerging criteria for preschooler apps, “Preschooler apps motivate through rewards or points”. The CRAG’s criteria validate that preschooler apps offer “indicators of progress” during children’s play by indicating that preschooler apps should allow movement “up numbers”. Further, “indicators of progress” and motivation through “rewards or points” relate directly to Item 5 of the emerging criteria for preschooler apps, “Preschooler apps are motivating and capture the attention of preschoolers”, as “fun games” may motivate by awarding rewards or points.
The connections between the two processes reveal the third design principle for preschooler apps:

3. Preschooler apps motivate through rewards or points and provide children with an indicator of their progress during play.

**Addition of new attributes.** The emerging criteria for preschooler apps also present four new motivating attributes of preschooler apps as follows. First, “exciting music” was deemed a motivating feature of preschooler apps in Item 5 of the CRAG’s criteria, indicating the CRAG’s appreciation for the multimodal affordances of play experiences with apps. Second, the inclusion of “like a story” in Item 5 of the CRAG’s criteria demonstrates a recognition of engaging children through the development of a narrative during play. Third, Item 6 in the CRAG’s criteria suggests that preschooler apps should be “like ABC Kids”, a direct reference to the influence of popular culture and media on children’s play. Finally, Item 7 in the CRAG’s criteria for preschooler apps suggests that children should be able to produce their own content (e.g., through drawings).

Therefore, four design principles for preschooler apps are added to the existing list:

4. Preschooler apps include multimodal features such as music.

5. Preschooler apps promote the development of a narrative during play.

6. Preschooler apps motivate through their connections with popular culture and media.

7. Preschooler apps offer opportunities for preschoolers to produce their own content.
Chapter Conclusion

Presented below is a compiled a set of nine initial design principles for preschooler apps, based on the comparisons between the CRAG’s emerging criteria for preschooler apps and the five attributes identified during the CRAG’s digital play:

1. Preschooler apps motivate through predetermined rules that promote interactivity, providing opportunities for “lots to touch”.

2. Preschooler apps should offer children a range of age-appropriate choices that:
   a. are based on a range of topics and interests that preschoolers like
   b. promote positive experiences that are not “scary”
   c. promote a sense of being in control and independent play: “easy” and “not too hard”.

3. Preschooler apps motivate through rewards or points and provide children with an indicator of their progress during play.

4. Preschooler apps includes multimodal features such as music.

5. Preschooler apps promote the development of a narrative during play.

6. Preschooler apps motivate through their connections with popular culture and media.

7. Preschooler apps offer opportunities for preschoolers to produce their own content.

8. Preschooler apps allow children to assume the roles of characters.

9. Preschooler apps enable children to make adjustments through “personalisation or customisation”.

Item 8, “Preschooler apps allow children to assume the roles of characters”, and Item 9, “Preschooler apps enable children make adjustments through personalisation and customisation”, are included in the set of design principles for preschooler apps. These two design principles originate from the five identified attributes of the CRAG’s digital play and were not mentioned during the CRAG’s discussion around the emerging criteria.
for preschooler apps. These two design principles were not explicitly articulated as important in relation to the preschooler’s apps, but they were articulated and observed during the CRAG’s digital play with their favourite apps.

This set of initial design principles for preschooler apps marked a significant step in the process of co-designing of the app. It continued to be refined in the succeeding cycles of the research as the members of the CRAG generated and developed their ideas for a co-designed app for preschoolers.
Chapter 5
Subsequent cycles — Development of a Co-designed App for Preschoolers with the CRAG

Chapter Overview

Cycles 2 to 5 aimed to engage the CRAG in a range of experiences designed to help them develop ideas for an app for preschoolers. Conducted over CRAG Sessions 2 to 6 and Digital Playgroup Sessions 1 to 3, the findings presented in this section trace the modifications of the design process from individual design ideas into one combined idea for a co-designed app. Thus, the shift from understanding individual digital play practices to gaining a shared understanding of preschooler apps was guided by the distinct processes employed in the following subsequent cycles:

- Cycle 2: generating individual ideas for the co-design of an app
- Cycle 3: transforming individual ideas into one design for an app
- Cycle 4: applying design ideas to a prototype
- Cycle 5: inviting preschoolers to play with the app prototype.

A general overview of the research sessions over the next four cycles is presented in Table 5.1. These four cycles offered opportunities for the CRAG to contribute towards the initial set of design principles presented in Table 4.4. The initial design principles from Chapter 4 were confirmed and adjusted through the analysis of the findings from each of the four subsequent cycles. Additionally, the analysis of these findings identified emerging design principles. The confirmation, adjustment and identification of emerging design principles are consolidated in the findings from Cycles 1 to 5, presented as a refined set of design principles at the conclusion of the chapter.
Table 5.1
Summary of Sessions for Cycles 2 to 5

<table>
<thead>
<tr>
<th>Cycle 2: Generating individual ideas for the co-design of an app</th>
<th>CRAG Session and Date</th>
<th>Overview of activities</th>
</tr>
</thead>
</table>
| CS2 20 August | Generating ideas for the co-design of an app:  
• drawing app icons to generate ideas  
• creating detailed designs through arts and crafts | |
| After Cycle 2 and before Cycle 3 | Researcher Produced Visual 1: The “App Store” Mock-Up | |

| Cycle 3: Transforming individual ideas into one design for an app | CS3 3 September | Transforming individual ideas into one design for an app:  
• sharing design ideas with the crag  
• mixing design ideas into one design for the app | |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>After Cycle 3 and before Cycle 4</td>
<td>Researcher Produced Visual 2: Paper-based prototype of co-designed app</td>
<td></td>
</tr>
</tbody>
</table>

| Cycle 4: Applying design ideas to a prototype | CS4 17 September | Revisiting features of preschooler apps using paper prototypes:  
• elaborating My Little Town section  
• elaborating the pool section  
• elaborating the bug section  
• elaborating the sports section  
• elaborating the arts section  
• elaborating the character section | |
| --- | --- | --- |
| CS5 15 October | Revisiting features of preschooler apps using paper prototypes:  
• elaborating My Little Town section  
• elaborating the sports section  
• elaborating the arts section | |
| During Cycle 4 | Researcher Produced Visual 3: Screen-based prototype of co-designed app | |
| CS5 15 October | Revisiting features of preschooler apps using digital prototypes:  
• elaborating bug section | |
| CS6 29 October | Revisiting features of preschooler apps using digital prototypes:  
• elaborating My Little Town section  
• elaborating the bug section  
• elaborating the character section | |

<table>
<thead>
<tr>
<th>Cycle 5: Inviting preschoolers to play with the app prototype.</th>
<th>After Cycle 4 and before Cycle 5</th>
<th>Researcher Produced Visual 3: Screen-based prototype of co-designed app</th>
</tr>
</thead>
</table>
| DP1 to DP4 5 November 26 November 3 December 10 December | Revisiting features of preschooler apps using digital prototypes:  
• elaborating My Little Town section  
• elaborating the bug section  
• elaborating the character section  
• elaborating the pool section  
• elaborating the sports section | |
Cycle 2: Generating Individual Ideas for the Co-design of an App

Cycle 2 focused on determining the CRAG’s individual understandings of preschooler apps. This was a continuation of the process employed in the first cycle, discussed in Chapter 4. In Chapter 4, the CRAG expressed their perspectives regarding apps that they played and apps designed for preschoolers. In Cycle 2, the individual expression of these perspectives was sought to distinguish the themes within the CRAG members’ understandings of preschooler apps. The opportunities presented to each CRAG member to express their individual understandings of preschooler apps acknowledged the varied experiences and expertise that each CRAG member contributed to this stage of the study.

Cycle 2 aimed to generate and develop individual ideas for the co-design of an app over two design processes. The first process involved the CRAG in drawing app icons to generate individual ideas for a preschooler app. In the following process, the CRAG used arts and crafts materials to develop design details for the ideas generated from the app icons. These two processes enabled all six members of the CRAG to express their individual understandings of preschooler apps as they generated individual ideas.

Drawing App Icons to Generate Ideas

The researcher led the children in a tour of the App Store as the first step towards generating ideas for an app. The App Store is the online shop for the purchase of apps designed for Apple devices. The researcher showed the CRAG two screenshots of the App Store to learn from the CRAG what they knew about the images presented to them (see Figure 5.1). The researcher drew the children’s attention to the section of the App Store that determined appropriate apps for children under the age of five, how the app icons were presented on the screen, the different types of icons on display and how to access information about each app (e.g., name, detailed descriptions and reviews made by people who have used the app).
All children recognised the screenshot of the App Store. The CRAG members confidently called out its features, displaying a consumerist understanding of the App Store:

Owen: You buy apps…
Ava: Then wait to load so you can play.
Henry: You have to pay.
Ava: Or it can be free and then you have to do a password (CST20.08).

The age rating in the App Store provided the opportunity to explore the concept of preschoolers being the target audience of the app to be designed.

Researcher: Do you know who we are designing the app for?
Owen: For kids under the age of 5, like my little brother Lochie.
Marnie: I have a brother, I have two.
Researcher: Does anybody else have a younger brother or sister?
[Marnie and Henry raise their hands.]
Researcher: If you don’t have a younger brother or sister, do you know anybody who is under 5 years old?
Ava and Henry raise their hands.

Owen: [To Ruben.] You know my brother.
Kate: I know 22 people.
Owen: I know a hundred! (CST20.08)

The tour of the App Store prompted the CRAG to think about preschoolers as the audience for their app design ideas. The CRAG made connections with other children of the same age both within and outside their own families. The tour also demonstrated the children’s awareness of the role app icons play in distributing information, such as an app’s description, target audience and developers.

The researcher presented the children with a researcher-produced image depicting a simplified screenshot of the App Store (see Figure 5.1). The image was used as a template to elicit the children’s ideas for app icons. The template featured blank fields where text should appear and blank boxes where images should appear. The researcher invited the children to draw an app icon, label their app and include a description, then indicated how the app icon would be situated in the blank box and the developer’s name — in this instance, the child’s name — would be situated in the two blank fields within the template.

Figure 5.1. Simplified “screenshot” of app information in the App Store (RPV20.08).
The objective of this activity was to present the CRAG with an opportunity to express their ideas visually through a medium that is familiar to children. The researcher offered drawing materials such as pencils, crayons and coloured markers to the CRAG members. Each CRAG member used these drawing materials to draw an idea for an app icon on a piece of paper. Discussion with the researcher enabled each child to share the title of their app and a brief discussion of what it was about. The process of drawing of icons resulted in six different ideas produced by each member of the CRAG (see Figure 5.3).
<table>
<thead>
<tr>
<th>Marnie’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s about bugs. You’re meant to try and get it away from people trying to squash the bug. You need to tap really fast before the humans squash them.</td>
</tr>
<tr>
<td>App name: Bug Squash</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Owen’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>You can tap on a place and then you can do what you do at that place. If I went to the fire station then if the bell rings, I would get into the fire truck then it will tell me which way to go.</td>
</tr>
<tr>
<td>App name: My Little Town</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ava’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s about arts and craft because some kids like art and craft when they are young.</td>
</tr>
<tr>
<td>App name: Arts and Craft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ruben’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>You do lots of sports and these are all the options. They (preschoolers) will like soccer, sprint and jog.</td>
</tr>
<tr>
<td>App name: Sports Run</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>London’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Shopkins and Splashlings play together. They do the Olympics like swimming races and see what time they have.</td>
</tr>
<tr>
<td>App name: Shopkins and Splashlings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Henry’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s a doodle app where you can draw with shapes and colours. You can make a smiley face with stars and shapes.</td>
</tr>
<tr>
<td>App name: Doodle App</td>
</tr>
</tbody>
</table>

*Figure 5.3. App icon drawings and transcript of children’s design ideas (PPD20.08).*
The children’s ideas offered a range of themes, including chasing bugs, outdoor experiences in a swimming pool, sports, exploring a town and creating through drawing, arts and crafts. The brief description of each app idea demonstrated a preview of what the CRAG expected from preschooler apps, emphasising that a range of choices offered during play, the app’s responses to input from children, and open-ended discovery and goal-oriented types of play are presumed by the CRAG as typical play experiences.

**Creating Detailed Designs through Arts and Crafts**

The researcher encouraged the CRAG members to explore and extend their ideas in detail using a range of art materials such as boards, coloured paper, foam shapes, pipe cleaners, glue and scissors. The use of arts and crafts materials sought to facilitate the children to further explore their ideas through another medium with which they are familiar. Using this alternate medium as a means of expression, the CRAG affirmed their ideas regarding preschooler apps.

Further, the researcher prompted the members of the CRAG to work in pairs as they created detailed designs using arts and craft materials. The role of pair work in this stage of the study was to gauge the CRAG’s inclination to collaborate with each other. Only two children (Ruben and Owen) were willing to work in pairs at this stage, while the other four worked individually to extend their initial designs (see Figure 5.4).
<table>
<thead>
<tr>
<th>Marnie’s description:</th>
<th>Ruben’s and Owen’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>They are the people and they are the bugs. The people try to squash the bugs with their hands. It’s a game. You need to make the bugs run away from the people.</td>
<td>This is a house in My Little Town where you can walk. You got to try and get coins by winning soccer matches or games. When you get enough points, you can spend them to unlock new places in the town. The door handle is very important. When you open the door, it might show you a map and you can walk inside and find some coins inside.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ava’s description:</th>
<th>London’s description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s all the art and crafts things. You can make with them. You can make a person.</td>
<td>I’m going to make a swimming pool with steps… and floaties. The ball is the raft. The pipe cleaners are the fence. There can be a friendly race or a swimming race. If they fall into the water, the crocodile will eat them. There are bad sharks and crocodiles. The pipe cleaners are for safety protection. There will be trampolines.</td>
</tr>
</tbody>
</table>

| Henry’s description: | |
|---------------------| |
| It’s something where you can make all different colours like big blobs of paint. If you draw a rectangle, you press red and tap in the middle of the shape. You can have a rubber in case you accidentally do something wrong. | |

*Figure 5.4. Detailed designs created by the CRAG (PPD20.08).*
The children’s detailed designs ideas extended on some key features of the original design ideas for their apps. These key features included the range of choices available for the creation of drawings and artworks, game-like features involving challenges such as chasing bugs, avoiding sharks and crocodiles, and accruing points by winning races and games. In both processes of drawing the app icons and creating detailed designs, the CRAG members were provided opportunities to express and explain their ideas to the researcher and to each other.

**Cycle 3: Transforming Individual Ideas into One Design for an App**

Cycle 3 focused on developing a shared understanding of preschooler apps among the members of the CRAG. The progression from an individual understanding of preschooler apps in Cycle 2 to a shared understanding of preschooler apps in Cycle 3 was valuable in determining recurrent themes within these understandings. Enabling a shared understanding of preschooler apps among the CRAG members as a group provided the CRAG members with an opportunity to explicate their understanding of preschooler apps while considering the different perspectives of other children.

Cycle 3 aimed to develop the CRAG’s individual design ideas into one co-design for an app over the following design processes scaffolded by the researcher:

1. Each child shared their individual ideas to the rest of the CRAG.
2. The CRAG worked in pairs to mix their ideas with each other.
3. The CRAG combined all their ideas into one design ideas as a group.

**Researcher Produced Visual 1: App Store™ Mock-Up**

The researcher created a mock-up of the App Store to simulate how the children’s app icons, detailed designs and descriptions would appear if they were accessible from Apple’s App Store and to provide the CRAG with a visual stimulus with which they could present their ideas to the rest of the CRAG. The researcher set each of the CRAG’s
design ideas within the screenshot of Apple’s App Store: Bug Squash; Sports Run; Arts and Crafts; Doodle App; Shopkins and Splashlings and My Little Town (see Figure 5.5). The children were able to tap on their app icon design, which opened detailed information set within the App Store template (see Figure 5.1). For example, Henry’s ideas for Doodle App is set within the App Store mock-up in Figure 5.6.

Figure 5.5. Depicting the CRAG’s app icons within the mock App Store (RPV03.09).

Figure 5.6. Henry’s app design ideas set within the simplified App Store template (RPV03.09).
The researcher developed the App Store mock-up using HTML, the system of codes used for displaying data on the internet. This App Store mock-up, however, was not hosted on a web server and was available only on the local computer upon which it was displayed. This was important in avoiding copyright issues with Apple’s App Store and also ensured that the children’s works were not published in a public server without their consent. The App Store mock-up was displayed on a computer on wheels (COW), similar to an interactive whiteboard, accessible only to the research team and the participants (see Figure 5.7).

Figure 5.7. Marnie uses the App Store mock-up to present her ideas (CSV03.09).

Sharing Design Ideas with the CRAG

The App Store mock-up served the valuable role of establishing to the CRAG that their ideas influenced the design of a working interactive medium that they could interact with at this early stage of the design process. The researcher asked whether any of the CRAG members recognised the image presented to them. The responses from the five CRAG members who attended CRAG Session 3 (CS3) demonstrated their recognition of the App Store and its purpose as an online distributor for the purchase of apps. They
exhibited a sense of excitement upon recognising their apps represented within the mock-up of the App Store. The children approached the COW without invitation to point at their apps. Two children interacted with the mock App Store by tapping on the screen. They demonstrated a sense of ownership and pride in seeing their app icons situated within the mock App Store.

Researcher: Does anybody know what this is a picture of?
Henry, Kate, Owen: [In unison] The App Store!
Researcher: The App Store, that’s right. And what happens in the App Store?
Henry: Our apps! [Points at the screen.]
Owen: Our apps is there!
Ruben: You buy apps. [In response to the researcher.]
Researcher: You buy apps, that’s right.
Henry: [Gets up from his chair to investigate closer.] My app’s there!
Owen: [Gets up from his chair and points at his app icon.]
Researcher: Your apps are there. Isn’t that cool?
Henry: And Ruben’s. [Taps on Ruben’s app]
London: That’s my app, pointing at her app icon drawing. [Gets up from her chair.]
London and Owen: [Both tap on the screen at the same time.]
Marnie: That’s mine. [Stands up to point at her app icon.]
Ruben: [Stands up to join the group.] (CST03.09)

The display of the children’s app icon ideas urged the CRAG members to approach the COW without any instigation from the researcher. The freedom of movement displayed by the CRAG indicated the growing ease that the children felt in this study environment and demonstrated that their opportunities to speak did not rely upon the researcher’s invitations to do so. In the following excerpt, five members of the CRAG approached the COW of their own accord. Their conversations displayed their understandings of the different features of the App Store.
This is not the actual App Store because our apps are not finished yet. This is just an image of the App Store and images of your app icons.

London: That’s Ava’s. [Points at Ava’s app icon.]

Researcher: Why don’t you tap on Ava’s app icon and see what happens? [Offers the stylus to London.]

Henry: Reviews. Click on reviews. [Instructs London.]

Researcher: There are no reviews yet. The app is not finished yet. We just have the pictures that you made. Eventually we’ll have the description there too.

London & Kate: [Both tap on the screens to explore the “App Store”.] (CST03.09)

The researcher prompted the CRAG to share their ideas to the rest of the CRAG using the App Store mock-up. All five CRAG members, who participated in CRAG Session 3, had an opportunity to share their design ideas. They explained their ideas regarding the design features of their proposed app while indicating which features they deemed important to share (see transcripts in Figure 5.8).

<table>
<thead>
<tr>
<th>Owen’s and Ruben’s Presentation of My Little Town</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Owen:</strong> This is my app, which I call “My Little Town”. You can tap on things that are in the town. You can do what you usually do there.</td>
</tr>
<tr>
<td><strong>Researcher:</strong> Fantastic!</td>
</tr>
<tr>
<td><strong>Henry:</strong> 6767 [Reading the number on the artwork.]</td>
</tr>
<tr>
<td><strong>Ruben:</strong> It is Owen’s number, he wrote. That’s a street sign</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Henry’s Presentation of Doodle App</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Researcher:</strong> Tell us about your app.</td>
</tr>
<tr>
<td><strong>Henry:</strong> The doodle app is about where you can draw a game then you can pick a colour and then the whole thing you drew just go that colour.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Ruben’s Presentation of Sports Run</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ruben:</strong> This is my app. It’s based on a sport. There’s soccer, baseball, volleyball, sumo, boxing and lots more. But it’s very easy. Like for soccer, you just need to tap a person and the game makes a decision for you on what to do. It’s not that hard for under five year old’s.</td>
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<table>
<thead>
<tr>
<th>London’s Presentation of Splashlings and Shopkins App</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>London:</strong> Well, it’s a “Splashlings” and “Shopkins” app where you play in the Olympics. The Olympics has lots of stuff so I cannot tell you lots of stuff.</td>
</tr>
<tr>
<td><strong>Researcher:</strong> What happens there? [Pointing to an image created by London.]</td>
</tr>
</tbody>
</table>
London: It’s a swimming pool race. So they have to swim over there and they have to go on a bridge.

Figure 5.8. The CRAG’s presentation of their app ideas to each other (CST03.09).

The presentation of the CRAG’s ideas opened the opportunity to take initial feedback from each other. The researcher assisted Marnie through a series of prompts. She timidly articulated her ideas to the rest of the CRAG (see Figure 5.9). The CRAG members then identified positives, negatives and areas for improvement to Marnie’s ideas in a group reflection (Figure 5.10).

<table>
<thead>
<tr>
<th>Marnie’s Presentation of Bug Squash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher: <strong>What are these?</strong></td>
</tr>
<tr>
<td>Marnie: They are the bugs</td>
</tr>
<tr>
<td>Researcher: <strong>What are these?</strong></td>
</tr>
<tr>
<td>Marnie: The people</td>
</tr>
<tr>
<td>Researcher: <strong>And what are these?</strong></td>
</tr>
<tr>
<td>Marnie: They’re the things that bugs eat.</td>
</tr>
<tr>
<td>Researcher: From what I remember, the bugs are being squashed by the people and you have to tap to get away from being squashed. Is that right?</td>
</tr>
<tr>
<td>Marnie: [Nods.]</td>
</tr>
<tr>
<td>Henry: It’s a really good colour… that it’s got lots of colours.</td>
</tr>
<tr>
<td>Owen: Lots of colours and they are really neat.</td>
</tr>
<tr>
<td>Ruben: That she made food for the bugs.</td>
</tr>
<tr>
<td>London: I like that she does everything that the app is about.</td>
</tr>
<tr>
<td>Owen: That it is a bit inappropriate because the bugs can die.</td>
</tr>
<tr>
<td>Casey: Humans are laughing that the bug got squashed – that the bugs will die.</td>
</tr>
<tr>
<td>London: Maybe the preschoolers shouldn’t play with them. Little ones don’t play and not so little can play.</td>
</tr>
<tr>
<td>Kate: (I like) that it has bugs on it, and that you have to tap to get away.</td>
</tr>
</tbody>
</table>

Figure 5.9. Transcript from Marnie’s presentation of her app idea.
The process of sharing design ideas with the rest of the CRAG affirmed the CRAG’s design ideas and also offered the opportunity for the members to acknowledge each other’s presence and their individual roles within the CRAG as a group. The analysis of the children’s conversations as they shared their ideas is discussed alongside the findings of the succeeding design process.

**Mixing Design Ideas into One Design for the App**

The following design process of mixing ideas engaged the CRAG members in a collaborative task to work together towards a single design app design. This design process aimed to encourage the CRAG members to consider the differences in individual perspectives and engage them in negotiations to prioritise different design features among the mixed app design ideas.

In this process, the researcher scaffolded the combination of each CRAG’s ideas with
each other’s by using the “cake” metaphor utilised in CCI Methodologies (Guha, et al., 2005):

Researcher: Does anybody know what it’s like to mix the ingredients of a cake? You have different ingredients, flour, sugar and egg. On their own they do not taste nice but it is delicious when mixed together to bake a cake. Also, you do not need too much of each ingredient. When you mix your ideas, make sure the big idea has a little bit of each your ideas in it (CST03.09).

The researcher encouraged the CRAG to work in small groups to create three screen designs for their apps using art supplies. Two groups of children collaborated in mixing their ideas into one app idea while one child worked as an individual designer. The process of mixing ideas further exemplified the features of preschooler apps that were identified in the preceding design processes.

**Mixing Ideas Group 1.** Marnie and London worked together in mixing Bug Squash and Shopkins and Splashlings. The girls created one drawing to depict their mixed idea (see Figure 5.11).

![Marnie's and London's drawing](image)

**Marnie’s description:**

Shopkins and bugs are together because they are friends. They’re trying to get away because the humans want to eat the Shopkins and the bugs don’t want to get squashed by the humans. You have two lives to use. If you are a bug, if you get squashed, that means you have one more (life) left.

**London’s description:**
The squares are for the swimming pool. They dive at rainbows, so we have to do colours (on squares).

*Figure 5.11. Marnie and London mix their ideas (PPD03.09 and CST03.09).*

Marnie described an extended narrative in her description of the mixed idea. The humans chase the Shopkins to eat them in the same manner that the humans chase the bugs to try to squash the bugs. The premise of the design remains the same in that the Shopkins and the bugs have to avoid being caught by humans. London, meanwhile, integrated the bugs into the pool idea, explaining that each box in the drawing in Figure 5.11 is part of the swimming pool. She described how the Shopkins and bugs dive into the pool with rainbow colours.

Their descriptions of the mixed idea displayed minimal negotiation for prioritising between the different designs. The two girls described two separate narratives, keeping their original app design ideas intact apart from the inclusion of additional characters in their design ideas. The Shopkins characters were incorporated into Marnie’s bugs idea and bugs were included in London’s pool play idea. Additionally, Marnie reverted to squashing bugs within her app idea without acknowledgement of whether the squashing of bugs was appropriate content for preschoolers to engage in, an issue previously discussed in Cycle 2. Marnie’s idea asserts that the option to have the game-like feature of restarting the game with multiple lives is appropriate content for preschoolers.

**Mixing Ideas Group 2.** Henry, who initially meant to work with his younger sister, Kate, ended up working on his own. He depicted three different screens on one page (see Figure 5.12). He divided the page in three sections; “pick a paw”, “pick a colour” and the “draw” area for his “doodle” app idea.
Henry’s description:

What happens first, is you pick a cat’s paw. You use the cat's paw to pick a colour. And then it picks that and then you draw. And then you can just tap them.

*Figure 5.12.* Henry draws three screens for his “doodle” app idea (PPD03.09 and CST03.09).

The design idea for Henry’s Doodle App remained intact in the absence of another CRAG member to mix ideas with. Henry continued to expand on his ideas for the drawing app describing a new feature of his design which customises the play experience by providing a range of cat’s paws to draw with.

**Mixing Ideas Group 3.** Ruben and Owen worked with Casey, an older sibling of Marnie’s and a guest to that session, to mix their ideas. Ruben suggested: “You can do ‘My Little Town’ and then in the town I can do the sport stadium.” The boys created three screens for the mixed idea, producing images for “the town”, “the cricket ground” and “choose an athlete” (see Figure 5.13).
Ruben’s, Casey’s and Owen’s description:

Owen: This is the town that he made. This is first. You choose a character… We choose a character then it goes into the city.

Casey: That’s a house. That’s a house and that’s a martial arts stadium.

Ruben: There’s a sports stadium and lots more houses.

Owen: There’s the sports stadium, that’s the cricket ground. Those are the seats.

Ruben: This is where you choose a character in the sports stadium. There’s Usain Bolt, Steven Gerrard and Messi.

Figure 5.1. Three-screen elaboration: “the town”, the “sports stadium and “choose an athlete” (PPD03.09 and CST03.09).

The mixed ideas presented here is a successful example of negotiation between two different app design ideas. Ruben’s sports app idea is integrated as one of the places that a preschooler can visit when exploring Owen’s idea for My Little Town. However, the boys were not able to determine a singular function for the sports stadium: it was identified as both a cricket ground and a martial arts stadium. In this instance, Casey, had an interest in martial arts, which was included in their mixed ideas. Additionally, the mixed design idea featured the selection from a persona of an athlete, indicating a preference for the customisation or personalisation of the play experience.

**One design idea for the co-design of an app.** Mixing ideas produced three to four design ideas, which needed to be further consolidated into a single design idea for the co-design of a preschooler app. The researcher prompted the CRAG members to push their tables together to form one big table where a large piece of butcher’s paper was set
out. In this step, the children were invited to use art materials to consider how they might blend each other’s ideas into one idea for an app.

The CRAG member’s single design on the butcher’s paper displayed the five distinct sections for the app. Marnie and London depicted their design ideas separately: Marnie drew a house with a back garden where the bugs run around while London drew a swimming pool area for the Shopkins and Splashlings. Henry drew a smiley face with stars as the eyes to represent his design idea for “doodle”, which was a re-creation of his app icon drawing from Cycle 2. A building represented the sports section of the app, while street signs pointing to the different areas in the town were created beside the sports building.

The CRAG’s work on the butcher’s paper did not display an openness towards negotiating a singular priority over one or any of the designs. Figure 5.14 demonstrates how the CRAG members held on to their original app idea despite the activity to mix their ideas. However, Ruben and Owen described a resolution that brings the separate ideas together as different places to visit within the town.

Owen: All of this is put together in just one town.
Ruben: [Agrees.] That’s just a mini-town and there’s lots of towns all over the place. (CST03.09)
With this in mind, the researcher was provided direction for the creation of a prototype of the app, which was presented to the CRAG in the subsequent cycle of the co-design process. An overview of the single design for the app and its separate sections is presented below;

- “My Little Town” features different places to visit; “you can tap on the different places” in the town and “do what you usually do there”.
- The places to visit include a sports stadium, a garden with bugs, a swimming pool, and an art house.
- The sports stadium offers different choices of sports including soccer, baseball, volleyball, sumo, sprints and boxing.
- In the garden, the objective is to make the bugs run away from humans who are trying to squash them.
- A range of ideas are presented to take place in the swimming pool, such as
swimming races, picking coloured leaves to win a championship and avoiding falling into the water to be eaten by sharks and crocodiles by making use of safety protection.

- In the art house, children will create using arts and crafts materials; this can include making a person. They can draw with shapes and colours, make different colours with blobs of paint and there is a rubber in case users make a mistake.

**Cycle 4: Applying Design Ideas to a Prototype**

Cycle 4 focused on determining how the CRAG’s shared understanding preschooler apps was applied to a prototype of the co-designed app. The objective of Cycle 4 was to elicit the finer details of the app design as the CRAG responded to the prototypes. The process of interacting with the prototypes enabled the CRAG to engage in a collaborative effort as they further illustrated their understandings of the distinct features of preschooler apps that motivate children’s play.

An analysis of the design ideas presented in the first and subsequent cycles revealed that Design Principle 1 — that preschooler apps promote interactivity with opportunities for “lots to touch” — was one common feature among the different design ideas. Therefore, the researcher invited the CRAG to re-visit “lots to touch” as a feature of preschooler apps to frame the children’s responses to the prototypes.

To re-visit this specific criterion of “lots to touch”, the researcher presented the children with a sample three-screen elaboration of My Little Town (see Figures 5.15 and 5.16) developed using HTML. The researcher demonstrated how tapping on one of the houses in the town changed the screen image to a close-up image of that house. Demonstrating how the parts of the house (e.g., the walls, the roof and the windows) might change in colour as the researcher tapped on the screen, the researcher sought and received confirmation that the CRAG understood how these visual changes were examples of “lots
to touch” as a feature of preschooler apps. The researcher also demonstrated how tapping on that house may open up another image with bugs on it.

Figure 5.15. The three-screen elaboration in HTML developed by the researcher (RPV17.09).

Figure 5.16. Demonstrating interactivity using the three-screen elaboration in HTML (RPV17.09).

Researcher Produced Visual 2: Paper-Based Prototype

The researcher initially presented the children the different sections of the app as a paper prototype. The use of paper prototypes is a typical medium employed in the early stages of software development since it allows children to participate in the design stages. In this study, the use of paper prototypes provided the CRAG with the opportunity to enact the interactions they expected from the app.

The researcher used crayons and paper to draw the following backgrounds on a piece of A3 paper: a swimming pool, a sports oval and a grassy area to represent a garden; there were also two blank A3 pieces of paper for the town and the art house. Each background
was accompanied by a combination of typical objects and those mentioned by the CRAG in their design ideas, also produced by the researcher using crayons and paper. Each of these objects was laminated to facilitate being handled by the CRAG without tearing. These paper prototypes were picked up and moved around by the CRAG in an examination of their ideas of interactivity. The children used the laminated objects to identify the different ways that a preschooler would have “lots to touch” within the app. Throughout this stage of the design process, the researcher scaffolded the CRAG to make connections between their ideas and the criteria for preschooler apps the CRAG identified in Cycle 1.

**Paper prototype of My Little Town.** Four members of the CRAG shared and elaborated on each other’s ideas as they defined what interactivity or “lots to touch” means for the different sections of the app. The CRAG manipulated the following laminated objects and used these as stimuli for their ideas: three houses, clouds, trees, the sun, a door, a car, and a footpath (see Figure 5.17). Ava built on Owen’s initial idea of day becoming night while both Ruben and London suggested how a bird could fly from tree to tree, how a car can drive across the town and how the footpath might change to bricks. Owen suggested that the app should have a capacity to “undo” certain actions.

---

Owen: [Re-arranges the laminated objects.]
That goes there, that goes there and that goes there.
The ideas presented by the CRAG referenced their prior experiences to generate ideas for “lots to touch”. The CRAG members described rules that could be predetermined by the app design, illustrating how “touches” on the app can provide interactivity. They also expressed a wish to explore these touches without any risks, indicating that the option to undo an action was desirable in the app design.

**Paper prototype of the pool section.** The CRAG manipulated the following laminated objects and used these as stimuli for their ideas: floating ring, rubber ducks, beach ball, rubber boat, swimming noodles and a mermaid’s tail (see Figure 5.18). The children’s ideas included activities such as rowing across the pool in a boat, playing pool games with a beach ball or swimming noodles, and prompting a mermaid to swim. Both London and Owen described swimming in the pool, with the option to do a race across the pool. Ruben suggested that rubber ducks should say “quack”, while the other children offered a variety of sounds that can be incorporated into the app design.
| London: | You can have a race to there and jump to the plank there. |
| Ruben: | When you tap on the rubber duck, they say quack. |
| London: | Yup, if you tap on that the rubber duckies races. |
| Ruben: | If you tap on the noodles or the beach ball, there’s a person comes on it and throws it up. |
| Ava: | If you press on that [the dinghy], it can row and pick up all the stuff so you can pack it away. |
| Researcher: | Owen, do you have any ideas? |
| Owen: | When you tap on that area, the person swims to that place. |
| Ava: | If you click on the mermaid, it would put the body up and then it will swim. |
| Researcher: | One of the features you mentioned for preschoolers is “exciting music” and “lots of sound”. Are there any sounds that you will hear when you’re in the pool? |
| Owen: | the ocean |
| Ruben: | rain |
| Ava: | You can probably hear the splashing when the ducks quack. |

Figure 5.18. Paper prototype (RPV17.09) and transcript for the swimming pool section (CST17.09).

The swimming pool activities described by the children made connections with the children’s prior experiences, while London’s and Owen’s description of swimming races demonstrated game-like features, inferring an objective of winning during play. Their ideas detailed how a sequence of inputs or touches from a child could initiate any of the
predetermined activities suggested such as rowing across the pool in a boat or playing pool games with a beach ball or swimming noodles. The suggestion for the rubber ducks to say “quack” prompted the researcher to remind the CRAG how they have identified that “lots of sound” and “exciting music” were features of a preschooler app they had previously identified.

**Paper prototype of the bug section.** The CRAG manipulated the following laminated objects and used these as stimuli for their ideas: grass, flowers, hands and bugs of different colours and sizes (see Figure 5.19). The CRAG offered alternative suggestions regarding what should occur within the app (i.e., a human gently picks up the bug instead of trying to catch and squash it). The CRAG then determined that this part of the town should be renamed “Bug Play” instead of “Bug Squash” to reflect the modifications they have decided on.

| Ava: | Oh you could put one [bug] behind there and put it behind the plant. |
| London: | Pick the flower [while she holds the hand]. Okay, I will put this in the hand. The flower is in the hand. |
| Owen: | And the bug is in this hand… |
| Researcher: | And what happens when the bug is in someone’s hand? |
| Ava: | You can slap it. |
| Researcher: | Slap it? Is that going to be okay? |
| London: | Don’t slap it. |

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Ava: They can just scoop it up. [Demonstrates].
London: And put them back into the thing.
Ruben: If you scoop it up, you can just have it close… Maybe the hands can put it down carefully… and then the bug will smile… Whatever bug it is, it makes that sound.
Ava: The wings can be trying to hide for protection.

Figure 5.19. Paper prototype (RPV17.09) and transcript for the bug section (CST17.09).

The CRAG’s scrutiny of whether squashing the bugs was age-appropriate content for preschoolers reflects the CRAG’s criterion for preschooler apps that they should be “not scary”. In the alternative suggestion offered by the CRAG, a sequence of predetermined rules takes place within the app where a hand gently picks up the bugs. Two CRAG members suggested that the bug should cover its eyes with its wings, smile, then the hand that picked the bug up gently puts it back. This suggestion further extended the narrative that four members of the CRAG collaborated on.

**Paper prototype of the sports section.** The CRAG manipulated the following laminated objects and used these as stimuli for their ideas: different types of balls and sports equipment (see Figure 5.20). The CRAG considered that certain sports, such as basketball and rugby, were “too rough” for preschoolers. When the researcher probed the idea of “tackling in a preschooler app”, Owen offered the alternative of touching instead of tackling to prevent preschoolers from feeling “scared”. As the conversation progressed, the children evaluated different types of sports that preschoolers would be able to choose from. Their observations prompted that those types of sports deemed “too rough” should be omitted from the app design.
Ruben: Voleyball is not that rough so we can just put that in there.
Owen: Tennis - tennis is okay.
Owen: Basketball is bad because and sometimes you go like that.
[Demonstrating bumping into Ruben.]
Owen: In tennis.
Ruben: That’s not too rough at all.
Owen: It’s just hitting the ball. [Demonstrates again.]
London: What about football?
Ruben: That’s definitely rough.
Owen: [Demonstrates.] London, say if Ruben has the ball. This is how you tackle. You just grab them and just tackle.
London: I’ve watched them on TV. I’m not scared.
Owen: Oh and baseball isn’t rough at all.
Ruben: And running.
Researcher: Okay so I think we’ve got enough. So we’ve got baseball, running, tennis, volleyball, table tennis. I think that’s plenty.

Figure 5.20. Paper prototype (RPV17.09) and transcript for the sports section (CST17.09).

Additionally, the dialogue in Figure 5.21 exhibits how two CRAG members determined the range of choices that should be available when choosing sports equipment.

Owen: When you like tap the batons, you can change the colour of your baton. Like of you tap on the blue, you can change it to blue … and
you can press an arrow and then it changes the ball and you don’t have to unlock them.

Ruben:  Five different colours of batons. Five patterns on the baton… And about ten shoes… the batons, five.

Owen:   And the bats probably around six? Seven?

Researcher:  Why do you need seven different types of bats?

Ruben:  About four. Four.

Owen:   Four.

Researcher:  What are the different types of bats?

Ruben:  Like different patterns – some could have stripes, googly lines.

Figure 5.21. Transcript for the sports section (CST15.10).

The sports section engaged the CRAG in reviewing types of sports that they deemed appropriate for preschoolers. The CRAG’s review of the type of sports acknowledged that age-appropriate content should promote positive experiences, with a distinct awareness of how preschoolers should be offered a range of choices of sports based on their own interests. The children’s suggestions also demonstrated an awareness of the affordances of digital technologies for customisation.

Paper prototype of the art section. The CRAG manipulated the following laminated objects provided by the researcher for the art section of the app: different art materials such as coloured pompoms, pipe cleaners, crayons, coloured blobs, different coloured shapes and scissors (see Figure 5.22). The children used these laminated objects as stimuli for their ideas for the art section of the app. The open-ended nature of this section of the app is highlighted in Ruben’s statement, “You can draw wherever you want.” The CRAG’s suggestions for this section of the app indicated their understandings of how preschooler apps allow children to produce their own content. The children demonstrated their expectations that the app should allow for the manipulation of objects, such as through changing the size of shapes to create a roof, and the use of drawing tools to create content.
Ava: You could make it like shape, if you put this there. [Placing a triangle on the roof], you can set how big you want it.

Researcher: What do you think Ruben?
Ruben: When you tap on the crayons you can draw on that one.
Researcher: Where do you draw?
Ruben: You can draw wherever you want.

Figure 5.22. Paper prototype (RPV17.09) for the arts section (CST17.09).

The CRAG’s ideas for “lots to touch” for the different sections of the app had so far supported each other’s. However, their discussion of the arts and crafts section of the app revealed that this was not always the case. For one feature of the art and craft section, four children had four different suggestions. While Ava spoke about using shapes to fit into the house structure, Ruben expected the app design to function as a drawing tool. The children’s ideas interchanged between two different paths of creating content through arts and crafts and customising the design of a house.

Ava: If you press on the drawing you can go inside the house and make stuff in it.
Henry: Yeah, that’s what it’s like and the whole house is blank and you create what you want… a TV, a lounge, a couch.

Figure 5.23. Transcript for the arts section (CST15.10).
The CRAG’s suggested ideas indicated an opportunity to take multiple paths for playing and to assign multiple functions of objects. Regardless of the differences, their suggestions offered a range of choices regarding materials and tools to create with. The CRAG’s suggestions also included opportunities to manipulate objects (e.g., through changing shapes and sizes) as another method by which preschoolers could produce their own content.

<table>
<thead>
<tr>
<th>Ruben</th>
<th>They can be the backgrounds to the pictures, the borders.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ava</td>
<td>It could be like you can drag it and grab it.</td>
</tr>
<tr>
<td>London</td>
<td>You can put your pompons and your straws</td>
</tr>
<tr>
<td>Ava</td>
<td>If you press some of these colours, you could press on whatever you want to. These shapes will be in different colours and you just try them... then you can cut... and then there’s glue so you stick these stuff on.</td>
</tr>
<tr>
<td>Henry</td>
<td>You tap on the glue then it’s the glue that you’ve got on your hand. And then you press the scissors and then it will cut the things that you’ve got.</td>
</tr>
</tbody>
</table>

*Figure 5.24. Transcript for the arts section (CST17.09 and CST15.10).*

Both Ava and Henry expressed digital play’s affordances to share what is displayed on an iPad screen with other people. Ava also mentioned how the arts and crafts app should allow children to “print it” (CST17.09), while Henry mentioned in a previous conversation that the app could feature a way of sending creations from the Doodle app to other people (CST03.09).

**Developing the character section.** Owen’s initial app icon idea that “you can walk” in My Little Town prompted a new section for the co-designed app. The idea was affirmed in the later stages of the design process, in both the mixing of ideas and in developing a single idea for the co-designed app, wherein Ruben explained “how we choose a character that goes into the city and then you can tap on where you want to go.”
The researcher posed the question of what type of characters, if any, would be present in the co-designed app. The four CRAG members who were present at the session responded by each drawing a character, which they envisioned would walk around the town (see Figure 5.25). The children’s propositions were centred on their own identities yet they displayed their awareness of the affordances of digital technologies for customisation and a degree of understanding of the role of avatars and non-playing characters in assisting digital play. The CRAG displayed an understanding of how their avatar or character could provide technical support when a child is unsure of how to proceed with their play. Their ideas detailed the character’s non-playing function of “giving you messages” or “telling you what to do” should the child not know “how to play the game” or “what to do”.

Owen: You can take a picture of yourself then you tap on the picture then you go to photos then you do that and then the character who looks like you goes up on the street then you can move yourself around.

Ava: Or you can make your own body and then you put your head stuck on it.

Ruben: This is just another person, you can design another guy. This is just a person that’s already made from the game. I can choose him because he is already automatically walking around the town giving like messages to you.

Researcher: Messages?

Ruben: Like how you play the game, if you need help or stuff like that.

Owen: Or like, if you don’t know something, just press the head and then it just walks up to you and tells you what to do if you need to pass the challenge or anything.
Figure 5.25. Characters drawn by the CRAG members (PPD17.09) and transcript from the session (CST17.09).

The CRAG’s discussion of the role of selected characters have during the play experience demonstrated the appeal of creating a digital representation of themselves. The CRAG identified the open-ended capacity of technology, which would allow them to create their own content by drawing the bodies of the characters and using the device’s camera to take a photograph of themselves. The CRAG’s ideas evolved to correspond with Ava’s idea to “make a person” (PPD20.08). Thus, a digital representation of themselves would walk around My Little Town.

**Researcher-Produced Visual 3A: Screen-based Prototype of the Co-designed App**

The CRAG’s reflections regarding the application of their design ideas as they engaged with screen-based prototypes were obtained for three sections of the co-designed app: the bug section, the character section and the My Little Town interface. These three sections of the app were developed as a screen-based prototype by the researcher using the Adobe Creative Suite. The researcher recreated the paper background for each section of the app and the different laminated objects as vector images. These vector images were imported into Adobe Animate, which the researcher used to code the script that rendered the vector images as interactive elements. The interactive elements facilitated a play experience that allowed the CRAG to tap on the screen as they had enacted on the paper prototypes.

**Screen-based prototype of the bug section.** The bug section of the co-designed app was the first digital prototype developed by the researcher. The researcher presented the screen-based prototype displayed from an iPad to the CRAG (see Figure 5.26). The narrative presented followed the design ideas developed by the CRAG: three coloured bugs scurry across the screen amongst the grass, leaves and flowers, which can
be dragged aside. Tapping on a bug displays the bug scurrying across the palm of a hand where it stops, covers its eyes with its wings, then smiles. The CRAG along with Kate, a preschooler who was a guest at this CRAG session, offered some feedback when the researcher queried whether the bug section of the app matched the CRAG’s design ideas (see Figure 5.26).

| Marnie:  | It’s smiling [the bug]. |
| Henry: | Maybe there should be something else to do. |
| Marnie: | There should be actual humans in it and they’re walking around looking for bugs. |
| Kate: | They can fly… from one flower to another. |
| Marnie: | Maybe you can pick the grass. |

*Figure 5.26. Digital prototype of the bug section (RPV15.10) and transcript from the session (CST15.10).*

The children’s prior experiences continued to influence their reflections on the prototype. Kate’s and Marnie’s suggestions related their prior experiences (i.e., bugs “fly… from one flower to another” and “humans … look for bugs”). Two other CRAG members offered feedback while they played with the bug section of the co-designed app. In the excerpt below, the children’s prior experiences dictated the expectation that the right colour of bug should appear on the palm of the hand.
Owen: Oh you can move the leaves! …
Ruben: Did you want us to discover? Is that why you didn’t tell us?
Owen: Let’s tap a bug, ready?
No, no, no [as the bugs get away from him].
It’s covered its eyes, it’s smiling.
Ruben: Why does it only do a purple one? I’ve got an idea. If you tap a yellow one, make sure a yellow one…
Researcher: So the bugs should be the right colour (CST15.10).

The CRAG also considered whether the app design offered age-appropriate choices that was easy for preschoolers. The suggestion to change the speed with which the bugs scurry was made to allow preschoolers to catch the bugs more easily and would offer preschoolers a sense of being in control.

Owen: Maybe the bugs shouldn’t be so fast because it will be pretty hard for the toddlers to touch.
Ruben: I don’t think you need to change all of them. I think you just need to change this one.
Both boys: [Laugh as they play.]
Researcher: What would make you say “aye”?
Owen: Because it’s really hard to touch a bug.
Researcher: What happens when you catch it? What would you like to do?
Ruben: Maybe a bit more easier.
Both boys: [Continue to play commenting as they play.] (CST15.10).

In the following CRAG Session (CS6), Owen noticed that the suggestions he made in the previous session had been addressed by the researcher. Ava offered a strategic tip suggesting that a sequence of input may allow Owen to catch the bugs.

Owen: I want to get this one! Oh yay, I got this one and it came up in the right colour. It comes up in the right colour! [Calls out to the researcher.] It comes up in the right colour!
Researcher: Yes, I fixed that part.
Owen: But it’s still a little hard. Oh, so close!
Ava: You get to move the flowers then catch the animals.
Owen: Yay! (CST29.10).
The CRAG presented verbal commentaries while they engaged with the digital prototype of the bug section. In the excerpt below, London chanted as she played. Her gestures as she played led to a discussion in which the CRAG offered variations to the narrative of the bug section. London demonstrated both an expectation to squash the bugs and a desire not to do so. Ava and Owen offered different variations as to what might occur next within the app. Owen’s suggestion to “make a garden” also referenced the expectation that preschooler apps should allow the customisation of the play experience.

London: I’m going to get you. I’m going to get you. I’m going to get you. Woo!
Researcher: [Notices that London set her hand palm down over the screen.] Why do you put your hand over it? What do you want to happen when you do that?
London: So I can squash the bug.
Researcher: Do you want to squash the bug?
London: I don’t like bugs so I don’t squash them.
Ava: We can do that and then we can put it back where we want it and then we have to put out hand and then it goes out of our hand.
Owen: I know what we can do. You can move the flowers and then you can make a garden and then chase the bugs.
Researcher: So are we killing the bugs again or what are we going to do?
Owen: No, we’re just…
Ava: Grab the bug and it stays there. (CST29.10).

**Screen-based prototype of the character section.** The researcher presented the digital prototype of the character section displayed from an iPad to the CRAG. The digital prototype followed the design ideas developed by the CRAG. Selecting a character required choosing one of the four hand-drawn bodies from Figure 5.2 then choosing the face of one of the CRAG members to complete the character. The CRAG’s engagement with the prototype revealed how they readily assumed the role of the characters portraying themselves. In their conversations, the children referred to “I” and “you” as they spoke about the characters that they selected during play.
Ava: [To Owen] You’re not smiling. You’re not smiling.

Owen: I know.

Ava: I’m not smiling. I’m cranky.

London: I’m smiling… see I’m smiling…

Look, I’m smiling, guys. I’m smiling, guys.

Figure 5.2: Digital prototype of the characters section (RPV29.10) and transcript from the session (CST29.10).

Owen displayed a distinct awareness of preschoolers as the specific target audience for the co-designed app. He questioned whether his younger sibling, Lochlan, was represented in the selection of characters. Owen indicated a need for his younger brother to be represented with the knowledge that Lochlan was one of the participants in the following Digital Playgroup session. Owen offered a resolution, stating that Lochlan’s photo would turn into his on-screen character.

Owen: Who’s not in that photo?

Researcher: It’s a blank one.

Owen: Who’s missing out?

Researcher: There’s no one else at the moment.

Owen: Lochlan might be.

Researcher: Lochlan might. What do you think we should do?

London: We need to put Lochlan there.

Researcher: How are we going to do that?

Owen: I’ll tell you. You just take a picture of Lochlan next week and
As before, the CRAG’s engagement with the digital prototype of the co-designed app exhibited verbal commentaries. London chants “Hello” and “Bye-bye” as she swapped the different faces and characters from one to another.


Two instances of play took place during the CRAG’s engagement with the digital prototype of the character section which were not intentionally designed to take place. In the first instance, the children assigned faces to bodies that may not have matched their gender preferences.

Owen: Everyone, look. I’m putting Ruben on London’s character…
London: I’m doing me in Ava’s character…
Ava: Look at that. Look at that.
[Leans over to look at London’s iPad.]
Owen: You’re on mine. [Turns his iPad for Ava and London to see.] London: I’m putting Kate on yours…
Owen: I’m going to put Henry on this one. [Turns his iPad to show the girls.] Look at Henry.
London: [Turns her iPad to Ava and Owen.] Look at Henry.
[Ava squealing and laughing.] Look at Henry. He’s a beautiful lovely person girl.
Owen: Look at Ruben. He’s the same thing as Henry. (CST29.10)

In the second instance of play, the CRAG members dragged and spun the faces of the characters across the screen. This function was an unintentional aspect of the design that was corrected in the later prototypes of the co-designed app. The play experiences initiated a link to prior experiences of being carsick or seasick and also ventured into possible connections of prior experiences to potential future experiences.

Ava: Look at that. I like moving everyone’s faces.
London: I’m putting a stack of faces. I’m putting a stack of faces.
Ava: I’m spinning around. I’m spinning around. I’m spinning around…

Owen: This is pretty cool. This is pretty cool.

Ava: Do you really get car sick?

Owen: Do you get car sick?

Ava: Um… no…. Do you get seasick?

Owen: No I don’t. I don’t get sick. (CST29.10).

**Screen-based prototype of My Little Town interface.** The researcher presented the digital prototype of the My Little Town interface displayed to the CRAG from an iPad (see Figure 5.28). The digital prototype followed the design ideas developed by the CRAG. The person playing this app could make a character walk along the street of My Little Town. Interactive elements in this section of the app included turning day into night and vice versa, and making birds fly from one tree to another. This section of the app acted as the interface with which the character could choose a place to visit: a house that would lead to the back garden to look for bugs, a house that leads to the art section, an oval that led to the sport section, and the swimming pool. The digital prototype, however, was not complete at this stage. Although the images for each of the places were visible, tapping on each place opened a placeholder page.

*Figure 5.28. Digital prototype of My Little Town street (RPV29.10).*

Owen proposed a change of name of this section from “My Little Town” to “Tiny Town” at the beginning of CRAG Session 6 (CS6). He presented an image he created in his journal at home to the researcher.

Owen: That’s the “t” for tiny. That’s the “t” for town.
I was thinking it could be the icon for my app. I was thinking it could be in the middle of the town.

Researcher: [Reads from Owen’s journal.]
“This is my idea for my app. It could be in the centre of the town.” [To Owen] What a great idea! Fantastic. I really like it (CST29.10).

Owen’s suggestion was noted by the researcher, acknowledging his thoughts regarding the newly suggested name for the co-designed app. However, he was not able to recall the new name when engaging with the digital prototype later on in the session. The CRAG expressed enthusiasm over finding the screen versions of their design ideas. Owen identified that London’s character was in My Little Town and he was able “to move” London’s character around My Little Town.

Owen: Where’s “My Little Town”? I’ve got “My Little Town”.
London: Can I have a look at “My Little Town”?
Researcher: You can have a look at “My Little Town”.
London: Where’s “My Little Town”?
Owen: Oh, look. I can move you London. I can move you!
Researcher: This one. [Shows London how to get into the My Little Town.] London: My Little Town (in a sing-song tune).
Owen: There’s you [to London] (CST29.10).

The expectation to be represented as one of the characters was expressed by Ava, who asked the researcher, “How come you picked nobody else?” (CST29.10). The digital prototype of the co-designed app featured a limitation where only one character could along My Little Town; the researcher intended to correct this in the later versions of the app. Similarly, the recognition of the different places to visit in My Little Town featured limitations, explained by the researcher.

Owen: What are those things for? What are these for?
Researcher: That’s the oval for the running part that’s going to take place.
Owen: How do you play it?
Researcher: It’s not ready yet. It’s just showing how you can get in.
London: Can I go into the sports?
Researcher: The sports is not ready yet.
Owen: I found the pool. I found the pool.
London: My swimming pool. I found my swimming pool! (CST29.10).

The verbal commentaries affirmed their recognition of the interactive elements associated with the sun and the moon indicating the change from day to night and reverse.

Owen: Oh, you can make it night and day!
Researcher: Yes…
Owen: You tap the sun it’s night and when you tap the moon it becomes day!

**Cycle 5: Inviting Preschoolers to Play with the App Prototype**

Cycle 5 was the last cycle in the co-design process. This cycle engaged the two groups of participants for a series of Digital Playgroup sessions where the CRAG observed four preschoolers engage with the prototype of the co-designed app. The objective of Cycle 5 was for the CRAG to collect data on the preschooler’s views and opinions of their digital play with the co-designed app. The findings from this cycle revealed how the interactions between the CRAG and the preschoolers contributed to the growing understanding of children’s digital play with apps.

The CRAG members discussed how they would assume their role as co-researchers. The children were aware of their primary objective to observe the motivations of preschoolers as they played with the co-designed app.

Researcher: So when we show these apps to the preschooler, how are we going to do it?
Owen: Here’s our iPads. Play the game. Tell us how you like it… They have to tell us what they do on it and whose app was their favourite and if they can make their own app, like our apps, make it better. They will tell us how they would do it.
The CRAG members offered suggestions on how the observations of the preschoolers will take place:

Owen: We can say ‘how do you want us to improve it?’ and then we can try and improve it that way and then ask them to come another time and do it.

Researcher: How are we going to remember that?

Ava: We could tell you before we forget it... We can write it down.

Researcher: Are we going to show the whole app or in sections like today?

Owen: Maybe we can like: one minute, we do this. Then another minute, do that and then keep on going until we finish then we explain the whole app as we show the toddler. We each have a toddler. Maybe two people to a toddler (CST29.10).

During the Digital Playgroup session, the CRAG modelled digital play with the prototype of the co-designed app to the preschoolers and invited preschoolers to respond to their questions. Both groups of participants, the children and the CRAG, demonstrated their motivations for engaging with the prototype and shared their views via talk.

**Researcher Produced Visual 3B: Screen-Based Prototype of The Co-Designed App**

The different sections of the co-designed app presented to the preschoolers and the CRAG members consisted of the bug section, the character selection and the town interface. Additionally, digital prototypes of two new sections were created for the preschoolers and the CRAG to play with: the pool section and the sports section. The children’s engagement with the prototype is described below.

**Screen-based prototype of the pool section.** The digital prototype for the pool section of the co-designed app (see Figure 5.29) was presented to the CRAG and the preschoolers. The digital prototype followed the design ideas developed by the CRAG. A character somersaults from the diving board into the pool. The inflatable boat can be
rowed around the pool. The ducks swim across the pool and the ball is thrown from one character to another. The children’s play in the pool section demonstrated their expectation for interactivity, the ability to manipulate objects and to be represented as a character during play.

![Digital prototype of the pool section (RPV05.11) and transcript from the session (DPT05.11; DPT03.12).](image)

Owen: Let’s see who jumps the plank. I want to know.
Owen: Which is Ruben in the pool?
Ruben: I’m not in the pool.
Bella: I want to be a fish in there.
Researcher: And what will the fish do? What will you do in there?
Bella: Swim around. The fish will do backflips too.

*Figure 5.29. Digital prototype of the pool section (RPV05.11) and transcript from the session (DPT05.11; DPT03.12).*

The children expressed an expectation to be able to manipulate objects and the characters in this section of the app. Ava, a CRAG member, exclaimed “I want to … grab a person, drag around and do stuff” (DPT05.11) while Bella, a preschooler, stated, “When you tap these, these duckies move everywhere around the pool” (DPT03.12).

Ava further identified that the image of the pool noodles could not be manipulated during play: “I think those should be able to move too” (DPT05.11). An idea suggested by Kate, a preschooler, presented a resolution to Ava’s concern.
Henry: What happens when you press the noodles, Kate?

Researcher: [Shakes her head.] Nothing yet.

Researcher: [Asks Kate.] What would you like to happen?

Kate: It goes [gestures towards her mouth and makes a sound] then water goes out.

Researcher: [Attempts to copy the gestures and sounds made by Kate.] It goes —like a horn?

Kate: Then water goes out.

Henry: [Explains further.] You know how they got holes in the middle?

Researcher: Yes.

Henry: Water in there and then it goes squirting out.

Researcher: That’s a really good idea! Which way does the water squirt out?

Kate: [Points at the noodles and drags the stylus across the screen.]

Researcher: [Commentates while Kate gestures.] From there to there.

(DPT26.11)

The expectation to be represented as a character in the co-designed app was exhibited by the children. While Ruben wanted to know which character he would see diving from the plank or the board, Owen queried whether Ruben was represented as a character. Kate, a preschooler, queried if the mermaid could “be someone else” (DPT10.12), while Bella stated that she wanted “to be a fish” swimming around doing “backflips too” (DPT03.12).

**Screen-based prototype of the sports section.** The digital prototype for the sports section of the co-designed app was presented to the CRAG and the preschoolers (see Figure 5.30). The digital prototype followed the design ideas developed by the CRAG, enabling users to choose from a range of sports equipment in relation to soccer, baseball and running. Due to time limitations, the researcher was only able to create soccer in the digital prototype. The CRAG scaffolded the preschooler’s play by modelling, guiding and praising during play.
Lochie: Ruben, how do you get this to score a goal?
Owen: [Takes control of the iPad.] Now you can tap on that.
Owen: [Reaches over to tap on the screen a few times.]
Tap on that then press it.
All three: [Watches to see if the ball goes into the net. It does.]
Ruben: Yay, you scored Lochie! You’re an amazing player.
Lochie: [Smiles and cheers with two hands raised in the air.]
(Starts tapping the device as he was shown.)
Ruben: Now, you can play.
Lochie: [Scores another goal.] Goal one. I just scored another goal.

<table>
<thead>
<tr>
<th>Ruben:</th>
<th>You’re the best at this game, Lochie.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lochie:</td>
<td>[Continues to play, then looks up.] Oh, I did it again!</td>
</tr>
<tr>
<td></td>
<td>[He looks around to Ruben and announces once more.] I did it again! [Continues to play.]</td>
</tr>
<tr>
<td></td>
<td>[Turns to Ruben who is speaking to the researcher.]</td>
</tr>
<tr>
<td></td>
<td>Watch this! [Claps his hand to catch Ruben’s attention.]</td>
</tr>
<tr>
<td></td>
<td>Ruben, watch this! [Fails to grab Ruben’s attention.]</td>
</tr>
<tr>
<td></td>
<td>[Continues to play.] Ruben, watch this.</td>
</tr>
<tr>
<td>Ruben:</td>
<td>[Comes over to watch Lochie playing.]</td>
</tr>
<tr>
<td></td>
<td>You’ve made a good effort, Lochie.</td>
</tr>
<tr>
<td></td>
<td>[Claps his hands as he says]</td>
</tr>
<tr>
<td></td>
<td>Now you can have a round of applause.</td>
</tr>
<tr>
<td>Lochie:</td>
<td>[Laughs in response] (DPT26.11)</td>
</tr>
</tbody>
</table>

Figure 5.30. Digital prototype of the sports section (RPV26.11) and transcript from the session (DPT26.11).
The children’s interactions with each other demonstrated how the CRAG participated in scaffolding the preschooler’s digital play through modelling of play and offering praise. Ruben commentated “I’m going to play soccer” demonstrating to Lochie, a preschooler “That’s the soccer field” (DPT26.11). Ruben added the description, “You do lots of sports and these are all the options” (DPT26.11). This pertains to the opportunity for the children to personalise and customise their play by choosing the design of the sports equipment. Bella, a preschooler, showed her preference by selecting a ball: “I like the purple one” (DPT03.12).

Ruben’s role as the CRAG motivated Lochie’s engagement with the prototype of the co-designed app. Lochie continued to play the game, requesting Ruben to watch his play while he commentated on his achievements — “I did it again!” — to which Ruben offered praise such as “You’re the best at this game, Lochie.” and “You’ve made a good effort, Lochie. Now you can have a round of applause” (DPT26.11).

**Screen-based prototype of the bug, character and town sections.** The CRAG demonstrated their play with the digital prototype of the bug, character and town sections of the app to the preschoolers. The feedback from the children defined interactive elements and more features that could offer personalisation and customisation. The children’s design ideas extended the app’s capability to enable children to customise and blend real-life with their digital play.

Bella: [Taps on a tree in the town interface.]
Researcher: What would happen when you tap on a tree?
Bella: Move around [as she dances].
Researcher: Who is going to move around?
Bella: The tree.
Researcher: The tree. In what way is it going to move around?
Bella: Move, move move [as she sways from side to side].
Researcher: The tree? Will it dance? Side to side? The whole tree?
     [Researcher copies Bella’s movements.]
Bella: [Nods] (DPT03.12).

Bella communicated with the researcher how she expected the trees to interact with her taps on the iPad. Bella also demonstrated how she expected background sounds could play during her play.

Bella’s Mum: Did I hear you whistle? Do you think that’s what it should play when you see the stars? Twinkle twinkle little stars?
Mum & Bella: [Sings the song together.] (DPT03.12).

The children also expressed further features which would permit the personalisation and customisation of their play with the co-designed app. When Ava mentioned that the bug section “needs more because all you do is catch the bug”, another child suggested that perhaps “more than one garden” can be offered where “you can design your own” (DPT05.11). More customisation could also be offered with “different sorts of bugs… Dots for red ladybirds, blue beetles and flies that fly fast” (DPT03.12).

The feedback from the children for the character section expanded on the personalisation and customisation aspect. From suggesting that the co-designed app could offer “characters you can design… like design your own hair” (DPT05.11), the CRAG members suggested to “take a picture with an iPad” (DPT03.12) or “take a photo!” (DPT10.12) when a child queried how to be represented in the co-designed app. Thus, the children demonstrated their sense of being represented in their digital play experiences by incorporating their photos and blending real-life with their digital play experiences.

Overall, the children’s digital play with the prototype of the co-designed app demonstrated instances in which the children engaged in private speech and commentaries as they played. Lochie, a preschooler, chanted “duckie, duck, duck” as he tapped on the ducks and “kick, kick, kick. I’m going to play soccer” (DPT26.11). London commented, “I’m looking at the bug app. I’m going to get you. I’m going to get you.
The children’s engagement with the prototype of the co-designed app enabled them to relate their digital play experiences with real-life situations. Henry discussed a forthcoming pool party he was going to attend.

Henry: Because it’s my last game next week, we’re going to have a celebration, we’re going to my friend’s house. They’ve got a massive pool… and we’re all going to have a party in there (DPT26.11).

The CRAG demonstrated the app to the preschoolers with a sense of ownership. Ava demonstrated how the app allowed her to make choices and choose her own path of play. “You can choose if you want to be in the pool or if you want to be somewhere else” (DPT05.11).

Finally, the children’s reactions to finding their character representations motivated their play with the co-designed app as they recognised each other.

Implications for the Design Principles of Preschooler Apps

Cycles 2 to 5 engaged the CRAG in the development of their individual design ideas, in
sharing and mixing their design ideas with each other and in reflecting as a group on the application of these ideas to a prototype. The findings from these cycles were analysed by the researcher with reference to the children’s ideas for the design of preschooler apps. The analysis draws on examples across the subsequent cycles which build on the set of nine design principles initially proposed in Chapter 4. Each of the nine principles were confirmed or adjusted through the findings presented. Additionally, the analysis of the findings identified a number of emerging design principles. Thus, a set of refined design principles, which consolidates the confirmed, adjusted and emerging principles, is presented as a conclusion to the chapter. The development of the refined design principles in this phase of the design-based study is presented in Figure 5.31.

![Diagram of Design Principles]

*Figure 5.31. Development of refined design principles in Phase II of the study.*

**Building on Design Principles for Preschooler Apps**

The analysis of the CRAG’s design ideas and their reflection on these ideas illustrated and elaborated on each of the nine initial design principles. Tables 5.2 to 5.10 illustrate how the children’s design ideas and utterances from each cycle supported and elaborated on each of the design principles. The analysis of these findings affirmed and shaped
adjustments and extensions to each of the design principles. Any changes to the wording of the design principles appear in bold in Tables 5.2 to 5.10.

**Building on Design Principle 1.** The first design principle is focuses on the interactive elements present within preschooler apps that engage children in interactive experiences with “lots to touch” (see Figure 4.6). Cycle 2 built on this key idea, indicating that a sequence of tactile input from a preschooler can initiate predetermined responses from the app. Table 5.2 shows how the CRAG’s ideas reveal that the concept of interactivity can be extended. Game-like features were addressed in direct references to the design idea as “a game” and references to “winning” or “unlocking new places”.

Different facets of Design Principle 1 are further illustrated by the findings from Cycles 3 and 4:

- The CRAG identified predetermined rules of play that would encourage children’s input (e.g., tapping on the screen).
- Some ideas elaborated on the sequence of input while others indicated game-like features that could promote interactivity during play.

Therefore, Design Principle 1 is extended to include ideas with reference to sequences of input and game-like features. The findings that indicate these extensions are indicated in Table 5.2 in parentheses.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 2</td>
<td>• In Owen’s idea, if the child playing “the fire station”, then the app’s design may initiate the bell ringing. The child can play by getting into the “fire truck”, initiating the predetermined response that the fire truck will show “which way to go”. (sequence)</td>
</tr>
<tr>
<td></td>
<td>• Henry’s idea affirms that interactivity is achieved through a sequence of input that a preschooler is expected to initiate during play: “If you draw a rectangle”, then “press red and tap in the middle of shape”, the predetermined response from the app will display a red rectangle on the screen. (sequence)</td>
</tr>
</tbody>
</table>
The detailed ideas from London affirm the relationship between the preschooler’s input and the predetermined response from the app (sequence):

London: “If they fall into the water, the crocodile will eat them.”
London: “You can pick leaves… if the team finds their colour, they get to win the championships.”

Cycle 3

- Henry’s presentation of his design idea referred to how a drawing created on his app appears after making a sequence of choices.
- Ruben’s presentation of his idea referred to how the app “makes a decision for you on what to do.”
- London’s design idea featured a race with predetermined rules that state where to swim and the requirement “to go on a bridge” to complete the pool race. (game-like)
- Marnie included having another turn to play through multiple lives when describing how her ideas can be mixed with London’s. (game-like)

Cycle 4

- The CRAG’s suggestions for My Little Town described how touches on the laminated objects could promote a sequence of actions (e.g., changing night to day and bird flying from tree to tree).
- A sequence of actions determined the narrative that occurs after the hand picks up a bug in the bug section. (sequence)
- The art section indicated how the input from a preschooler can initiate interactivity to manipulate objects and customise the play experience.
- The character selection section indicated how the input from a preschooler can initiate interactivity to customise their play experience.
- The swimming and duck races suggested for the pool section demonstrate game-like features.
- Ava offered a tip which involved a sequence of actions that would allow Owen to catch the bugs while playing in the bug section.

Cycle 5

- Bella expected the trees in the town interface to sway from side-to-side when tapped.

Extended Principle

#1: Preschooler apps motivate through predetermined rules of play that promote interactivity providing opportunities for “lots to touch”. **A sequence of input from the child who is playing can initiate a predetermined response from the app that may exhibit game-like features.**

### Building on Design Principle 2

Design Principle 2 proposes that a range of age-appropriate choices should be made available to the preschoolers during their play experiences. Their play experiences should allow for preschoolers to make different types of choices. Offering a range of choices acknowledges the different interests and experiences that children may have that influence their play experiences. Engaging preschoolers with an appropriate level of difficulty and examples of ways preschooler apps can promote positive play experiences both demonstrate the concept of age-
appropriate content for preschoolers. Table 5.3 shows how a range of choices enable preschoolers to make decisions based on their interests and affirm their expectations to customise or personalise aspects of their play.

**Table 5.3**

**Building on Design Principle 2**

<table>
<thead>
<tr>
<th>Initial Principle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2: Preschooler apps should offer children a range of age-appropriate choices which are based on a range of topics and interests of preschoolers.</td>
<td></td>
</tr>
</tbody>
</table>

**Cycle 2**
- The primary feature of Ruben’s idea for “Sports Run” includes a range of sports options for preschoolers, such as “soccer, sprint and jog”.
- Avi’s idea offers “Arts and Crafts” as one of the activities a child can choose to play. Her idea was influenced by her understanding that “kids like arts and craft when they’re young.”
- London’s idea for the swimming pool section offered preschoolers a choice between “a friendly race or a swimming [competitive] race.”
- Henry detailed the range of choices offered to preschoolers through the “different colours” that will be made available in the design of “Doodle” app.

**Cycle 3**
- Ruben’s design offered a range of sports options with the intention of catering to the possible interests of preschoolers.
- Ruben also reflected on the level of difficulty appropriate for a preschooler audience.
- Henry’s affirmed the design idea in mixing design ideas. A screen, which he called “Pick a colour”, featured a range of colours available for a preschooler to choose from.
- The three-screen elaboration produced in mixing design ideas offered a range of choices in choosing a character and in choosing places to visit in the town.
- Owen and Casey, a guest to the CRAG session and an older sibling of one of the CRAG members, noted that the notion of dying bugs may not be suitable for preschoolers.
- London suggested different age recommendations for older children and preschool aged children, implying that a different type of play should be available for the two different age groups.

**Cycle 4**
- The CRAG considered that squashing bugs may not be appropriate content for preschoolers. They offered alternative suggestions to ensure that the play experience is “not scary” for preschoolers.
- The CRAG reviewed different type of sports that they deemed would be of interest to preschoolers and were not “too rough” for preschoolers.
- The art section offers a range of choices in terms of materials and tools for preschoolers to create with.

**Cycle 5**
- The sport section permits the children to choose from three different types of sports to play with: soccer, baseball and running.

Design Principle 2 is supported and consolidated by the data presented above. No
adjustments or extensions to the wording of the design principle are required.

**Building on Design Principle 3.** Design Principle 3 suggests that the indication of progress is a significant factor in establishing a sense of achievement during play. Table 5.4 shows how the collection of rewards such as coins, and winning or unlocking places indicate progress during play.

Table 5.4
Building on Design Principle 3

<table>
<thead>
<tr>
<th>Initial Principle</th>
<th>Relevant data</th>
</tr>
</thead>
</table>
| #3: Preschooler apps motivate through rewards or points and provide children with an indicator of their progress during play. | Cycle 2  
- Owen’s idea for My Little Town featured motivation through the collection of rewards or “coins” as an indicator of progress.  
- London stated that finding the team’s coloured leaves will “win the championships”.  
- Owen and Ruben also expressed how the collection of coins and “winning soccer matches and games” unlock places. |

Design Principle 3 is reinforced by the findings presented from Cycle 2. Therefore, no adjustments or extensions to the wording of the design principle is necessary.

**Building on Design Principle 4.** Design Principle 4 recognises that preschooler apps should include multimodal features such as sound. The CRAG’s discussions of their design ideas for the pool section indicated the types of sounds that could be heard during play along with the visual and the interactive “touch” aspects of their design ideas.

Table 5.5
Building on Design Principle 4

<table>
<thead>
<tr>
<th>Initial Principle</th>
<th>Relevant data</th>
</tr>
</thead>
</table>
| #4: Preschooler apps includes multimodal features such as music. | Cycle 4  
- The CRAG’s discussion about sounds took place after Ruben suggested that rubber ducks should say “quack”. The children offered a variety of sounds after prompting from the researcher, mentioning the sounds of “the ocean”, “rain” and “the splashing when the ducks quack”. |

Cycle 5  
- In the pool section, Bella expressed a wish to be represented as a dolphin swimming around that makes clicking sounds.  
- In the town interface, Bella whistled “Twinkle, twinkle little stars” as when day becomes night. She and her mother sang the song together while she played.
Design Principle 4 is supported by the data presented in the above table. No adjustments or extensions to the wording of the design principle are required.

**Building on Design Principle 5.** Design Principle 5 identifies the importance of a narrative in preschooler apps. The analysis of the findings from Cycles 2 to 4 outlined in Table 5.6 shows how the narrative sequence for the bug section corresponds with the preschooler app criterion “like a story”, identified by the CRAG in Cycle 1 (see Figure 4.6). The concept of the narrative in preschooler apps is extended by these findings, which offer multiple narratives for preschoolers to engage with in the app:

- London’s design ideas suggested that a preschooler would either avoid “bad sharks and crocodiles” or win championships in teams by finding flowers and leaves in the right colour.
- The mixing of ideas offered multiple narratives for the bugs and the Shopkins.
- An alternative narrative is suggested for the bug section.

The multiple narratives presented by the CRAG reveal an expectation that play will follow one of several paths and that objects within the app design can be assigned multiple functions depending on the path selected by the child. Therefore, the original criteria identified by the CRAG that preschooler apps should be “like a story” is extended based on the implication that preschooler apps should allow one or more narratives, one or more paths of play and one or more functions for objects for preschoolers to engage in. The findings indicating these extensions to the design principle are indicated in Table 5.6 in parentheses.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
</table>

Table 5.6
Building on Design Principle 5

**Initial Principle**

#5: Preschooler apps promote the development of a narrative during play.
Cycle 2

- London proposed multiple narratives that preschoolers can engage with within her app idea, including “friendly or swimming” races, keeping safe from “bad sharks and crocodiles” with the use of “safety protection” and “leaves in three colours” to “win the championships”.
  (narrative)
- London’s proposal multiple narratives featured the multipurpose use of pipe cleaners in her design idea. In the “swimming pool with steps, the pipe cleaners are the fence”, while where “there are bad sharks and crocodiles, the pipe cleaners are for safety protection.” (multipurpose)

Cycle 3

- In mixing design ideas, Marnie and London proposed two different narratives of being chased by humans and diving into pools.
  (narrative)
- In mixing design ideas, multiple structures or houses in the town included a sports stadium. The purpose of the stadium seemed to differ between two children. One indicated it was a martial arts stadium while another claimed that it was a cricket ground. (multipurpose)

Cycle 4

- The alternate narrative offered by the CRAG involves gently picking up bugs instead of squashing them. (narrative)
- Ava and Owen offered multiple narratives that might occur after engaging with the screen-based prototype of the bug section. Ava described returning bugs to the garden while Owen suggested that preschoolers should be able to “make a garden”. (narrative)
- For one feature within the art section of the app, the CRAG members had different suggestions. Ava suggested how different shapes can fit into the shape of the house while Ruben expected the art section to function as a drawing tool. The children interchanged between the two ideas of creating content and customising the design of the house. (narrative)

Extended Principle

#5. Preschooler apps promote the development of one or more narratives during play which offer multiple paths for play and may feature objects that have multipurpose functions.

Building on Design Principle 6. Design Principle 6 affirms the influence of popular culture and media in preschooler apps. Table 5.7 demonstrates how the CRAG incorporated the Shopkins and Splashlings brands of toys and the swimming events from the Olympics in their design ideas. Further, the inclusion of characters based on popular athletes is another application of popular culture and media within the CRAG’s design ideas.

Table 5.7
Building on Design Principle 6

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 2</td>
<td>• London’s app ideas incorporated the toys Shopkins and Splashlings.</td>
</tr>
</tbody>
</table>

199
and swimming events popularised by the Olympics televised at the time of data collection.

<table>
<thead>
<tr>
<th>Cycle 3</th>
<th>London’s idea continued to make references to Splashlings, Shopkins and the Olympics.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ruben’s design idea revolved around sports, influenced by the Olympics, which national media aired at the time of data collection.</td>
</tr>
<tr>
<td></td>
<td>Mixing design ideas extended the narrative of the bug section to include the Shopkins characters.</td>
</tr>
<tr>
<td></td>
<td>Mixing design ideas included references to choosing a character based on athletes popularised by the media, such as “Usain Bolt, Steven Gerrard and Messi.”</td>
</tr>
</tbody>
</table>

Design Principle 6 is supported by the data presented above. No adjustments or extensions to the wording of the design principle have been made.

**Building on Design Principle 7.** Design Principle 7 refers to the app features that enable preschoolers to create and produce their own content. Making their own content was a criterion for preschooler apps initially identified during the first cycle. Its inclusion as Design Principle 7 was prompted by the CRAG’s criterion that preschooler apps should have “lots to draw” (see Figure 4.7).

Several other ways that preschoolers can create and produce content through the app design are revealed in the analysis of Cycles 2 to 4. Table 5.8 demonstrates how the children’s design ideas aimed to engage preschoolers in an open-ended exploration of shapes and colours to produce their own content. The range of colours and materials would allow preschoolers to adjust, personalise or customise their play experiences. Likewise, the manipulation of shapes would enable children to produce their own screen-based digital art. Therefore, the original criterion identified by the CRAG that preschooler apps should have “lots to draw” is adjusted to include the concept of open-ended exploration and the manipulation of objects to produce original content.

**Table 5.8**

<table>
<thead>
<tr>
<th>Initial Principle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>#7: Preschooler apps offer opportunities for preschoolers to produce their own content.</td>
<td>Cycle</td>
</tr>
</tbody>
</table>

200
Cycle 2
- Ava’s design idea incorporates “arts and crafts… you can make with”. (open-ended exploration)
- The basis of Henry’s Doodle App idea was to provide a platform for preschoolers that Henry described as “something where you can make”. (open-ended exploration)
- In Doodle App, Henry detailed how one can “draw with shapes and colours”. (manipulation)
- The artwork created in both ideas is open for the child to explore. Ava offered that “you can make a person”, while Henry suggested that a child could “make a smiley face” and “make all different colours”. (open-ended exploration)

Cycle 3
- Henry shares his design idea describing how a preschooler could ‘pick a colour’ that turns “the whole thing you drew” into that colour. (manipulation)
- Henry elaborated on how Doodle App offers choices for customising children’s play: “You pick a cat’s paw, you use the cat’s paw to choose a colour, and then you draw.” (open-ended exploration)

Cycle 4
- Ruben and Ava both offered suggestions demonstrating how objects could be manipulated to create their own screen-based art. Ava talked about manipulating the size of a triangle to create a roof, while Ruben chose crayons as the art material declaring that he could “draw wherever you want.” (manipulation and open-ended exploration)

Adjusted Principle
#7: Preschooler apps offer open-ended exploration enabling preschoolers to manipulate objects and produce their own content.

Building on Design Principle 8. Design Principle 8 recognises the role of characters assumed by children during play. Assuming the role of a character was a key feature of apps identified in Cycle 1 during the CRAG’s demonstration of apps they played with. The CRAG’s demonstration of their play in Cycle 1 involved the use of “I” or “you” as they projected the role of the character in the app onto themselves or onto the person they were speaking to. Table 5.9 reveals how the roles of characters can be assumed during play. The CRAG also integrated “you” or “I” as they described the key features of their app design ideas in Cycle 2.

The concept of assuming the role of characters was extended in Cycle 4 through the CRAG’s proposition to offer options of a range of characters to choose from, thus enabling preschoolers to customise the characters they assumed during play. The CRAG also came to a shared understanding of how they perceived that characters should be portrayed in the app. Extending from Ava’s design idea to “make a person”, discussed
above in Design Principle 7, the CRAG drew bodies for different characters and suggested that the device’s camera should be used to take a photograph of their faces.

The analysis of the findings demonstrates how the CRAG used the opportunity for open-ended creation to recreate themselves as the characters that would walk around My Little Town. Further, the CRAG members demonstrated a requirement for the capacity to adjust the representation of themselves as characters. This is evidenced by their reactions to other children’s playful interchange of genders when selecting the characters within the app. The findings that indicate these extensions to the design principle are indicated in Table 5.9 in parentheses.

Table 5.9
Building on Design Principle 8

<table>
<thead>
<tr>
<th>Initial Principle</th>
<th>Relevant data</th>
</tr>
</thead>
</table>
| Cycle 2             | • The CRAG often used “I” or “you” to describe how the app design functioned, indicating that they felt as if they were characters acting in the app:  
                      Owen: If I went to the fire station and then if the bell rings, I would get into a fire truck then it will tell me which way to go.  
                      Henry: You can draw with shapes and colours. You can make a smiley face with stars and shapes (PPD20.08) |
| Cycle 3             | • The option to choose a character based on a popular athlete in mixing design ideas is an example of how the CRAG perceived that assuming a role of a character is a key feature of preschooler apps.  
                      Ruben: This is where you choose a character in the sports stadium. There’s Usain Bolt, Steven Gerrard and Messi. (CST03.09) |
| Cycle 4             | • The CRAG described how the characters in the app could be created to be a representation of themselves.  
                      Owen: You can take a picture of yourself then tap on the picture, then you go up to photos … and the character who looks like you goes up on the street then you can move yourself around.  
                      Ava: Or you can make your own body and then put your head stuck on it (CST17.09) (representation)  
                      • The CRAG playfully switched gender stereotypes as they played with a screen-based prototype of the character section. This is an example of emerging play which was not intended by the design. However, the analysis of this data is relevant in understanding the CRAG’s reflections regarding the adjustment of their representations. (adjust)  
                      Owen: I’m going to put Henry on this one. [Turns his iPad to show the girls.] Look at Henry.  
                      London: [Turns her iPad to Ava and Owen.] Look at Henry. [Squealing and laughing.] Look at Henry. He’s a beautiful lovely person girl.  
                      Owen: Look at Ruben. He’s the same thing as Henry. (CST29.10) |
Building on Design Principle 9. Design Principle 9 focuses on the capacity for customisation or personalisation in preschooler apps. Table 5.10 demonstrates the possible designs options offered within the app that would allow preschoolers to customise their play through a range of choices. The range of options in the sports section and the character selection are examples of the different ways that preschoolers could tailor their play experiences. Further applications of customisation in the children’s design ideas include the option to select from different designs of sports equipment and cat’s paws to draw with. Finally, the design ideas related to making a garden and drawing the bodies of the characters manifest open-ended creativity as a method for personalising play experiences.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 2</td>
<td>Ruben’s design idea offered a range of sports to choose from.</td>
</tr>
<tr>
<td>Cycle 3</td>
<td>Henry identified a screen he called “Pick a paw”. In “Pick a paw”, Henry described how a preschooler can choose a cat’s paw from different designs to draw with in Doodle App.</td>
</tr>
<tr>
<td>Cycle 4</td>
<td>The CRAG’s app design enabled the customisation of play through the range of choices available to preschoolers when choosing characters and choosing the designs of the sports equipment: Owen: When you like tap the batons, you can change the colour of the baton. Like if you tap on the blue, you can change it to blue (CST17.09) In the bug section, Owen described how the play experience can be customised when preschoolers were allowed to “make a garden”.</td>
</tr>
<tr>
<td>Cycle 5</td>
<td>In the bug section, Ava mentioned that the play experience “needs more” to which Tayah suggested that perhaps there can be “more than one garden” where you can “design your own” (DPT05.11) More customisation in the same section can be offered with “different sorts of bugs… dots for red ladybirds, blue beetles and flies that fly fast.” (DPT03.12) Bella expressed her preference for the purple ball when choosing from the sports equipment in the sports section.</td>
</tr>
</tbody>
</table>

Design Principle 9 is reinforced by the findings presented in the above table. Therefore,
no adjustments or extensions to the wording of the design principle are necessary.

**Additional Emerging Design Principles**

Apart from building on the existing set of nine design principles, the analysis of the CRAG’s individual design ideas, shared design ideas and reflection on the application of these ideas to a prototype for the app resulted in the identification of an additional five emerging design principles. Tables 5.11 to 5.15 trace how the children’s design ideas and utterances from each cycle contributed to the identification of these emerging design principles.

**Emerging Design Principle 10.** The CRAG’s real-life experiences shaped the design ideas that they presented in the subsequent cycles. Table 5.14 shows the different experiences that influenced the CRAG’s design ideas and their recognition of the visualisation of their ideas. The data presented also make a connection with potential future experiences related to their play.

<table>
<thead>
<tr>
<th>Cycle 2</th>
<th>London’s design idea for the swimming pool design appeared to diminish where her real-life experiences began to dictate the narrative to her app design. London: You know I went to this place in America … I really like pools because you get to swim in it. And at that free place, I got to swim in the pool and I swim the whole lap of the pool. We made a raft like this…the different colours just go line, line, line… until it could fit me on. Researcher: Oh, good fun!... What is going to happen in this pool? London: It’s going to have a pool like in that hotel (CST22.08).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 3</td>
<td>Owen’s real-life experiences determined that, in My Little Town, &quot;you to do what you usually do there&quot;. Ruben also connected his own real-life experiences, confirming that a street sign is usually seen as part of a town. Marnie’s real-life experiences dictated that people squashed bugs and that bugs need food to eat.</td>
</tr>
<tr>
<td>Cycle 4</td>
<td>The CRAG’s ideas for the street section of My Little Town demonstrated how their real-life experiences influenced the design, for</td>
</tr>
</tbody>
</table>
example through the change from day to night, birds in the trees, brick footpaths and a car driving down the street.

- The CRAG’s real-life experiences informed their design ideas for the pool section: pool races, playing catch with a beach ball, rowing and packing pool toys away.
- The CRAG’s prior experiences related to the reflections made by the CRAG while they played with the digital prototype of the co-designed app. In the bug section, humans “look for bugs” and “bugs fly from one flower to another”. Further, when selecting characters, the CRAG’s conversation during play related prior experiences of being carsick or seasick and ventured into potential future experiences.

<table>
<thead>
<tr>
<th>Cycle 5</th>
<th>Henry related a forthcoming pool experience to his play in the pool section of the app.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Henry: Because it’s my last game next week, we’re going to have a celebration, we’re going to my friend’s house they’ve got a massive pool and we’re all going to have a party in there (DPT26.11)</td>
</tr>
</tbody>
</table>

**Emerging Design Principle 11.** Provision of support during play is an emerging design principle drawn from the children’s design ideas in Cycles 2 and 4.

Table 5.12 reveals how the CRAG identified a specific object and the characters situated within the app design as being able to assist the child playing.

**Table 5.12**
**Findings Related to Design Principle 11**

<table>
<thead>
<tr>
<th>Emerging Principle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>#11: Preschooler apps can provide support to preschoolers during play.</td>
<td></td>
</tr>
<tr>
<td>Cycle 2</td>
<td>Owen described the app idea, “When you open the door, it might show you a map and you can walk inside.”</td>
</tr>
<tr>
<td>Cycle 4</td>
<td>Ruben stated the role of the character: “I choose him because … he is walking around the town giving messages to you…. Like how you play the game if you need help or stuff like that”.</td>
</tr>
</tbody>
</table>

**Emerging Design Principle 12.** Risk-free exploration featured in the design ideas presented by the CRAG in Cycles 2, 3 and 4. Table 5.13 further details how the CRAG relied on the technologies’ capacity to enable them to use a rubber to delete or correct their work “in case you accidentally do something” (see Figure 5.4). The capacity to restart an activity or make use of an “undo” button when unintentional input is made further supports the emerging design principle and the affordance of technology to enable risk-free exploration.
Emerging Design Principle 12. Design principle 12 emerges from the design ideas that utilise the affordance of technologies to enable children to undo, delete or restart certain actions.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 2</td>
<td>Henry’s design idea includes a “rubber in case you accidentally do something wrong.” (CST20.08).</td>
</tr>
<tr>
<td>Cycle 3</td>
<td>Kate suggested that bugs should have the option to restart and having multiple lives so that children can continue playing the game. Kate: If the bugs die, they can come back alive again, they can continue the game … and if you get squashed, you’ll have to restart that level. (CST03.09)</td>
</tr>
<tr>
<td>Cycle 4</td>
<td>Owen suggested that there should be an undo button when “you accidentally delete it” in describing his ideas for the street section of My Little Town (CST17.09).</td>
</tr>
</tbody>
</table>

Emerging Design Principle 13. Design principle 13 emerges from the design ideas that utilise the affordance of technologies to share digitally created artworks and transform digital creations into a tangible medium via printing. Table 5.14 outlines the findings from Cycle 4 that support this design principle.

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 4</td>
<td>Both Ava and Henry made suggestions to share what was created in the app with other people. Ava mentioned that children should have the option to “print it” (CST17.09). Henry wondered in a previous conversation whether the app can feature a way of sending creations to other people (CST03.09).</td>
</tr>
</tbody>
</table>

Emerging Design Principle 14. This emerging design principle is derived from the CRAG’s proposal to use the camera function of the device to allow preschoolers to use their photograph as their on-screen character. Table 5.15 demonstrates how the CRAG’s conversations regarding the selection of characters uses the capacity of digital technologies to blend off-screen and on-screen content during play.
Table 5.15
Findings Related to Design Principle 14

<table>
<thead>
<tr>
<th>Emerging Principle</th>
<th>Cycle</th>
<th>Relevant data</th>
</tr>
</thead>
</table>
| #14: Preschooler apps blend digital on-screen and real-life off-screen presentations. | Cycle 4 | - The children offered suggestions to include on-screen representations of their peers into the app.  
London: We need to put Lochlan there.  
Researcher: How are we going to do that?  
Owen: I’ll tell you. You just take a picture of Lochlan next week and put it on. (CST29.10) |
| | Cycle 5 | - The children offered suggestions to create on-screen representations of themselves.  
Marnie: Take a picture with an iPad. (DPT03.12)  
Leo: I’m not in it.  
Researcher: What are you going to do?  
Ava: Take a photo! (DPT10.12)  
- The children’s recognition of their peers in the app prototype motivated their play.  
London: How did Lochie get in there? Guys, look!  
Henry: Oh cool, that’s Bella! Kate, that’s Bella and you.  
Ruben: Lochie, Lochie - there’s a picture of you on the boat!  
Lochie: Owen, look! I’m in the pool.  
Kate: Bella and me! Bella is from my school. (DPT05.11) |

Chapter Conclusion

Cycles 2 to 5 allowed for elaboration on the different design processes employed during the development of ideas for the co-designed app with the CRAG. These design processes—the analysis of the CRAG’s individual ideas, their shared design ideas and their reflection on the application of these ideas to a prototype for the app—offered insights that contributed to the set of refined design principles for preschooler apps.

The refined set of design principles for preschooler apps now comprises 14 principles. From the findings presented in this chapter. All the initial nine design principles from the first cycle were supported with examples from the findings presented in this chapter. The analysis of children’s design ideas resulted in the adjustment or the extension of some of these (#1, #5, #7, and #8). Some additional principles also emerged from the data analysis from Cycles 2 to 5, which accommodated for the additional ideas presented by the CRAG.
It is important to acknowledge that while each design principle is distinct, most are interconnected when applied to analysis of particular apps. That is, the application of one design principle may be present in multiple features of preschooler apps and, likewise, a design feature of an app may be an application of more than one design principle.

A list of the refined design principles is presented in Figure 5.32. Adjustments to the wording of the first nine design principles and the newly emerged design principles (#10 to #14) are presented in bold. Appendix K offers a detailed description of each of these design principles.

<table>
<thead>
<tr>
<th>Design Principle 1.</th>
<th>Preschooler apps motivate through predetermined rules that promote interactivity providing opportunities for “lots to touch”. A sequence of input from the child who is playing can initiate a predetermined response from the app that may exhibit game-like features of play.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Principle 2.</td>
<td>Preschooler apps should offer children a range of age-appropriate choices.</td>
</tr>
<tr>
<td>Design Principle 3.</td>
<td>Preschooler apps motivate through rewards or points and provide children with an indicator of their progress during play.</td>
</tr>
<tr>
<td>Design Principle 4.</td>
<td>Preschooler apps include multimodal features such as music.</td>
</tr>
<tr>
<td>Design Principle 5.</td>
<td>Preschooler apps promote the development of one or more narratives during play that offer multiple paths for play and may feature objects that have multipurpose functions.</td>
</tr>
<tr>
<td>Design Principle 6.</td>
<td>Preschooler apps include references to popular culture and media.</td>
</tr>
<tr>
<td>Design Principle 7.</td>
<td>Preschooler apps offer open-ended exploration enabling preschoolers to manipulate objects and produce their own content.</td>
</tr>
<tr>
<td>Design Principle 8.</td>
<td>Preschooler apps allow children to assume the roles of characters that enable them to adjust the representation of themselves.</td>
</tr>
<tr>
<td>Design Principle 9.</td>
<td>Preschooler apps enable children to make adjustments through personalisation or customisation.</td>
</tr>
<tr>
<td>Design Principle 10.</td>
<td>Preschooler apps should relate and connect to children’s real-life experiences.</td>
</tr>
</tbody>
</table>
Design Principle 11. Preschooler apps can provide support to preschoolers during play.

Design Principle 12. Preschooler apps allow risk-free exploration by enabling children to undo, delete or restart actions.

Design Principle 13. Preschooler apps allow digital artefacts to be shared digitally or transformed into a tangible object.


Figure 5.32. List of refined design principles derived from Cycle 2 to Cycle 5.

In summary, these 14 design principles have been developed through the analysis of findings from Cycles 2 to 5 (Tables 5.2 to 5.15). The analytical process resulted in the affirmation of all and the extension of some of the nine initial design principles from Cycle 1. An additional outcome of the analysis was the identification of five additional, emerging design principles. Cycles 2 to 5 concluded the research sessions involving the CRAG as co-designers and co-researchers. The next chapter presents a detailed discussion of the design principles in relation to current literature.
Chapter 6
Discussion and Conclusion

Chapter Overview

The study adopted a Design-Based Research (DBR) approach to explore children’s perspectives of digital play and to add children’s perspectives to the existing criteria for quality digital play. This chapter addresses the gap in research — the absence of children’s perspectives in design principles for digital play — and makes connections between the research questions and the design-oriented methodological approach. The responses to the research questions are then discussed. The existing design criteria revealed in the review of literature are examined in connection to the study’s findings on children’s perspectives to address the study’s theoretical contribution to understandings of digital play and to justify the claims based on the analysis of the data. The study’s practical contribution is presented with evidence of the successful application of methodologies based on children’s rights and CCI as a novel methodology for obtaining children’s perspectives regarding digital play. The chapter concludes with recommendations for the implications and the significance of the study towards research, policy and practice.

Addressing the Gap in Research

The absence of children’s perspectives in the development of design principles is the gap identified in the literature review. This study addresses this gap by gaining young children’s perspectives through co-designing an app with them and thus responding to the following research question:

_How are design principles for preschooler apps influenced by children as co-designers and co-researchers in the development of an app?_

This research question emphasises the theoretical contribution of the study (i.e., the contribution of children's perspectives to the design principles for an app for
preschoolers) while situating the study within the methodological design adopted to detail the role of the children in the design-oriented approach that the study employed. The theoretical and practical design aspects of a DBR approach were significant in the formulation of research question.

The discussion of the findings of the study is shaped in this chapter by responding to the two sub-questions, which addressed the theoretical and practical facets of the study:

1. How do children’s perspectives contribute to design principles of apps for preschoolers?
2. What processes do the Children’s Research Advisory Group (CRAG) enact as they co-design and trial an app for preschool children?

The first sub-question addresses the theoretical contribution of the study, which examines the current design principles for a preschooler apps existing in literature in comparison to children’s perspectives, to identify what new contributions children offer towards these current design principles. The second sub-question addresses the contribution of the study to existing research methodologies. The response to this sub-question details the methodological process by which children’s views regarding digital play were obtained in their role as co-designers and co-researchers in the development of an app.

**How do children’s perspectives contribute to design principles of apps for preschoolers?**

Children’s ideas regarding the design principles for the app for preschoolers were discussed and expanded on during a prolonged process of app design. This section explores the development of design principles in relation to Phase III of the DBR study (see Figure 6.1). It compares the themes drawn from existing design criteria presented in literature (from the fields of education and software design) with the refined design principles obtained from children’s perspectives presented in this study.
The proposal of design principles is one of the ways in which theoretical understanding is expressed as a result of design-based studies (Bakker, 2019). The refinement of design principles, resulting from different contexts to which these are adapted, determines their validity (Bell, Hoadley & Linn, 2013).

The review of literature presented in Chapter 2 traced the evolution of design principles between the shifting media platforms of computer games to mobile apps, and the sometimes-overlapping purposes of learning and play. The identified design principles presented related to children’s play and software design features (summarised in Table 6.1).

Table 6.1
Themes Identified from the Literature Review in Education and Software Design

<table>
<thead>
<tr>
<th>Themes relating to children’s play</th>
<th>References</th>
</tr>
</thead>
</table>
Relatable situations and characters; including narratives and connection to popular culture

<table>
<thead>
<tr>
<th>References</th>
</tr>
</thead>
</table>

Collaboration and social interactions

<table>
<thead>
<tr>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hirsh-Pasek, et al., 2015; Marsh, et al., 2015; Van den Abeele &amp; Zaman, 2008; Shoukry, et al., 2015; Verenikina, et al., 2010; Verenikina &amp; Kervin, 2011; Verenikina, Siraj &amp; Kervin, 2018</td>
</tr>
</tbody>
</table>

Assigning symbolic meaning

<table>
<thead>
<tr>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hirsh-Pasek, et al., 2015; Marsh, et al., 2016; Verenikina &amp; Kervin, 2011</td>
</tr>
</tbody>
</table>

Themes relating to software design features

<table>
<thead>
<tr>
<th>Themes</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual design and multimodal features</td>
<td>Alsumait &amp; Al-Osaimi, 2009; Marsh, et al., 2015; Revelle &amp; Reardon, 2009; Shoukry, et al., 2015; Verenikina &amp; Kervin, 2011; Verenikina, et al., 2010</td>
</tr>
<tr>
<td>Interactivity incorporating challenges and rewards</td>
<td>Hirsh-Pasek, et al., 2015; Marsh, et al., 2015; Shoukry, et al., 2015; Van den Abeele &amp; Zaman, 2008; Verenikina, et al., 2010; Verenikina &amp; Kervin, 2011</td>
</tr>
<tr>
<td>Customisation and personalisation</td>
<td>Marsh, et al., 2015; Gerkushenko, et al., 2013; Shoukry, et al., 2015</td>
</tr>
<tr>
<td>Assistance and support</td>
<td>Marsh, et al., 2015; Shoukry, et al., 2015; Verenikina &amp; Kervin, 2011</td>
</tr>
</tbody>
</table>

The set of refined design principles presented in Chapter 5 (summarised in Table 6.2) reveal that the children’s perspectives on preschooler apps align with the themes identified in the literature as related to play and software design features. The addition of children’s perspectives provided in this study presents another opportunity for refining and ensuring the validity of the design principles. It was essential in this study to position children as active participants in constructing their own knowledge and understandings of society (Bodrova & Leong, 2007; Vygotsky, 1978). Further, through creating intersubjectivity (Vygotsky, 1978) between the researcher and the CRAG, children were able to share their understandings of preschooler apps, which contributes to existing understandings of digital play.

Table 6.2
The Set of Refined Design Principles for Preschooler Apps from Children’s Perspectives

<table>
<thead>
<tr>
<th>Design Principles from Cycles 1 to 5 of the Co-Design of an App for Preschoolers</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1. Preschooler apps motivate through predetermined rules that promote interactivity providing opportunities for “lots to touch”. A sequence of input from the child who is playing can initiate a predetermined response from the app that may exhibit game-like features of play.</td>
</tr>
</tbody>
</table>
#2. Preschooler apps should offer children a range of age-appropriate choices.
#3. Preschooler apps motivate through rewards or points and provide children with an indicator of their progress during play.
#4. Preschooler apps include multimodal features such as music.
#5. Preschooler apps promote the development of one or more narratives during play that offer multiple paths for play and may feature objects that have multipurpose functions.
#6. Preschooler apps include references to popular culture and media.
#7. Preschooler apps offer open-ended exploration, enabling preschoolers to manipulate objects and produce their own content.
#8. Preschooler apps allow children to assume the roles of characters that enable them to adjust the representation of themselves.
#9. Preschooler apps enable children to make adjustments through personalisation or customisation.
#10. Preschooler apps should relate and connect to the children’s real-life experiences.
#11. Preschooler apps can provide support to preschoolers during play.
#12. Preschooler apps allow risk-free exploration by enabling children to undo, delete or restart actions.
#13. Preschooler apps allow digital artefacts to be shared digitally or transformed into a tangible object.
#14. Preschooler apps blend digital on-screen and real-life off-screen presentations.

The comparison of the themes and design criteria from the literature (presented in Table 6.1) and the refined design principles representing children’s perspectives (presented in Tables 6.2) reveals that the children’s perspectives on preschooler apps align with the themes identified from literature as related to play and to software design features (see Tables 6.3 and 6.4).
<table>
<thead>
<tr>
<th>Summary of design criteria</th>
<th>Design principles for preschooler apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Themes from literature review (Chapter 2)</td>
<td>Children’s perspectives presented in findings (Chapters 4 and 5)</td>
</tr>
<tr>
<td>Self-initiated play, discovery and exploration (C)* (E)**</td>
<td>#2. Preschooler apps should offer children a range of age-appropriate choices.</td>
</tr>
<tr>
<td></td>
<td>#12. Preschooler apps allow risk-free exploration by enabling children to undo, delete or restart actions.</td>
</tr>
<tr>
<td>Relatable situations and characters; including narratives and connection to popular culture (C) (E)</td>
<td>#5. Preschooler apps promote the development of one or more narratives during play that offer multiple paths for play and may feature objects that have multipurpose functions.</td>
</tr>
<tr>
<td></td>
<td>#6. Preschooler apps include references to popular culture and media.</td>
</tr>
<tr>
<td></td>
<td>#8. Preschooler apps allow children to assume the roles of characters that enable them to adjust the representation of themselves.</td>
</tr>
<tr>
<td></td>
<td>#10. Preschooler apps should relate and connect to children’s real-life experiences.</td>
</tr>
<tr>
<td>Collaboration and social interactions (C)</td>
<td>#13. Preschooler apps allow digital artefacts to be shared digitally or transformed into a tangible object.</td>
</tr>
<tr>
<td></td>
<td>#14. Preschooler apps blend digital on-screen and real-life off-screen presentations.</td>
</tr>
<tr>
<td>Assigning symbolic meaning (C) (E)</td>
<td>#5. Preschooler apps promote the development of one or more narratives during play that offer multiple paths for play and may feature objects that have multipurpose functions.</td>
</tr>
</tbody>
</table>

*Note: *(C) refers to a confirmed design principle. **(E) refers to an expanded design principle.*
Table 6.4
Corresponding Design Principles from Children’s Perspectives with Design Criteria from the Literature Review in Relation to Software Design Features

<table>
<thead>
<tr>
<th>Summary of design criteria (Chapter 2)</th>
<th>Design principles for preschooler apps (Chapters 4 and 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual design and multimodal representations (C)</strong></td>
<td>#4. Preschooler apps include multimodal features such as music.</td>
</tr>
<tr>
<td><strong>Interactivity incorporating challenges and rewards (C)</strong></td>
<td>#1. Preschooler apps motivate through predetermined rules that promote interactivity, providing opportunities for “lots to touch”. A sequence of input from the child who is playing can initiate a predetermined response from the app that may exhibit game-like features of play.</td>
</tr>
<tr>
<td></td>
<td>#3. Preschooler apps motivate through rewards or points and provide children with an indicator of their progress during play.</td>
</tr>
<tr>
<td><strong>Digital producers, rather than just consumers (C) (E)</strong></td>
<td>#7. Preschooler apps offer open-ended exploration, enabling preschoolers to manipulate objects and produce their own content.</td>
</tr>
<tr>
<td><strong>Customisation and personalisation (C) (E)</strong></td>
<td>#9. Preschooler apps enable children to make adjustments through personalisation or customisation.</td>
</tr>
<tr>
<td><strong>Assistance and support (C)</strong></td>
<td>#11. Preschooler apps can provide support to preschoolers during play.</td>
</tr>
</tbody>
</table>

*Note: *(C) refers to a confirmed design principle. ***(E) refers to an expanded design principle.*
The analysis of the findings revealed that children offered contributions that extended on the themes identified from the design principles presented in Chapter 2 (as summarised in Tables 6.3 and 6.4). The children’s ideas confirmed that self-initiated play, discovery and exploration enabled them to select from choices based on their interests. The design principles are expanded by the incorporation of multiple narratives for children, allowing consideration for the different contexts of each child engaged in digital play.

**Contribution of Children’s Perspectives to Design Principles for Preschooler Apps**

The contributions to design principles for preschooler apps offered by children’s perspectives were grouped in relation to two themes: interactive engagement in digital play and open-ended discovery and exploration within preschooler apps; these are discussed below.

**Interactive Engagement**

*Interactivity is manifested in a combination of multimodal elements such as visual and auditory representations displayed on the screen in response to children’s input.*

Visual and auditory representations in response to children’s tactile input were multimodal elements of digital play that were expected by children in digital play. Interactivity is a criterion for the design of preschooler apps defined by the children. They expected that preschooler apps should have “lots to touch”, with a variety of responses from the app (PPD20.08). The response of the app to children’s input is a distinct and significant characteristic of children’s interactions with technology (Shoukry, et al., 2015; Verenikina, et al., 2010; Verenikina & Kervin, 2011). The children recognised the conditional situation presented by apps when a child interacts with them, which the children typically expressed using an “if-then” statement. For example, Owen and Henry described their design ideas for the app stating, “If I went into the fire station… the bell rings, I would get into the fire truck” and “if you draw a rectangle…
press red and tap in the middle of the shape”, a red rectangle appears on the screen (PPD20.08).

Feedback from the app, according to the children, was manifested in the incorporation of multimodal elements of images and sounds (CST17.09). Owen suggested, “when you touch the sun, it comes out” and “it goes away” when “the moon comes up”. The interactive imagery is further defined by Ava when she added, “Make the sky darker… so it’s like night-time when the moon comes out”. Ruben suggested that “when you tap on the rubber duck, they say quack” to which Ava added, “You can probably hear the splashing when the ducks quack.” The combination of sounds and visual effects is a recommended motivational design feature of apps. While some caution has been recommended to ensure that the inclusion of these features is meaningful and not distracting to the children’s play experiences, the multimodal features attract attention and commonly appeal to children (Marsh, et al., 2015; Shoukry, et al., 2015; Verenikina & Kervin, 2011).

*Interactive engagement is encouraged through a selection of design choices that engage children in differentiated levels of difficulty. The assistance and support offered to children scaffolds preschoolers’ active engagement in play.*

Interactive engagement is further stimulated when children are engaged in suitable levels of difficulty during play. Interactivity allows children to gain a sense of control when challenges are designed to be “not too easy” yet “not too hard” (Van den Abeele, 2008). The children explicitly expressed that preschooler apps “shouldn’t have things that are too hard for preschoolers”, expecting that preschoolers “can play and do everything” (CST20.08). When testing the prototype of the app, Ruben recommended that tapping on the bugs to catch them should be made easier. This was justified by Owen, who indicated
that “the bugs shouldn’t be so fast because it will be pretty hard for the toddlers to touch” (CST15.10). The capacity with which children independently achieve tasks within the ZPD enables them to develop abstract thinking, meta-communication skills and an understanding of the roles and rules of society and is achieved through engagement in imaginative play (Marsh; 2010; Verenikina & Kervin, 2011). The potential of apps to support active learning is offered through differentiation by adjusting the level of difficulty for each child (Hirsh-Pasek, et al., 2015; Shoukry, et al., 2015). Additionally, differentiated play, which allows children to set the level of complexity (e.g., speed, time limits or goals), supports the development of children’s sense of agency and their sense of control over their digital play experiences.

The notion of progressing through levels of difficulty was further described by the children. London stated that children “move up numbers” during play (CST20.08) implying that children expected the incorporation of feedback and rewards as design features of apps. The children’s ideas included the collections of rewards, coins and coloured leaves (CST20.08) The inclusion of motivational feedback and encouragement (e.g., through badges, cheering and clapping) promotes positive experiences during play and informs children of their progress through the different challenges and levels (Marsh, et al., 2015; Shoukry, et al., 2015; Verenikina & Kervin, 2011).

This development occurs through children’s interaction with others, such as parents and educators, who offer scaffolding strategies to support the development of children (Edwards, 2013; Hirsh-Pasek, et al., 2015). Assistance and support integrated in the app design allow children to engage in their play independently when these supports are suited to children’s needs (Marsh, et al., 2015). The children’s design ideas suggested that support for their play could be offered through a map that shows the user where to go (PPD20.08) or through a character “walking around the town giving messages… like how to play the game” when help is needed (CST17.09). Characters represented in apps
as agents or avatars promote a type of social interaction between children and apps that can support children’s development (Shoukry, et al., 2015). Collaboration and social interactions among siblings, peers and adults are recommended for young children’s engagement in digital play (Hirsh-Pasek, et al., 2015; Marsh, et al., 2015; Vanden Abeele & Zaman, 2008; Verenikina, et al., 2010; Vereninina & Kervin, 2011; Verenikina, Siraj & Kervin, 2018). These interactions support the development of children’s imaginary play and assist in building on children’s understandings (Verenikina, et al., 2018). Additionally, collaboration among siblings and peers encourages children to engage in talk and provide each other with support during play (Marsh, et al., 2015, Verenikina, et al., 2018).

**Open-ended Discovery and Exploration**

*Open-ended exploration and discovery are facilitated by the choices offered to children during play. The choices offered to preschoolers during play should be interesting and relate to their real-life experiences.*

Children’s engagement in imaginative play is characterised as spontaneous and self-initiated (Marsh, et al., 2015; Verenikina & Kervin, 2011). Allowing children to make choices engages them in exploratory and discovery during play (Verenikina & Kervin, 2011). Discovery-oriented play is defined by the selection of choices offered to children during play (Verenikina & Kervin, 2011). The children expressed that the selection of choices during play should be based on topics and themes that interest preschoolers. The initial design criteria for preschooler apps defined by the children included “toddler-type” interests such as “ponies, teddies, unicorns” and arts and craft, based on Ava’s understanding that “kids like arts and craft” (CST20.08; PPD20.08). The ability of an app to connect to the real-life experiences of children appeared important. Intrinsic motivation to play is developed by offering themes of interest which relate to preschoolers’ real-life experiences.
Making connections to real-life experiences through relatable situations and characters in digital play enables children to explore and take on the roles and rules of adult society (Marsh, 2010; Verenikina & Kervin, 2011). The children’s real-life experiences influenced their design ideas for the app. London referred to a holiday in America during which she enjoyed swimming in pools (CST20.08) and Marnie mentioned relatable situations as she generated the initial design idea of “people trying to squash the bug” (PPD20.08). The familiarity of the objects, sounds, narratives and characters during play support children’s understanding of the world around them. The affordance of digital play to embed this type of familiarity supports the development of children’s agency, offering children opportunities for adopting different roles and rules of adult society through digital play that is not typically possible in the real world.

The incorporation of popular culture and media in children’s digital play also appeals to children’s interests (Marsh et al., 2015). Both Ruben and London suggested design ideas that were influenced by the media attention on the Olympics at the time of data collection (CST20.08; PPD20.08; CST03.09; CST17.09). The influence of popular culture and media on both digital products and physical toys that children engage with expands children’s meaning-making and agency as they engage with the different types of play materials (Edwards, 2014). Additionally, children’s engagement with toys and apps that are influenced by popular culture and media can support the development of literacies as the children make connections from one type of play material to another (Edwards, 2013).

The children further expanded on their understanding of age-appropriate choices related to their real-life experiences. The children expressed that apps for preschoolers should be “not scary” (CST20.08). The children’s deliberations about suitable sports for preschoolers reflected this understanding. Owen and Ruben identified that volleyball and tennis are not “too rough” to include in the app (CST17.09). When London queried about
football, Ruben claimed that football may be too aggressive for preschoolers. Ruben stated, “That’s definitely rough”, which supported by mimicking how football tackles can be dangerous. The children’s perspectives expanded on the design principle that age-appropriate choices should promote positive experiences, demonstrating how their real-life experiences guided their expectations of their digital play experiences.

Children’s paths of play should encourage exploration. Owen’s design idea to explore different places in the town and Ruben’s design idea to select different types of sports are examples of non-linear exploration that enabled children to have a sense of control over their play (PPD20.08). The notion of risk-free play was further addressed by the suggestion that an undo button should be a design feature available in the app (CST17.09). This supports discovery-oriented play that allows numerous trial and error interactions with the app without any time limits. Multiple paths of digital play is a typical characteristic of children’s play. It establishes children’s freedom to explore based on their interests, repeat favourite parts and change decisions to explore alternatives while allowing children to develop inquiry skills through exploration and discovery.

Multiple paths of play support the development of different narratives for children to engage in during digital play. Embedding narratives in digital play enables children to engage in fantasy and pretend situations, which can also support the development of literacy learning and language development (Burke, 2010; Kervin, 2016). “Like a story” is one of the descriptions the children assigned to preschooler apps (CST20.08; PPD20.08), which confirms the design principle related to the use of narratives in digital play (Marsh, et al., 2015). The findings of the study expand on this design principle, indicating that multiple narratives should be embedded in digital play.

The children were able to illustrate their play narratives through their identification of specific components of the app. For example, London expanded her ideas for the app by
offering narratives to engage in when playing at the swimming pool: players can use “safety protection” to “keep safe from bad sharks and crocodiles” or “collect leaves in three colours” to win the swimming championships (CST20.08). She elaborated that pipe cleaners, a common arts & craft material used by children, function as safety protection against the bad sharks and crocodiles and also function as the fencing around the swimming pool during the swimming races. This example further expands on the design principle that the multiple paths made available during play generate an expectation that objects included in the app’s design should have multipurpose functions that relate to the narrative being explored by the child. Assigning symbolic meaning to the digital objects, symbols or icons used in digital play occurs when the children associate them with everyday experiences, thereby engaging in imaginative play (Marsh, et al., 2016, Verenikina & Kervin, 2011). As children’s play matures, children demonstrate the complexity of their imagination through the skills, dispositions and competences exhibited in the stories they tell. The narratives associated with children’s digital play manifest a type of cooperative play wherein the technology plays an important role in supplying scenarios and rules with opportunities for the children to contribute (Kervin, 2016).

*Open-ended exploration enables children to be digital producers, rather than just consumers.*

Children’s consumption of content through technology is presumed to have negative implications. Passive viewing of content displaces valuable activities, especially when children interact with technologies alone, limiting the social interactions that are key to children’s development in their early years (AAP, 2016; ECA, 2019). Children’s engagement with technologies offers children opportunities to engage in the production of their own content, enabling active participation that also supports the development of creative thinking (Cherner, et al., 2014; Fleer, 2013; Gerkushenko, et al., 2013; Goodwin
The various affordances of technology that permit children to create content enable them to source and curate their own content, resulting in deeper and more meaningful interactions with technology.

Opportunities for exploration and experimentation is afforded by open-ended apps, such as drawing apps and those that enable the children to engage in creating and constructing (Marsh, et al., 2015; Van den Abeele & Zaman, 2008; Verenikina & Kervin, 2011). “Lots to draw” was identified by the children as a criterion for preschooler apps that enables users to make their own content (CJ1). Henry, Ruben and Ava affirmed this criterion with their design ideas, which enabled open-ended creation “to make” and “draw whatever you want”, such as “a person” or a “smiley face” (PPD20.08; CST20.08; CST17.09). The children’s ideas demonstrated that opportunities to manipulate objects enable children to create new representations or construct digital artefacts during digital play. Such design features develop higher-order thinking skills and support the cognitive development of children (Cherner, et al., 2014; Goodwin & Highfield, 2013). Ava suggested that the shape of a triangle can be manipulated to create a roof for the house (CST17.09). The manipulation of objects appearing on the screen encourages engagement in make-believe play by enabling children to create new meanings or share a collective meaning during play (Verenikina & Kervin, 2011).

The capacity by which children create and produce content for digital play is extended by their expectation to digitally share their creations or transform their creations from a digital representation to a tangible artefact. When Henry wondered whether there was a way of sending creations to other people, Ava suggested a print-out of a digital artwork as a resolution (CST03.09; CST17.09). The children’s ideas demonstrate that the children’s creations can prompt social interactions, which are characteristic of imaginative play. Their ideas also exhibit the way in which digital creations are
transformed into a tangible artefact, displaying children’s competence in managing the blend of play between on-screen and off-screen (Danby, 2013; Kervin, et al., 2015).

*Opportunities to personalise and customise the design features within digital play enable self-expression and facilitate self-representation.*

Self-expression is afforded by opportunities for personalisation and customisation of the design features within the app. In the study, the children presented ideas for the customisation of the play experience through the range of choices that preschoolers were offered. The children dictated the number of choices and different designs for the different sports equipment. For example, the design of the app allowed children to customise the colour or pattern of the sports equipment to their liking (CST15.10). The capacity to customise the visual display based on the children’s interests offers an adaptable experience for children (Marsh, et al., 2015; Gerkushenko, et al., 2013; Shoukry, et al., 2015; Verenikina & Kervin, 2011).

Further, the representation of self is available through personalisation and customisation. Personalised characters or avatars may be customised to reflect cultural and social representations of children (Marsh, et al., 2015). The option to choose a character from sports athletes such as “Usain Bolt, Steven Gerrard and Messi” (CST03.09) demonstrates the associations the children made between their digital play experiences and their real-life experiences (Verenikina & Kervin, 2011). The children often used “I” or “you” in describing the characters in an app (CST20.08). This was further validated by their desire to create a character who walked around the streets of Tiny Town (CST17.09) This dimension of pretend engages children in role-playing, helping them develop understandings from the perspective of others (Gerkushenko, et al., 2013). Edwards (2013) identified that the use of avatar or characters in digital play as a form of symbolic play can support children to develop an awareness of self when represented as a digital
Use of device features such as camera, video capture, and audio recorder extend the representation of self and enables the digital incorporation of physical artefacts into digital play. The customisation of the characters to reflect a chosen identity is valuable to the development of children’s creativity and self-expression (Marsh, et al., 2015). Ava suggested to “make your own body” for the character then to use “your head… on it” (CST17.09). The idea of representation was followed up by the children throughout the different interactions with the prototype of the app. Their discussion around the representation of another child who was not present at that research session was resolved by the suggestion of “taking a picture” to make him as one of the characters within the app (CST29.10). The children’s suggestions affirm the relationship between children’s real-life experiences and the imaginary situations created in digital play, creating a blend of play (Bird & Edwards, 2015; Kervin, Verenikina, & Rivera, 2015; Marsh et al., 2015).

**What processes do the CRAG enact as they co-design and trial an app for preschool children?**

The study’s contribution to the methodological design of obtaining children’s perspectives is reinforced by Lundy’s (2007) model of children’s participation in research, which emphasises space, voice, audience and influence. The current study contributes to the development of this methodological approach for obtaining children’s perspectives by extending and adapting the model to the context of young children’s engagement in technologies for play. This allowed to support the young children’s involvement in sharing their perspectives of their digital play experiences and in participating in decision-making throughout the process of co-designing the app. Co-designing and redesigning the app over a sequence of research sessions provided the young children with various opportunities to express their views. It provided the “space”
for working together with peers and the adults on designing the app. The “voice” of children in the realm of designing preschooler apps allowed them to define their understanding of interactivity, identify motivational features of apps that are suitable for preschoolers and distinguish features which they perceived as vital elements for the design of digital play. Developing the app in collaboration with an adult empowered the children with an awareness that they have an “audience” for their views on digital play and their ideas can “influence” preschoolers’ digital play experiences. The four components of participation are discussed below in relation to the contributions of the study to the methodologies for obtaining children’s perspectives on digital play.

*An investment of time and involvement was required to establish the space where the CRAG was willing to share their perspectives.*

The establishment of a Digital Playgroup as the research “space” in which children’s perspectives on digital play was sought was a key component in obtaining children’s perspectives. A shared space with a specific purpose provided framing for the activities of the CRAG. Important to this space was taking time for all participants to become involved in the meetings and to build trust among the participants and the researcher. Important too was that each participant provided their consent to participate in the study within the negotiated and established roles of the children as co-designers and co-researchers.

Familiarity and trust are fundamental in ensuring that the children are willing to share their perspectives (Sumsion, 2003). The participants were familiar with each other, the site of the study and the focus of the study. The Digital Playgroup was initially established in 2015 specifically to understand digital play from the perspectives of children, as part of a larger ARC Discovery Project (ARC DP140200328). The majority of the CRAG members and preschoolers who participated in the Digital Playgroup had
been previous participants to the ARC Discovery Project for at least one year at the time of data collection (See Appendix B). The building of relationships among the CRAG and the preschoolers was supported by the snowballing participant recruitment technique, which ensured that the participants knew each other. The child-friendly facilities offered by Early Start at the University of Wollongong were an ideal environment for conducting research with children. The children were aware from previous experiences that the space was a place for play and that the Digital Playgroup was a space with a focus on play with digital technologies. Additionally, the children’s familiarity with the researcher supported the children to participate in this study and share their ideas with the researcher.

Children should be fully informed and given a choice to participate at different stages of the study (Alderson & Morrow, 2011; Harcourt & Conroy, 2005; Lundy, 2007). Obtaining children’s informed consent to participate in the study was vital to establishing the research space. Therefore, time was invested in ascertaining the children’s decision to participate in this study. The researcher facilitated a discussion of the session’s activities with the participating children at the beginning of each session, allowing them to ask questions and make suggestions and then inviting each child to write their name on a sheet displayed in the room (see Figure 6.2). This activity was used by the researcher as a scaffold to remind children of the research process, what had already occurred and what was yet to take place. In this manner, the researcher ensured that informing the children and consulting with the children regarding their participation occurred throughout the research session rather than only at the beginning of the study. In this study, the children were allowed the freedom to move around the space as they wished, including walking around, standing up, going over to other children to see what they were doing and freely having conversations with each other. They also were offered a snack, which they could eat at any point during the research session without asking for permission. Offering flexibility allowed the children to appreciate the extent of their comfort zones and gain a sense of understanding regarding which activities they wanted to participate in. This
environment also offered the children to be comfortable in pursuing their social needs and to interact with like-minded peers as they wished.

![Figure 6.2. CRAG consent sheet, badges and journals.](image)

The research space was also established by defining the role of the children as co-designers and co-researchers in the study. Children, as co-designers, were involved in the different phases of development of the co-designed app, from generating ideas, refining components and testing prototypes of the app. As design partners of technology, children’s ideas are given due weight (Druin, 2009), with the potential to influence policy, development and practice of children’s use of technology (Read & Markopoulos, 2013). As co-researchers, the children were involved in decision-making around the data collection procedures, the co-design processes employed in the development of the app prototype and gathering the perspectives of preschoolers who trialled the app in the last cycle. The willingness of the children to participate as co-designers and co-researchers in the study was established in the research space with the use of badges indicating the child’s name and role within the study. The children wore the badges attached to a lanyard during the research sessions. Involving children as co-researchers supports children in expressing their views (Lundy & McEvoy, 2011).
Accommodating children’s voice is an essential component of obtaining children’s perspectives and, therefore, should be facilitated by allowing children a range of opportunities to express themselves (Alderson & Morrow, 2011; Conroy & Harcourt, 2009; Dockett, Einarisdottir & Perry, 2009; Lundy, 2007). Children’s freedom to express their voice, therefore, is fostered inasmuch as their participation is facilitated. This was enabled in this study through a number of approaches discussed below.

This study employed the use of visual elicitation to obtain children’s perspectives. Image-based research includes the use of participant-produced visuals where the children took photos of the spaces of play in their home settings (CST06.08; CSV06.08), took screenshots from the apps they play with (CST06.08; CSV06.08), and used drawing and arts and crafts materials to express their understandings of their digital play with apps (PPD20.08; PPD03.09). The use of images produced by children as research partners allows them to present representations of the view that adult researchers can analyse (Thomson, 2008). London, Owen, Ava and Henry described the photographs of places at home where they typically use their devices for play (CST06.08; CSV06.08). The conversation around the children’s spaces of play extended to include the children’s perspectives of their parent’s control over their access to the devices for play. Henry, Ava, London and Owen also took screenshots from an app they selected to play with to identify which features are important to them in their play (CST06.08; CSV06.08). Henry’s description of one of the screenshots explained that the different character choices allowed him to control his play based on the different abilities of the characters: “I can show you what the different characters, what they do for different abilities” (CST06.08). Visual elicitation encourages a dialogue between the researcher and the children and allows an interaction between the images and the words expressed. It is an ideal methodology for researching with children because it allows children to share their
ideas at their own pace and using their own words (Clark-Ibañez, 2008). Further, it is especially important that the images are interpreted by the children who created them since their creation is contextually specific to the child, and, therefore, adult researchers are most likely not able to interpret the images in the same way (Pink, 2001; Thomson, 2008).

Another type of participant-produced visual created by the children involved drawings and created artworks to define their design ideas for the app (PPD20.08) and in expressing how their combined design ideas form a town (PPD03.09). The creation of drawings and artworks is a medium of expression familiar to children and is considered to be a novel methodology for understanding children’s knowledge and experiences (Leitch, 2008). London’s interpretation of her drawing and artwork described swimming in the pools during a holiday to America; it included proud commentary describing how she swam the whole lap of the pool and commentary about how she made a raft from that experience as she made sound effects to illustrate her ideas with the artwork she was making (CST20.08). Drawing and creating art facilitated the children to represent their experiences through an account of a specific event or through a narration with commentary, reactions and illustrations (Leitch, 2008). Storytelling is a more suitable methodology for obtaining children’s perspectives in comparison to a direct question-and-answer approach. This approach is less daunting since children are given the opportunity to share their competence in relation to various aspects of their lives, which addresses the imbalance of power and authority that the researcher, as an adult, holds over children as research participants (Clark-Ibañez, 2008).

During the research session, the children were not restricted to a set of way of working and sharing their views. London, Henry and Owen were happy to share with the rest of the group the photos they have taken of spaces in their homes where they played with their devices (CST06.08). Marnie, who met the other children for the first time that
session, preferred to speak to the researcher about the apps she liked to play with, but was also happy to share her play experiences with Ava who was sitting next to her (CST06.08). The children were offered flexibility regarding their decisions on how and with whom to share their views throughout the study. When working on the detailed design ideas using arts and crafts in Cycle 2, the researcher invited the children to work in pairs to encourage collaboration among the children. While Ruben and Owen volunteered to work with each other, Henry, Ava and Marnie, chose to work independently (CST20.08; PPD20.08). The purpose of nurturing an environment, where children had autonomy regarding how and with whom to share their views was to make it clear to the children that, in this space, they could freely express their ideas with the rest of the group. This practice was demonstrated by the children when each member of the CRAG freely shared their ideas during the research sessions. All participants who were members of the CRAG (Ava, Henry, Marnie, London, Ruben and Owen) volunteered their views in describing the interactive components of the co-designed app with the rest of the group and as they gave feedback on the screen prototype of the co-designed app (CST17.09; CST15.10).

The flexibility of the study’s design which supported the children’s autonomy, allowed the CRAG multiple opportunities to engage in decision-making. Children’s involvement in decision-making is a key aspect of children’s rights to voice their opinions in matters that affect them (Alderson & Morrow, 2011; Lundy 2007) especially since children do not regularly have opportunities for making decisions in their daily lives (Danby & Farrell, 2004). The decisions enacted by the children in this study supported the expression of their understanding of digital play with preschooler apps. Careful documentation of the children’s design ideas and how their preferences shifted enabled the researcher to revisit earlier ideas, supporting the metacognitive rationale for the changes made by the children.
Establishing an audience for the children’s views necessitated a demonstration of the influence of the views shared by the CRAG.

Opportunities for decision-making is supported by establishing an “audience” to listen to the children’s views and in demonstrating the “influence” that the children’s decisions have made (Lundy, 2007). Therefore, the researcher, as the primary audience of the children’s views, had a crucial role in listening and validating the children’s views throughout the study and enacting them into the on-screen prototype for the app.

Active listening, according to Harcourt & Einarsdottir (2011), is more than a technique for gaining the views of children; it refers to the perceived relationships between one’s self and others. Listening to children with intentionality is a skill developed through experience (Conroy & Harcourt, 2009; Schiller & Einarsdottir, 2009). The strategies employed by the researcher to truly and actively listen to children’s views involved making a conscious effort to confirm and clarify the children’s ideas. In conversations with children, it was essential for the researcher to adopt strategies that negated the role of the adult as the expert. It was also critical in the study to avoid making suggestions or extend ideas beyond what the children shared, especially as doing so can lead to the misuse or misrepresentation of children’s views, which invalidates research findings (Schiller & Einarsdottir, 2009).

The researcher clarified the children’s ideas by repeating, rephrasing or asking questions that encouraged children to expand on their ideas. For example, when Ruben explained that the character he selected to play with was “walking around giving messages”, the researcher clarified by asking, “Messages?” The act of active listening validated that the researcher was listening and also allowed the children to respond with ideas on what kind of “messages” the character would share during play (CST17.09). This strategy was consistently used by the researcher throughout the study as a basic indication to the
children that the researcher was the audience for their views. Asking non-leading questions and engaging the children in the interpretation of the data they presented were strategies that promoted active listening (Schiller & Einarsdottir, 2011). Additionally, taking account of non-verbal cues presented by the children along helped to achieve the ultimate aim of ensuring that decisions in the study were made “with” the children rather than “for” the children (Danby & Farrell, 2004; Lundy, 2007).

The design-oriented sequence of the study involved the use of iterative cycles of design, typical of a DBR approach. The iterative cycles of design facilitated a reciprocal exchange between the researcher and the children’s design ideas, creating a conversation between the researcher as the audience to children’s views while demonstrating the influence of the children’s ideas on the development of the app.

In this study, the paper prototypes and screen-based visuals as a way of affirming the design ideas shared by the children and also served as the next set of images with which to elicit the views of the children. The use of researcher-produced visuals is another type of visual elicitation with which the perspectives of children can be obtained (Thomson, 2008). For example, the researcher created a screen-based visual where the children’s app icon ideas were portrayed as apps available in an App Store mock-up (RPV03.09). The children’s drawings were easily recognisable in the App Store to the children, demonstrating to them that their ideas certainly had an audience. In the following cycles of the co-design process, the children’s artworks were depicted in paper prototypes produced by the researcher (RPV17.09). The children’s ideas expanded to include features of interactivity which were then presented back to them as screen-based prototypes (RPV15.10; RPV29.10; DPT05.11; DPT26.11; DPT03.12). The researcher’s response to the children’s ideas through the paper-based and screen-based prototypes demonstrated the influence that the children’s ideas had on the design of the app. The meaning-making created by the children was affirmed by the researcher’s responses, as
an audience is necessary to obtain children’s perspectives (Leitch, 2008).

Overview of the Study’s Theoretical and Methodological Contribution

A summary of the study’s contributions to the conception and theoretical understanding of digital play is presented below. This is accompanied by a summary of the methodological contributions to obtaining children’s perspectives on digital play with preschooler apps. Together, these summaries support the response to the study’s overarching research question and discuss the significance of the study to understanding digital play and its further research.

Conceptual and Theoretical Contribution

This study is design-based, and therefore, its theoretical contribution to the field is the conceptualisation of digital play expressed through the development and refinement of design principles (Bakker, 2019). Specifically, this allowed the researcher to include children’s perspectives to the conceptualisation of digital play and, in doing so, validating the existing principles offered in literature (Bell et al., 2013). Working with young children in this study allowed the researcher to first gain their understandings of digital play, which they communicated during the research through a variety of ways, and then to conceptualise and theorise their perspectives in relation to current research in the field. This process of defining and redefining design principles using the children’s perspectives and their connections with themes and design principles presented in the fields of education and software design involved an intensive process throughout the different phases of the design-oriented study. The development of the design principles has been discussed throughout the different chapters of this thesis and culminates in the following discussion (See Figure 6.3).
Figure 6.3. Development of design principles over Phases I, II and III of the study.

In summary, the design process reveals the children’s views on interactivity and their connections with real-life experiences through relatable situations. The opportunity to explore how the world works through digital play is presented through the familiar situations and experiences that influenced children in their design ideas. The children proposed that explorative opportunities suitable for preschoolers are offered by incorporating multiple narratives to explore during play.

The children’s perspectives confirmed and expanded on the design principles for preschooler apps identified in the literature review. The theme, “relatable situations and characters”, was affirmed by the children’s design ideas. This design principle values the connections that children made between digital play and their real-life experiences. The children’s perspectives demonstrated the influence of popular culture and media in their digital play and expanded the design principle by relating positive experiences to digital play situations.

“Assigning symbolic meaning” was also supported by the children’s expectations about the manipulation of objects. This design principle was expanded with the expectation that multipurpose objects should support the development of multiple narratives. The manipulation of objects during digital play confirmed the theme of children as “digital
producers of content, rather than just consumers”. This design principle was extended by the children’s intentions to share the digital product with others, confirming the theme of “collaboration or social interaction”. “Personalisation and customisation” was also confirmed by the children’s requirement for self-expression. This design principle was expanded by the children’s disposition to represent themselves through the use of device features such as cameras and voice recorders.

The children’s ideas on interactive engagement allowed them to gain a sense of control and build a sense of agency during play. The design features with connections to their real-life experiences enabled children to be producers of digital content and facilitated self-expression and self-representation. Finally, the children’s perspectives suggested that design principles are dependent on the requirements of each app design, rather than used as a checklist.

The study of children’s perspectives confirmed that the following design features of preschooler apps enable children to gain a sense of control and build a sense of agency:

- Interactivity is manifested in a combination of multimodal elements such as visual and auditory representations.
- Interactive engagement is encouraged through a selection of age-appropriate choices that engage children in suitable levels of difficulty.
- Assistance and support allow children to engage in play independently.

The analysis of children perspectives in the study allowed to researcher to confirm and then expand on the following design features, which encourage open-ended discovery and exploration in preschooler apps:

- The choices offered to children during play allow them to make connections with their real-life experiences.
- Open-ended exploration also enables children to be digital producers, rather than
just consumers.

- Opportunities to personalise and customise the design features within digital play enable self-expression and facilitate self-representation.

The children also identified the following design features, which affirm the blend of play made possible through interactivity and open-ended exploration of preschooler apps:

- A blend of play is afforded by design features that enable children to digitally share their creations and engage in social interactions.
- A blend of play enables the representation of self and digital incorporation of artefacts by using device features such as a camera or a voice recorder.

Based on the findings of the study, a model to communicate the children’s perspectives is suggested. The model for design principles for the preschooler apps depicted in Figure 6.4 demonstrates how different design principles are validated in the design process. As in most design frameworks, a single app does not need to meet each design principle presented in this study. Determining which design principles to include depends on the requirements and the purpose of the app in question (Shoukry, et al., 2015).
The model represents the conceptualisation of digital play and the theoretical contribution of children’s perspectives towards a set of design principles for preschooler apps. The model establishes children as the focal point for this understanding of digital play, representing children’s expectations that preschooler apps promote “interactive engagement” and “discovery and exploration” during their digital play experiences.

Interactive engagement, represented in blue in the model, is manifested through two components: children’s sense of control and the multimodal responses of the app to the children’s inputs. The theme — discovery and exploration — is represented in yellow in the model. Discovery and exploration is facilitated through three components of digital play experiences that allow children to be producers of digital content rather than
consumers, include content which relevant to the real-life experiences of children and encourage the expression of self and representation of children.

The relation to real life experiences refers to the ways that children’s digital play incorporates a variety of children’s real-life experiences and how children’s digital play, in return, influences children’s real-life experiences. The green arrows in the outer circle of the model represent the fluid capacity by which children engage in a blend of digital play with non-digital play or vice versa. The model emphasises the unique competencies and understandings that children perform as they engage in digital play.

The model acknowledges that the perspectives of children regarding digital play and the design of preschooler apps depend on the relationships between the children and the cultural contexts within which the study is conducted. The outer circle of the model refers to the specific cultural and social context that surrounding the perspectives of the participating children whose ideas have contributed to the study’s findings. The children’s real-life experiences and their digital play experiences influenced the creation of the co-designed app with the researcher, who also possesses a separate set of backgrounds, experiences and beliefs. Since the process of co-creating an app for preschoolers was set within this specific social and cultural context, a broader exploration of children’s perspectives is beyond the scope of this research.

**Methodological Contribution**

Gaining children’s perspectives through the design of an app is an innovative approach and is an important methodological contribution of the study. Obtaining children’s perspectives presents challenges and dilemmas, even when adult researchers are aware of the power imbalance between them and children (Alderson & Morrow, 2011; Conroy & Harcourt, 2009; Sumsion, 2003). When research is conducted in a manner that serves the
perspectives of adults, any contribution that children’s views may have is challenged (Lansdown, 2004). Children acknowledge that opportunities for decision-making is not often afforded in their daily experiences (Danby & Farrell, 2004), and that explicit approaches are expected when considering children’s consent to participate in research (Conroy & Harcourt, 2009; Dockett, et al., 2009; Sumsion, 2003).

The study of children’s user experiences is an important foundation of research in CCI (Read & Bekker, 2011; Read & Markopoulos, 2013). Studies that span two decades have identified that children’s perspectives contribute valuable insights to product design (Druin, 2002; Sim, et al., 2015). The novel approach of combining children’s rights and a design-oriented methodology meant that the children in the current study were actively involved as co-researchers and co-designers for an app for preschoolers. Establishing the Digital Playgroup, which offered children the opportunity to engage in and think about their digital play experiences, meant that the children were aware of their central role in this study.

The process of co-designing an app presented methodologies that offered children freedom of expression. Children’s visual and verbal responses were elicited through informal conversations, drawings, diagrams and photographs accompanied by narratives, all of which are methodologies that promote children’s rights for expression of their voices (Schiller & Einarsdottir, 2009). These modes of expression were familiar to children and did not necessarily require written expression (Sumsion, 2003). The use of photo elicitation engaged children in selecting which photos should to take and which photos to show the researcher (Burke, 2008). Likewise, in creating hand-drawn images and artworks, the children had the option to restart on a blank piece of paper when they wanted, allowing children to “edit” the images they chose to share. The use of these methodologies supported children’s decision-making through different forms of expression and presented authentic opportunities for children’s thinking to become
apparent (Conroy & Harcourt, 2009). The study’s use of visual elicitation through participant-produced visuals such as drawings, artefacts made from art and craft materials, photographs and app screenshots afforded children a range of methods to express their ideas and presented them opportunities to be involved in decision-making.

However, in the field of child-computer interactions (CCI), obtaining children’s perspectives within the design process aims to inform the design of a better product (Druin, 2009; Read & Bekker, 2011; Read & Markopoulos, 2013). This study adopted a different approach and applied methodologies based on children’s rights and children as design partners, to study children’s perspectives to better understand the phenomenon of children’s digital play with apps.

As the audience of children’s perspectives, researchers are responsible for demonstrating the impacts that the views of children have so that children can share their perspectives (Leitch, 2008). Therefore, the role of the researcher was crucial in effectively engaging children in the co-design process. The central role of the researcher in gaining the perspectives of children requires skills and experience in recognising the expertise that children share and engaging in an objective role of collecting, recording and disseminating children’s views towards theoretical contributions (Beazely, et al., 2009). The strategies by which the researcher asks questions and engages in the interpretation and representation of the children’s views are shaped by the researcher’s understanding of their role in facilitating research with children (Schiller & Einasrdottir, 2009).

The intricacies of understanding children’s interactions with technology recognise the role of children as they participate as co-designers of technology. This methodological contribution of engaging children as design partners of technology presents strengths in:

- affording children an opportunity to define digital play experiences that are relevant and appropriate for them (Guha, et al., 2005);
• listening to children in ways that can lead adults to learn and influence positive changes for children (Dockett, et al., 2009);
• demonstrating to children that adults can listen to children and take their views seriously (Lundy, 2007).

Therefore, children are empowered to recognise the role of digital play experiences in their lives, make sense of and question the world around them and have the capacity to inform the future design of children’s digital play experiences.

**Conclusion**

How, then, are design principles for preschooler apps influenced by children as co-designers and co-researchers in the development of an app?

As co-designers and co-researchers, the children confirmed and expanded on existing design principles, demonstrating how children generally can be further involved in meaningful explorations of digital play with preschooler apps. Design features that build a sense of agency, make connections with children’s real-life experiences and enable the blend of digital on-screen and off-screen play offer digital interactions that are meaningful to children. Through digital play experiences in this study, the children were able to take on roles not otherwise available to them. Interactive engagement enabled children to gain a sense of control and build a sense of agency. Digital play provides children the opportunity to draw upon their experiences. Connections with the children’s real-life experiences support children to be producers of digital content, facilitate self-expression and create opportunities for self-representation. The children demonstrated their ability to move between digital and non-digital play, highlighting their expectation that digital play presents opportunities for the blend of play.

Obtaining children’s perspectives of preschooler apps reveals valuable methodological
considerations. Given that most apps are created by adults for children, it seems appropriate that children are provided opportunities to give their own feedback. Gathering and examining children’s perspectives provides opportunities to significantly advance understandings in the field. Further, investment in the time and resources necessary to establish a space where children are willing to share their perspectives is invaluable. Enabling children to participate in a range of activities allowed them to express their voice and have their perspectives gathered. The Digital Playgroup and CRAG structures provided both structure and an audience for the children to not only be heard but potentially influence existing knowledge in the field. Further, the study offered them a medium through which they can form a better understanding of their everyday experiences and the world around them.

The discussions presented in this study offer insights into children’s digital play practices that have the potential to influence policies and further research. The children offered insights into what counts as digital play and ways they can be playful during digital experiences. Children’s perspectives of what they consider ‘playful’ will have significance towards understanding how children’s digital play experiences form part of the varied social and cultural contexts of each child. Each child experiences a unique digital context which support the construction of their sense of identity and a sense of belonging within a community. Acknowledging children’s digital identities recognises how children’s relationships with technology change and evolve as they make connections to the world. The development of children’s identity and their sense of belonging are specific learning outcomes identified in the Early Years Learning Framework (EYLF) (Commonwealth of Australia, 2009). By acknowledging the varied digital contexts of children, children’s perspectives of digital play are positioned to inform policies for the early years curriculum.
The richness and variety of children’s digital play experiences should be reflected upon when evaluating its quality and its affordances towards children’s learning and development. Achieving balance between open-ended play and intentional teaching can be informed by children’s perceptions of interactive engagement and how children engage in discovery and exploration through digital play. E.g., The opportunities for children to make connections with real-life experiences is enabled through features that allow open-ended exploration which also empowers children to create and produce through digital play instead of being just consumers. The development of such practice has valuable connotations towards the Statement on Young Children and Digital Technologies, in developing its recommendations for the integration of digital play in early years settings (ECA, 2018).

Children’s perspectives of digital play have valuable contributions towards the development of relationships and enriching interactions between children, adults and their peers. Their views offer a holistic understanding of the role of co-viewing and co-playing during their engagement in digital play. These valuable perspectives can identify how an adult’s responsiveness to children’s request for assistance and support can be extended to facilitate sustained conversations and language development. Such insights shared by the children regarding digital play challenges the solitary nature that often defines (and causes concern) about digital play. Rather, through listening to the advice, perspectives and challenges from the children, digital play as a social participatory form of play was emphasised. Such ideas presented by children, therefore, are important in defining measures for evaluating the quality of experiences offered through digital play and should be acknowledged by policies such as the 24-Hour Movement Guidelines, where technology-use is quantified using a single factor of set times or duration of use (CoA, 2019).

The children were clear about what added value to their digital play. They shared
understandings of their capacity to blend digital play and non-digital play through meaningful interactions such as sharing photos and creations and incorporating images and recordings of real-life artefacts into their digital play and vice versa. Such ideas support early years curriculum policies and educator practices to support children when including digital play experiences that allow children to communicate with others, collaborate with peers and make meaning of the world around them.

The ideas shared by the children indicate an expectation for engaging in digital play that permits children freedom of expression through personalisation and customisation, through opportunities for self-representation and how the children insisted on establishing some control over the digital representations of self. Enabling children through such digital contexts can inform ways in which the notion of a digital citizenship is built and, thus, children have a role in the ways digital play practice is developed in educational settings particularly since the representation of children generate issues of rights and can reinforce biases (ECA, 2018).

Supporting children in valuing their understanding of their digital play experiences is a vital inclusion within the Early Years Learning Framework, signifying the value of children and their contributions to the world around them (CoA, 2009). Likewise, assigning value to children’s digital play contexts supports children in acknowledging the role of digital play in their health and wellbeing. Children’s perspectives are fundamental factors in determining how digital play practices can offer enriching experiences that may be often associated with fear and distrust. As such, the ideas brought forward by the children regarding digital play can support curriculum policy such as the Early Years Learning Framework (CoA, 2009) and educator practices set out in the Statement for Young Children and Digital Technologies in developing healthy digital play practices (ECA, 2018).
Further, involving children as design partners and co-researchers provided further insight into their perspectives of digital play. A holistic understanding of digital play was obtained through interviews, production of artefacts, feedback on prototypes and children’s observations of other children, which provided the unique opportunity to explicate their ideas and insights further. When children are positioned as experts, they are able to inform policies on children’s engagement with technologies for play in ways that adults alone are unable to do. The theoretical implications of children’s perspectives provide educators and families with new ways to evaluate and select apps for children’s play and has implications towards the design of apps for children’s play.

This research is the beginning of a new line of inquiry. Further research must be conducted with children as co-researchers to gather their perspectives on different technology platforms, various uses (e.g., for learning, play and games) and different contexts (e.g., school and home). This research was limited by working with a small group of young children in a particular social and cultural context in Australia; therefore, further research in different cultural contexts is desirable. It is important to reiterate that this research was guided by a specific definition of children’s digital play as engaging with various apps for recreational purposes. Therefore, it would be interesting to further conceptualise the findings of this study in relation to a wider range of understandings of digital play offered by current research (Edwards, 2013). Finally, considering the methodological contribution of this study, future research must be conducted to enrich understandings of children’s digital play from children’s perspectives.
References


Telecommunication, Vienna, Austria.


Constructionism and creativity in youth communities (pp.17-25). Teachers College Press.


## Appendices

### Appendix A

### Overview of Data Collection for Each Design-Based Research Cycle

| Cycle 1: Gathering the CRAG’s perspectives of digital play with apps |
|---------------------------------|---------------------------------------------------------------|
| CRAG Session and Date           | Overview of activities                                       |
| CS1 6 August                    | Context of crag’s digital play experiences:                 |
|                                 | • Sharing children’s digital play spaces and habits         |
|                                 | CRAG’s digital play with selected apps:                     |
|                                 | • Sharing features of apps played by the children           |
| CS2 20 August                   | CRAG’s perceptions of preschooler digital play:              |
|                                 | • Sharing features of preschooler apps                      |

<table>
<thead>
<tr>
<th>Cycle 2: Generating individual ideas for the co-design of an app</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS2 20 August</td>
</tr>
<tr>
<td>After Cycle 2 and before Cycle 3</td>
</tr>
<tr>
<td>Researcher Produced Visual 1: The “App Store” Mock-Up</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cycle 3: Transforming individual ideas into one design for an app</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS3 3 September</td>
</tr>
<tr>
<td>After Cycle 3 and before Cycle 4</td>
</tr>
<tr>
<td>Researcher Produced Visual 2: Paper-based prototype of co-designed app</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cycle 4: Applying design ideas to a prototype</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS4 17 September</td>
</tr>
<tr>
<td>Revisiting features of preschooler apps using paper prototypes:</td>
</tr>
<tr>
<td>• elaborating My Little Town section</td>
</tr>
<tr>
<td>• elaborating the pool section</td>
</tr>
<tr>
<td>• elaborating the bug section</td>
</tr>
<tr>
<td>• elaborating the sports section</td>
</tr>
<tr>
<td>• elaborating the arts section</td>
</tr>
<tr>
<td>• elaborating the character section</td>
</tr>
</tbody>
</table>

| CS5 15 October                                               |
| Revisiting features of preschooler apps using paper prototypes: |
| • elaborating My Little Town section                         |
| • elaborating the sports section                             |
| • elaborating the arts section                               |

| During Cycle 4                                               |
| Researcher Produced Visual 3: Screen-based prototype of co-designed app |

| CS5 15 October                                               |
| Revisiting features of preschooler apps using digital prototypes: |
| • elaborating bug section                                    |

| CS6 29 October                                               |
| Revisiting features of preschooler apps using digital prototypes: |
| • elaborating My Little Town section                         |
| • elaborating the bug section                                |
| • elaborating the character section                          |

| Cycle 5: Inviting preschoolers to play with the app prototype |

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<table>
<thead>
<tr>
<th>After Cycle 4 and before Cycle 5</th>
<th>Researcher Produced Visual 3: Screen-based prototype of co-designed app</th>
</tr>
</thead>
</table>
| DP1 to DP4 5 November 26 November 3 December 10 December | Revisiting features of preschooler apps using digital prototypes:  
• elaborating My Little Town section  
• elaborating the bug section  
• elaborating the character section  
• elaborating the pool section  
• elaborating the sports section |
### Overview of Children who Participated in the Study

<table>
<thead>
<tr>
<th>Participant</th>
<th>Role</th>
<th>Age</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruben</td>
<td>CRAG</td>
<td>6 yrs</td>
<td>Ruben was a participant in Digital Playgroups since he was 5.</td>
</tr>
<tr>
<td>Henry</td>
<td>CRAG</td>
<td>7 yrs</td>
<td>Henry was a participant in Digital Playgroups since he was 6. He is the older sibling of Kate, a preschooler who attended the Digital Playgroup.</td>
</tr>
<tr>
<td>Owen</td>
<td>CRAG</td>
<td>7 yrs</td>
<td>Owen was a participant in Digital Playgroups since he was 6. He is also the older sibling of Lochie, a preschooler who attended the Digital Playgroup.</td>
</tr>
<tr>
<td>London</td>
<td>CRAG</td>
<td>5 yrs</td>
<td>London was a participant in Digital Playgroups since she was 4.</td>
</tr>
<tr>
<td>Marnie</td>
<td>CRAG</td>
<td>7 yrs</td>
<td>Marnie’s parent had previously participated in Digital Play research data collection. While she has no personal experience of participating in the Digital Playgroup, her family was included in the recruitment base for the study. She is the older sibling of Murphy.</td>
</tr>
<tr>
<td>Ava</td>
<td>CRAG</td>
<td>6 yrs</td>
<td>Ava was a participant in Digital Playgroups since she was 4.</td>
</tr>
<tr>
<td>Murphy</td>
<td>Pre-schooler</td>
<td>5 yrs</td>
<td>Murphy’s parent had previously participated in Digital Play research data collection. While he has no personal experience of participating himself, his family was included in the recruitment base for the study. He is the younger sibling of Marnie.</td>
</tr>
<tr>
<td>Bella</td>
<td>Pre-schooler</td>
<td>5 yrs</td>
<td>Bella was a participant in Digital Playgroups since she was 4.</td>
</tr>
<tr>
<td>Kate</td>
<td>Pre-schooler</td>
<td>5 yrs</td>
<td>Kate was a participant in Digital Playgroups since she was 4. She is the younger sibling of Henry.</td>
</tr>
<tr>
<td>Lochie</td>
<td>Pre-schooler</td>
<td>3 yrs</td>
<td>Lochie was a participant in Digital Playgroups since he was 2. He is also the younger sibling of Owen.</td>
</tr>
<tr>
<td>Casey</td>
<td>Guest</td>
<td>&lt; 12 yrs</td>
<td>Casey’s parent had previously participated in Digital Play research data collection. While he has no personal experience of participating himself, his family was included in the recruitment base for the study. He is the older sibling of Marnie and Murphy.</td>
</tr>
<tr>
<td>Tayah</td>
<td>Guest</td>
<td>&lt; 12 yrs</td>
<td>Tayah had previously participated in the Digital Playgroup as an accompanying sibling. She is the older sibling of Ava.</td>
</tr>
<tr>
<td>Leo</td>
<td>Guest</td>
<td>&lt; 12 yrs</td>
<td>Leo had no previous participation in the Digital Playgroup but is the older sibling of Bella.</td>
</tr>
</tbody>
</table>
# Appendix C

## Audit Trail of Collected Data

### Key: Codes for Data Sources

<table>
<thead>
<tr>
<th>Code</th>
<th>Activity</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>CST</td>
<td>Transcript from CRAG Session (followed by date of activity)</td>
<td>CST06.08</td>
</tr>
<tr>
<td>DPT</td>
<td>Transcript from Digital Playgroup (followed by date of activity)</td>
<td>DPT05.11</td>
</tr>
<tr>
<td>CSV</td>
<td>Image of a video capture from CRAG Session (followed by date of activity)</td>
<td>CSV06.08</td>
</tr>
<tr>
<td>DPV</td>
<td>Image of a video capture from CRAG Session (followed by date of activity)</td>
<td>DPV05.11</td>
</tr>
<tr>
<td>PPD</td>
<td>Participant produced document (followed by date of activity)</td>
<td>PPD20.08</td>
</tr>
<tr>
<td>RPV</td>
<td>Researcher produced visual (followed by date of activity)</td>
<td>RPV17.09</td>
</tr>
<tr>
<td>CJ</td>
<td>CRAG’s Journal</td>
<td>CJ1</td>
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### Audit Trail of Data

**First cycle: Gathering the CRAG’s perspectives of digital play with apps**

<table>
<thead>
<tr>
<th>Session and date</th>
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<th>Data code</th>
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</thead>
<tbody>
<tr>
<td>CS1 06 August</td>
<td><strong>Transcript from video footage and audio</strong>&lt;br&gt;Spaces for digital play&lt;br&gt;Ava&lt;br&gt;Marnie&lt;br&gt;London&lt;br&gt;Owen&lt;br&gt;Henry&lt;br&gt;Ruben&lt;br&gt;Playing favourite apps&lt;br&gt;Ava&lt;br&gt;Marnie&lt;br&gt;London&lt;br&gt;Owen&lt;br&gt;Henry&lt;br&gt;Ruben</td>
<td>CST06.08</td>
</tr>
<tr>
<td></td>
<td><strong>Images from video footage</strong>&lt;br&gt;Spaces for digital play&lt;br&gt;Ava&lt;br&gt;Marnie&lt;br&gt;London&lt;br&gt;Owen&lt;br&gt;Henry&lt;br&gt;Ruben&lt;br&gt;Playing favourite apps&lt;br&gt;Ava&lt;br&gt;Marnie&lt;br&gt;London&lt;br&gt;Owen&lt;br&gt;Henry&lt;br&gt;Ruben</td>
<td>CSV06.08</td>
</tr>
<tr>
<td></td>
<td><strong>Participant produced visual</strong>&lt;br&gt;Playing favourite apps&lt;br&gt;Ava&lt;br&gt;Marnie&lt;br&gt;London&lt;br&gt;Owen&lt;br&gt;Henry&lt;br&gt;Ruben</td>
<td>PPD06.08</td>
</tr>
<tr>
<td>CS2 20 August</td>
<td><strong>Transcript from video footage and audio</strong>&lt;br&gt;Perceptions of preschooler apps&lt;br&gt;Ava&lt;br&gt;Marnie&lt;br&gt;London&lt;br&gt;Owen&lt;br&gt;Henry&lt;br&gt;Ruben</td>
<td>CST20.08</td>
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</table>
## Cycle 2: Generating individual ideas for the co-design of an app

<table>
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<th>Data collected</th>
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<tr>
<td></td>
<td><strong>App icons</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ava</td>
<td>Ava</td>
</tr>
<tr>
<td></td>
<td>Marnie</td>
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</tr>
<tr>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Ava</td>
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<td>Henry</td>
</tr>
<tr>
<td></td>
<td>Ruben</td>
<td>Ruben</td>
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## Cycle 3: Transforming individual ideas into one design for an app

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<tr>
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<td>Marnie</td>
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<tr>
<td></td>
<td>Henry</td>
<td>Henry</td>
</tr>
<tr>
<td></td>
<td>Ruben</td>
<td>Ruben</td>
</tr>
<tr>
<td></td>
<td><strong>Mixing ideas</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marnie and London</td>
<td>Marnie and London</td>
</tr>
<tr>
<td></td>
<td>Owen</td>
<td>Owen, Ruben and</td>
</tr>
<tr>
<td></td>
<td>Henry</td>
<td>Casey</td>
</tr>
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## Images from video footage

<table>
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<tr>
<td></td>
<td>Marnie</td>
<td>Marnie</td>
</tr>
<tr>
<td></td>
<td>London</td>
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<tr>
<td></td>
<td>Owen</td>
<td>Owen</td>
</tr>
<tr>
<td></td>
<td>Ruben</td>
<td>Ruben</td>
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</table>

## Participant produced document

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<th>Data code</th>
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<tbody>
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<td>Mixing ideas</td>
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<tr>
<td></td>
<td>Marnie and London</td>
<td>Marnie and London</td>
</tr>
<tr>
<td></td>
<td>Owen</td>
<td>Owen, Ruben and</td>
</tr>
<tr>
<td></td>
<td>Henry</td>
<td>Casey</td>
</tr>
<tr>
<td></td>
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## Cycle 4: Applying design ideas to a prototype

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<th>Data code</th>
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<tbody>
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<td>CST17.09</td>
</tr>
<tr>
<td></td>
<td><strong>Paper prototype</strong></td>
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<tr>
<td></td>
<td>Ava</td>
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</tr>
<tr>
<td></td>
<td>London</td>
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<td></td>
<td>Owen</td>
<td>Owen</td>
</tr>
<tr>
<td></td>
<td>Ruben</td>
<td>Ruben</td>
</tr>
<tr>
<td></td>
<td><strong>Drawing characters</strong></td>
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<tr>
<td></td>
<td>Ava</td>
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</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td>Ruben</td>
<td>Ruben</td>
</tr>
<tr>
<td>Participant produced document</td>
<td>Transcript of video footage and audio</td>
<td>Data code</td>
</tr>
<tr>
<td>-------------------------------</td>
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<tr>
<td>Drawing characters</td>
<td>Paper prototype</td>
<td>CST15.10</td>
</tr>
<tr>
<td>Ava</td>
<td>Marnie</td>
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<td>Ruben</td>
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<td>Digital prototype</td>
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<td>Henry</td>
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<td></td>
<td>Ruben</td>
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</tbody>
</table>

**Cycle 5: Inviting preschoolers to play with the app prototype**

<table>
<thead>
<tr>
<th>Session and date</th>
<th>Data collected</th>
<th>Data code</th>
</tr>
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<tr>
<td>DP1 05 November</td>
<td>Transcript of video footage and audio</td>
<td>DPT05.11</td>
</tr>
<tr>
<td>DP2 26 November</td>
<td>Digital prototype</td>
<td>DPT26.11</td>
</tr>
<tr>
<td>DP3 03 December</td>
<td>Ava</td>
<td>DPT03.12</td>
</tr>
<tr>
<td>DP4 10 December</td>
<td>Marnie</td>
<td>DPT10.12</td>
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<td>Lochie</td>
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</tr>
<tr>
<td></td>
<td>Bella</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Murphy</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix D

**Design Principles Confirmed, Expanded and Identified in Cycle 2 to Cycle 5**

<table>
<thead>
<tr>
<th>Design Principle (Preschooler apps…)</th>
<th>Cycle 2</th>
<th>Cycle 3</th>
<th>Cycle 4</th>
<th>Cycle 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1. … motivate through predetermined rules that promote interactivity providing opportunities for “lots to touch”. A sequence of input from the child who is playing can initiate a predetermined response from the app that may exhibit game-like features of play.</td>
<td>E**</td>
<td>C*</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>#2. … should offer children a range of age-appropriate choices.</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<tr>
<td>#3. … motivate through rewards or points and provide children with an indicator of their progress during play.</td>
<td>C</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>#4. … include multimodal features such as music.</td>
<td>-</td>
<td>-</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>#5. … promote the development of one or more narratives during play which offer multiple paths for play and may feature objects that have multipurpose functions.</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>#6. … include references to popular culture and media.</td>
<td>C</td>
<td>C</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>#7. … offer open-ended exploration enabling preschoolers to manipulate objects and produce their own content.</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>#8. … allow children to assume the roles of characters that enable them to adjust the representation of themselves.</td>
<td>C</td>
<td>C</td>
<td>E</td>
<td>-</td>
</tr>
<tr>
<td>#9. … enable children to make adjustments through personalisation or customisation.</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>#10. … should relate and connect to the children’s real-life experiences.</td>
<td>I***</td>
<td>C</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>#11. … can provide support to preschoolers during play.</td>
<td>I</td>
<td>-</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>#12. … allow risk-free exploration by enabling children to undo, delete or restart actions.</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>#13. … allow digital artefacts to be shared digitally or transformed into a tangible object.</td>
<td>-</td>
<td>-</td>
<td>I</td>
<td>-</td>
</tr>
<tr>
<td>#14. … blend digital on-screen and real-life off-screen presentations.</td>
<td>-</td>
<td>-</td>
<td>I</td>
<td>C</td>
</tr>
</tbody>
</table>

**Note:**

*(C)* refers to a confirmed design principle.

**(E)** refers to an expanded design principle.

***(I)** refers to a newly identified design principle.
Appendix E

Ethics Approval

RENEWAL & AMENDMENT APPROVAL
In reply please quote: HE15/090
Further Information Phone: 4221 3386

17 May 2016

Dear Dr Verenikina,

Thank you for submitting the progress report. I am pleased to advise that renewal and amendment/s dated 13 May 2016 for the following Human Research Ethics application have been approved.

Please note that, as this can only take effect from the date of approval and as the previous approval expired on 19 March 2016, data collected between 19 March 2016 and 17 May 2016 was collected without ethics approval. This is in breach of your obligation as a researcher to maintain approval from appropriate ethics committees (Australian Code for the Responsible Conduct of Research 2007).

Ethics Number: HE15/090
Project Title: iPad applications and imaginative play amongst pre-schoolers: Families’ perspectives (Version #4)
Researchers: Dr Irina Verenikina, Assoc Professor Lisa Kervin, Ms Maria Clara Rivera, Miss Rachel Dragan
Amendment/s: Letter of Invitation to Parents/Caregivers Version 5
Participant Information Sheet Version 1 – 23/05/2016
Consent Form for Parents/Carers Version 1 – 23/04/2016
Focus Group Topics for CRAG Version 1 – 23/04/2016
Research Session Consent Form for Children Version 1 – 23/04/2016

Date Approved: 17 May 2016
Renewed From: 17 May 2016
Expiry Date: 16 May 2017

Please note that approvals are granted for a twelve month period. Further extension will be considered on receipt of a progress report prior to expiry date.
This certificate relates to the research protocol submitted in your original application and all approved amendments to date. Please remember that in addition to completing an annual report, the Human Research Ethics Committee requires that researchers immediately report:
• proposed changes to the protocol including changes to investigators involved
• serious or unexpected adverse effects on participants
• unforeseen events that might affect continued ethical acceptability of the project.

A condition of approval by the HREC is the submission of a progress report annually and a final report on completion of your project. The progress report template is available at http://www.uow.edu.au/research/ethics/UOW009385.html. This report must be completed, signed by the appropriate Head of School and returned to the Research Services Office prior to the expiry date.

Yours sincerely,

Associate Professor Melanie Randle
Chair, UOW & ISLHD Social Sciences
Human Research Ethics Committee

The University of Wollongong/ Illawarra and Shoalhaven Local Health Network District (ISLHD) Social Science HREC is constituted and functions in accordance with the NHMRC National Statement on Ethical Conduct in Human Research.
Appendix F

Letter of Invitation to Parents/ Caregivers

Dear Parent/Caregiver

Your child is invited to participate in a study conducted by Dr Irina Verenikina, Dr Lisa Kervin and Clara Rivera from the University of Wollongong. Our project is entitled The study of the potential of digital play in the development of young children. We write to seek your consent and assistance to conduct research with your child/ren to participate in the study.

Understanding digital play has become more pressing as young children has increasing access to mobile digital technologies such as iPad’s, iPhone’s, iPods, and other tablets daily. Yet children’s views of digital play have not been recognised. In this study, young children aged 3-5 will interact with selected iPad applications while children aged 6-11 will participate in focus group sessions discussing their ideas regarding digital play and how these ideas transform into the design of an app.

Further information can be found in the Participant Information Sheet (attached). If you agree to be included in this study please email Clara Rivera at mcr@uow.edu.au

Thank you for your participation in the first phase of our study and for your interest in this study.
Appendix G

Participant Information Sheet for Parents/ Caregivers

PARTICIPANT INFORMATION SHEET

Dear Parent/Caregiver

The project *The study of the potential of digital play in the development of young children.*

This research study is conducted by Dr Irina Verenikina, Dr Lisa Kervin and Ms Clara Rivera, from the University of Wollongong. This research is funded by the Australian Research Council (ARC) Discovery Grant.

PURPOSE OF THE RESEARCH

The objective of this phase of the study is to explore children’s perspectives on the role and place of digital technologies in the lives of children in relation to their learning and development.

INVESTIGATORS

Dr Irina Verenikina  
School of Education  
02-42214285  
irina@uow.edu.au

Dr Lisa Kervin  
School of Education  
02-42213968  
lkervin@uow.edu.au

Ms Clara Rivera  
School of Education  
mcr@uow.edu.au

METHOD AND DEMANDS ON PARTICIPANTS

Children’s talk about their experience of digital play will help our understanding of the role of digital technologies in their lives. As children’s daily interactions with digital technologies such as iPad’s, iPhone’s, iPods, and tablets steadily increase, so do the number of commercially designed applications aimed at children become readily accessible. It is important that the children’s voice is recognised when considering best practices for digital play.

If you consent for your child to participate, the research sessions will be conducted face-to-face at a pre-determined schedule nominated by you at the Early Start facilities at University of Wollongong. It will last approximately 60 minutes consisting of two 25-minute sessions with a break in the middle. Children will have the freedom to move in and out of the session as they wish.

The children are required to bring their own device for the research session. If required, the researcher will provide the participating family a digital device for the child to interact with.

The research sessions will be video recorded and the recorded data will be used for research purposes only. A three-way video recording of the observation will take place:

- Camera 1 is a static video camera on a tripod.
- Children who are interacting with devices will be fitted with Camera 2, which will be an action camera (eg. a GoPro). It will be attached on your child’s forehead by a head strap. This will capture your child’s hand movements and their detailed interaction with the apps. Please indicate should you wish to have access to an
action camera prior to the observation session, so that your child can get used to having the camera on their head for the purposes of observation.

- Camera 3: Occasionally, the researcher will conduct a video recording of your child during digital play from a separate device (eg iPhone or iPad).

It is expected that this study will generate interest from families who are willing to share how their child responds to digital play. The results of this study will enhance the understanding of the role that digital technologies play in the lives of young people.

POSSIBLE RISKS, INCONVENIENCES AND DISCOMFORTS

If you agree for your child/ren to participate, there will be no further demand on your time in addition to what was described in the previous section. These can be summarised as follows: you will be asked to commit approx. 60 min of your time for a research session.

During the observation session, the children will be asked to wear a head strap with an action camera attached to record their gestures and interaction when using an iPad. The action cameras can be made available to you prior to the observation sessions so that your child can get accustomed to wearing the head strap with an action camera attached.

The data collected will be used in a manner that maintains confidentiality at all times. No participant identities of either you or your child will be revealed. The videotapes, transcripts, and documented data will be used for the sole purpose of research, and will be viewed by researchers only. All electronic and hardcopy data will be stored in Dr. Irina Verenikina’s office at the University of Wollongong. The data resulted from the study will be treated in a confidential manner at all times. Pseudonyms will be used for all the participants when reporting results of the study including any results mentioned in conference presentations and publications. Some of the video footages of the iPad screen might be used in conference presentations, but those will be used in a totally non-identifiable manner only, that is your child cannot be recognised (no faces shown at any time).

Your participation in this project is completely voluntary. You are free to withdraw from the study at any time without any adverse consequences. Should you request to withdraw from participation, all collected data including audio files obtained to date will be withdrawn from the research and destroyed. Note: this will be possible up to the point when the results are published.

ETHICS REVIEW AND COMPLAINTS

This study has been reviewed by the Social Sciences Human Research Ethic Committee of the University of Wollongong. If you have any concerns or complaints regarding the way in which this research has been conducted, you can contact the Ethics Officer, on (02) 4221 3386 or email rso-ethics@uow.edu.au.

Thank you for your interest in this study.
Appendix H

Consent Form for Parents/ Caregivers

CONSENT FORM (FOR PARENTS/ CARERS)

THE STUDY OF DIGITAL PLAY IN THE DEVELOPMENT OF YOUNG CHILDREN.

I have been given information about this project, The study of the potential of digital play in the development of young children and discussed it with the project researchers, Dr. Irina Verenikina, Dr. Lisa Kervin or Clara Rivera from the Faculty of Social Science at the University of Wollongong.

I have been advised on the nature of the research, which aims to understand the role and place of technologies in the lives of young children in relation to their learning and development. I understand that if I agree to participate, I give my consent for researchers to observe my child while playing and during discussions regarding digital technologies. The research sessions will be video recorded and this data will be used for research purposes only.

I have had an opportunity to ask Dr. Verenikina, Dr. Lisa Kervin or Clara Rivera questions about the research.

I understand that my participation is voluntary and that I am free to refuse to participate and the collected data from the research at any time. My refusal to participate or withdrawal of consent will not have any adverse consequences for me.

If I have any enquiries about the research, I can contact Dr Irina Verenikina, +61 2 4221 4285, irina@uow.edu.au, Dr Lisa Kervin, +61 2 4221 3968, lkervin@uow.edu.au, or Clara Rivera, +61 2 4239 2247, mcr@uow.edu.au. If I have questions or concerns regarding the way the research is or has been conducted, I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on +61 2 4221 3386 or email rso-ethics@uow.edu.au

By signing below I am indicating my consent to participate in the research project, conducted by Dr Irina Verenikina, Dr Lisa Kervin, and Clara Rivera, as it has been described to me in the participant information sheet and in discussion with the researchers. I understand that the data collected will be used confidentially for academic publications, and I consent for it to be used in that manner.

Signature ____________________________ Date: ___/___/___

Name of parent/ carer (please print) ____________________________

Name of child (please print) ____________________________ Age: _____________

Name of child (please print) ____________________________ Age: _____________

Name of child (please print) ____________________________ Age: _____________

Name of child (please print) ____________________________ Age: _____________

Name of child (please print) ____________________________ Age: _____________
FOCUS GROUP TOPICS FOR CRAG

THE FOCUS GROUP SESSIONS WILL LAST APPROX 25 MIN AND WILL BE SHAPED AROUND THE FOLLOWING TOPICS:

<table>
<thead>
<tr>
<th>FOCUS GROUP SESSION</th>
<th>TOPIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Understanding children’s digital play (Where does digital play take place and what does it look like?) Playing with apps. (What do you like/ not like? What should be kept the way it is? How can it be changed?)</td>
</tr>
<tr>
<td>2</td>
<td>Generate ideas for an app. (Draw an app icon. What does the app do? What is taking place in the app?)</td>
</tr>
<tr>
<td>3</td>
<td>Playing with co-designed app. (What do you like/ not like? What works/ does not work? What should be kept the way it is? How can it be changed?)</td>
</tr>
<tr>
<td>4 - 8</td>
<td>Reflecting on observations of pre-school children during digital playgroup observation sessions. Ideas for re-designing the co-designed app. (What do you like/ not like? What works/ does not work? What should be kept the way it is? How can it be changed?)</td>
</tr>
</tbody>
</table>
Appendix I

Consent Form for Children

RESEARCH SESSION CONSENT FORM (FOR CHILDREN)

The researcher will discuss the following at the start of the research session.

THE FOCUS GROUP SESSIONS WILL INVOLVE THE FOLLOWING RESEARCH DESIGN, PROCESS AND DEMANDS:

- _______________________________________________________________________
- _______________________________________________________________________
- _______________________________________________________________________
- _______________________________________________________________________
- _______________________________________________________________________
- _______________________________________________________________________

# Please write your name if you agree to participate.

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</table>
Appendix J

Child-Friendly Consent Form for Participants

Digital Play

Today ____________

We will:
1. _____________________________
2. _____________________________
3. _____________________________
4. _____________________________

Signed By:

[Signature]
Appendix K

Description of the Refined Design Principles from Cycle 2 to Cycle 5

**Design Principle 1.** Preschooler apps motivate through predetermined rules that promote interactivity providing opportunities for “lots to touch”. A sequence of input from the child who is playing can initiate a predetermined response from the app that may exhibit game-like features of play.

The first design principle relates to the interactive elements present within preschooler apps that engage children in play experiences with “lots to touch” (see Figure 4.6). Sequences of tactile input from a preschooler in the form of “taps” and “touches” on the screen can initiate predetermined responses from the app. These responses from the app may feature game-like characteristics that further motivate children during play.

**Design Principle 2.** Preschooler apps should offer children a range of age-appropriate choices.

Design Principle 2 proposes that preschooler apps should allow preschoolers to make different types of age-appropriate choices. Offering a range of choices acknowledges the different interests and experiences that children may have. Additionally, engaging preschoolers with an appropriate level of difficulty and offering choices that promote positive play experiences both demonstrate the concept of age-appropriate content for preschoolers.

**Design Principle 3.** Preschooler apps motivate through rewards or points and provide children with an indicator of their progress during play.

Design Principle 3 suggests that the indication of progress is a significant factor in establishing a sense of achievement during play. The collection of rewards such as coins and the notion of winning or unlocking places are examples which indicate progress during play.
Design Principle 4. Preschooler apps include multimodal features such as music.

Design Principle 4 recognises that multimodal features such as sound should accompany the visual and the interactive “touch” aspects of preschooler apps.

Design Principle 5. Preschooler apps promote the development of one or more narratives during play that offer multiple paths for play and may feature objects that have multipurpose functions.

Design Principle 5 identifies the importance of presence of one or more narratives in preschooler apps. Offering one or more narratives in preschooler apps allows preschoolers to engage in non-linear play that may follow one of several paths. This implies that objects within the app design can be assigned multiple functions depending on the path selected by the child.

Design Principle 6. Preschooler apps include references to popular culture and media.

Design Principle 6 affirms the influence of popular culture and media in preschooler apps. The incorporation of brand of toys and references to what is broadcast and published by mainstream popular media are common applications of the influence that popular culture and media have on children’s play experiences.

Design Principle 7. Preschooler apps offer open-ended exploration enabling preschoolers to manipulate objects and produce their own content.

Design Principle 7 refers to the app features that enable preschoolers to produce their own content. Open-ended exploration of shapes and colours is an example of how preschoolers can produce digital art. In this instance, the application of Design Principle 7 allows preschoolers an opportunity to engage in an activity in which they can have “lots
“to draw” (see Figure 4.7), should they wish to. The design principle involving creating and producing content, however, is not limited to visual imagery and can be applied, for example, to an open-ended creation of audio or music loops and to using words and language to create lyrics or stories.

**Design Principle 8.** Preschooler apps allow children to assume the roles of characters that enable them to adjust the representation of themselves.

Design Principle 8 refers to the range of characters assumed by children during play to represent themselves. Assuming the different roles of the characters during play enables the children to take on the persona of the character, referring to the character as “I” or “you” as a representation of themselves or another person included in their play. This design principle also uses the capacity of digital technologies to adapt these representations through open-ended creation of characters and adjustment of characters.

**Design Principle 9.** Preschooler apps enable children to make adjustments through personalisation or customisation.

Design Principle 9 focuses on the capacity for customisation or personalisation in preschooler apps, offered to preschoolers through a range of choices. The range of options made available, such as a range of designs or the capacity for open-ended creation, enables children to tailor their play experiences.

**Design Principle 10.** Preschooler apps should relate and connect to the children’s real-life experiences.

Design Principle 10 connects the real-life experiences of preschool children with those presented in a preschooler app. The connections made with real life experiences assist children in making sense of the world around them and enable them to make connections with potential future experiences related to their play.
**Design Principle 11. Preschooler apps can provide support to preschoolers during play.**

Design Principle 11 stipulates the provision of support during play. A specific object or the characters situated within the app design should be able to provide assistance or predict when assistance is required.

**Design Principle 12. Preschooler apps allow risk-free exploration by enabling children to undo, delete or restart actions.**

Design Principle 12 focuses on the affordance of technologies to enable preschoolers to engage in risk-free exploration during play. Including the capacity to use a rubber to delete or correct their work and the capacity to restart an activity are some ways in which preschooler apps can enable risk-free exploration during play.

**Design Principle 13. Preschooler apps allow digital artefacts to be shared digitally or transformed into a tangible object.**

Design principle 13 refers to the affordance of technologies to share digitally created artworks and to transform digital creations into a tangible medium via printing.

**Design Principle 14. Preschooler apps blend digital on-screen and real-life off-screen presentations.**

Design principle 14 uses the affordance of digital technologies to blend off-screen and on-screen content during play. Using the camera function of the device to allow preschoolers to use their photograph as their on-screen character exemplifies how this design principle can be applied in the co-design process.