Tinkering, Play-Based Learning and Children's Funds of Knowledge in the Post-Digital: Responding to the Problem of Technology Integration in ECEC

submitted by

Honor Victoria Mackley

Master of Education (Research), Australian Catholic University

Master of Arts (European Leisure Studies), Loughborough University

Bachelor of Education (Physical Education), University of Limerick

A thesis in total fulfilment of the requirements of the degree of

Doctor of Philosophy

Institute for Learning Sciences and Teacher Education
Faculty of Education and Arts

Australian Catholic University

September 2023

Abstract

This thesis addresses the well documented and ongoing problem of integrating digital technologies in Early Childhood Education and Care [ECEC] pedagogy, a problem which has been complicated in recent times by young children's immersion in the digital as mode of social practice, a phenomenon increasingly referred to as the 'post-digital'. Current understandings of the post-digital are sometimes described as messy, where it is claimed that borders between the digital and non-digital have now become so blurred that it is difficult to distinguish between where children's digital and non-digital activities begin and end (Apperley et al., 2016; Jandrić et al., 2019; Pettersen, Arnseth, et al., 2022).

The aim of this research was to examine the capacity of tinkering with unplugged technologies as a form of play-based learning to support children's lived experiences in the post-digital in response to the problem of digital technology integration. This aim recognises that play-based learning is a significant pedagogy in ECEC and that tinkering affords opportunities for such play. The term unplugged technologies in this thesis refers to formerly working digital artefacts which no longer function such as decommissioned computer keyboards, computer mice, computer cases, as well as video gaming controllers. Unplugged technologies offer opportunities for children to engage with technologies that educators may view as more appropriate for learning because they can be hands-on rather than relying only on working digital technologies for learning.

This thesis employed Actor-Network Theory [ANT] (Latour, 2005) as a model of social constructivism to work within an ontology that considers the material, non-material and humans equal in terms of capacity to exert agency. This theoretical perspective enabled the constitutive actants of the problem of digital integration to be examined through a methodology of participatory co-design where three educators collaborated with myself-as-researcher to design and implement stages of play-based learning in the form of tinkering with unplugged technologies.

The findings suggest that educators identified a number of Learning Outcomes as per Australian national and state curricula arising from children's tinkering with unplugged technologies. Through data analysis informed by ANT (Latour, 2005), children's Learning Outcomes were traced to a range of actants which jointly co-constituted manifestations of children's lived experiences in the post-digital. Manifestations were represented by children creating their own versions of technologies in the form of 'iPad', 'computer' and 'gamer'.

Manifestations of children's lived experiences in the post-digital were examined in terms of their composite actants to illustrate how a variety of actants operate within a network of activity to shape a response to the problem of integration of digital learning opportunities into ECEC. Two actants were found to be more influential than others in the three manifestations of children's lived experiences in the post-digital, these being play-based learning and children's own funds of knowledge. Understanding the various actants in tinkering networks with unplugged technologies can alert educators to entry points for technology integration in ECEC, thereby providing a more helpful and stable starting point for educators than descriptions of children's post-digital play as entangled and messy.

Keywords: Tinkering, play-based learning, digital technologies, post-digital, funds of knowledge, early childhood

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACARA	Australian Curriculum, Assessment and Reporting Authority
ACECQA	Australian Children's Education & Care Authority
ACU	Australian Catholic University
AGDE	Australian Government Department of Education
AIHW	Australian Institute of Health and Welfare
ANT	Actor-Network Theory
ARC	Australian Research Council
COVID-19	Coronavirus Disease of 2019
CPU	Central Processing Unit
DEEWR	Department of Education, Employment and Workplace Relations
DET VIC	Victorian Department of Education and Training
DIY	Do-It-Yourself
ECT	Early Childhood Teacher
ECEC	Early Childhood Education and Care
EYLF V2.0	Early Years Learning Framework
NHMRC	National Health and Medical Research Council
OECD	Organisation for Economic Co-Operation and Development
PDT	Pedagogical Documentation Technology
QCAA	Queensland Curriculum and Assessment Authority
SCOT	Social Construction of Technology
SST	Social Shaping of Technology
STS	Science and Technology Studies

UA	Universities Australia
VEYLDF	Victorian Early Years and Development Framework

Statement of Original Authorship

This thesis contains no material that has been extracted in whole or in part from a thesis that I have submitted towards the award of any other degree or diploma in any other tertiary institution.

No other person's work has been used without due acknowledgment in the main text of the thesis.

All research procedures reported in the thesis received the approval of the relevant Ethics Committees.

Signed: [redacted]

Date: 05/09/2023

Honor Victoria Mackley

Publications Produced During Candidature

Publications

Mackley, H., Edwards, S., Mclean, K., & Cinelli, R. (2022). Building collaborative competencies through play with outdoor loose parts materials in primary school, *Cambridge Journal of Education*, 52(4), 431-451, DOI: 10.1080/0305764X.2022.2030300

Mackley, H. (2022). Tinker play with unplugged tech. *Every Child Magazine*, Vol. 28 No.4. EC2204-Tinker-play-with unplugged-tech.pdf (earlychildhoodaustralia.org.au)

Conferences:

Mackley, H. (2023, February). Tinkering with unplugged technologies in the post-digital world. Presented at the Australian Journal of Early Childhood [AJEC] Research Symposium: Early childhood knowledges, generations, and time. Online.

Seminars:

Mackley, H. (2023, May). Design based research methods for understanding children's digital life worlds. Presented to University of Gothenburg, Sweden.

Mackley, H. (2022, April). Exploring young children's play-based learning through tinkering with unplugged technology in an Early Childhood Education and Care setting. Presented at the ARCLP19 Research Seminar Series.

Mackley, H. (2021, April). Tinkering in play-based settings: Developing Early Childhood Education learning outcomes through 'hands on' manipulations of non-working technologies. Presented at the ARCLP19 Research Seminar Series.

Digital Content

Mackley, H. (2022, December). Tinkering with unplugged technologies. ABC Early Learning Little Talks. Early Learning Little Talks: Tinkering with unplugged technology - ABC

Kids. Retrieved from https://www.abc.net.au/abckids/early-education/early-learning-little-talk-tinkering-with-unplugged-technology/13660708

Acknowledgments

I acknowledge the Jagera and Turrbal people as the Traditional Custodians of Meanjin (Brisbane), the lands on which this research was conducted. I pay my respects to their Elders, past, present and emerging.

My heartfelt thanks to my supervisors Professor Susan Edwards, Dr. Kate Highfield and Dr. Renata Cinelli for your unwavering assistance and encouragement. To Kate for your bubbly enthusiasm and magnanimous support, and to Renata for your many hours of careful reading and proofing of my chapters, as well as providing me with pragmatic and practical advice.

A very special thanks to Suzy my principal supervisor to whom I am forever grateful. Your incredible guidance, support and energy over the last six years has shepherded me along this life-changing journey, as we progressed initially through a Master of Education (Research) and then through this PhD. I clearly remember our first pivotal phone conversation where I shared my idea for a research project and asked you as a supervisor to take me on. A million thanks for the opportunity, I feel very privileged.

Thank you to Jane Caughey, my PhD ‘buddy’, for your camaraderie and great chats throughout the last couple of years. It has been so helpful to share the vicissitudes of our learning experiences together.

To my husband Hamish, without whom this PhD would absolutely not have been possible. You are the most patient, supportive and loving partner a person could have with your calming presence and staunch belief in me. Thanks especially for ‘talking me down off the edge’ on occasions!

To our two sons, Max and Sam, this challenge has been a team effort with each of you helping to share the load when I was very often missing in action at my computer screen. I hope I have inspired you both to set aspirational goals and shoot for the stars through hard work and dedication.

Back in Ireland, mum and dad, thanks for your words of encouragement and pride in my achievements. To my brother Iain for your robust critic of qualitative research (!), and to Emma for your many offers to proof my work. And to my Australian family, Suzee, Georgie, Ian and Helen for your regular check-ins and confidence boosting messages.

Thank you to my wonderful school-teaching colleagues, Tara, Helen, Isabella, Kate, Anne and Jess who have always been so interested in my research, and a special mention to Lisa and Nena with whom I have had much fun as we collaborated to extend my research into a primary school setting.

I also and very importantly want to thank the educators and centre directors, along with the participating children for all their efforts and valuable time in taking part in this research.

This research was supported by the Australian Government Research Training Program Scholarship which provided funding to enable me to conduct this research for which I am very appreciative.

CHAPTER 1 : INTRODUCTION

1.1 Introduction

This chapter introduces the research reported in this thesis. The aim of this thesis is to engage with an ongoing problem in Early Childhood Education and Care [ECEC] whereby educators have found it challenging to integrate digital technologies into their pedagogy. In this thesis, the term 'educator' is used throughout to refer to all people who work with young children, encompassing a range of training levels and qualifications. Digital technologies refer to digital objects and tools which are used for information, communication and entertainment across contemporary social practices. Hesitancy to include digital technologies in play-based learning is a continuing problem in ECEC for many years, and in recent times has become even more necessary to address because young children are growing up in a period of human history known as the 'post-digital'. The post-digital refers to the notion that digital technologies have become so interwoven in daily life that it is no longer meaningful to consider the digital in contrast to the non-digital. This has particular significance for children's contemporary play practices which are reported to be informed by their experiences living in a post-digital world (Pettersen, Arnseth, et al., 2022a).

In this thesis, the problem of technology integration was grappled with by using tinkering with unplugged technologies as a form of play-based learning in ECEC. Tinkering is similar to play-based learning because it involves physical, hands-on exploratory learning encompassing open-ended as well as guided discovery within provisioned learning environments (Bevan et al., 2014; Martinez & Stager, 2019). In ECEC, play-based learning has long been held as central to ECEC pedagogy, and in contemporary times now includes approaches to intentional teaching in which educators are involved in children's play to support learning. Detailed in Chapter Three, the term unplugged technologies in this thesis refers to formerly working digital artefacts which no longer function such as decommissioned computer keyboards, computer mice, computer cases, as well as video gaming controllers.

This chapter starts with a brief overview of the problem addressed by the research, followed by a statement of the project aim and research questions. A personal orientation to the research is then presented, including justification for the use of first-person throughout the thesis. An outline of the main theoretical framework used in the thesis is provided, and then a summary of each of the main chapters presented.

1.2 The Problem Addressed by this Research

Hesitancy around the pedagogical integration of digital technologies in ECEC is a significant challenge for the sector and is traced across decades of literature. Changing technological advancements, curriculum expectations and theoretical thinking have historically impacted technology uptake by educators, and this has been characterised by a range of documented issues including barriers to integration such as educator beliefs and attitudes, as well as lack of knowledge, skills and confidence amongst others (Ertmer, 1999; Plumb & Kautz, 2015; Veen, 1993). The problem of integration can be seen across three generations of research (Edwards, 2022) where, upon the advent of computers in education, first generation thinking considered digital technologies as overly abstract and socially isolating for young children, as well as limiting imagination and creativity (Clements, 1987; Cordes & Miller, 2000; Yelland, 1998). Second generation thinking, in response to rapid technological advancements and the introduction of touchscreen and mobile technologies, progressed to viewing technologies as viable pedagogical tools to support learning via digital play, informed by conventional theories of play including developmentalism, constructivism and socio-cultural theory.

More recent third generation thinking in ECEC signals a current post-digital moment in time where it is argued that social practices, and by extension children's play practices, are now so interwoven with digital technologies, that it is no longer possible to point to what is entirely digital or non-digital. For many young children, the post-digital forms part of their daily lives and routines where for example digital devices, mobile technologies, internet of toys and in many cases voice activation devices circulate in and through their everyday realities (Berry, 2015; Nansen et al., 2019a). The post-digital also permeates ECEC settings as children bring lived experiences of the digital from their homes and community settings into their physical learning spaces to inform and transform their play (Marsh, 2019b).

Increased awareness of children's social practices as interlaced and evolving with the digital has heralded a sense that ECEC in general and educators in particular are becoming more accepting of the need to embed technologies in pedagogy, but that they still grapple with ways to do this which align with play-based learning and intentional teaching (Havu-Nuutinen et al., 2017; Kewalramani & Havu-Nuutinen, 2019). This challenge can be further exacerbated by accounts of children's play and social activities in the post-digital as forming messy relations (Apperley et al., 2016; Jandrić et al., 2019; Pettersen, Arnseth, et al., 2022) where it is hard for educators to see where any point of action and/or interaction involving children and the digital begin and end.

Addressing this need, children's tinkering with unplugged technologies can offer a way to feasibly do this because, as mentioned in Section 1.1, tinkering has close synergies with play-based learning. Play-based learning is a widely adopted form of pedagogy in ECEC through which children are provided with opportunities to engage actively with people, objects and representations to organise and make sense of their social worlds (Australian Government Department of Education [AGDE], 2022). In Australia and Queensland [where this research was conducted], play-based learning is specifically emphasised in the original Early Years Learning Framework [EYLF] ([DEEWR, 2009) and in the recently updated version of the EYLF V2.0 (AGDE, 2022). Play-based learning integrates the developmental benefits of play with expectations of academic learning (Pyle & Alaca, 2018; Weisberg et al., 2013; 2016), and involves educators being intentional in the roles they take in children's play and in how they plan learning environments and children's curriculum experiences (AGDE, 2022; Pyle & Danniels, 2017; Weisberg et al., 2013). At the time of conducting this research, prior to the launch of EYLF V2.0, the EYLF (DEEWR, 2009) referred to the practice of intentional teaching where educators are deliberate, purposeful and thoughtful in their decisions and actions. In the updated EYLF V2.0, the practices of play-based learning and intentional teaching have been merged to strengthen the connection between play-based learning and intentionality, where being thoughtful and purposeful in actions is something that both educators and children can do (AGDE, 2022). This thesis acknowledges the now broader conceptualisation of intentionality as encompassing children as well as educators, however considering this project was carried out in 2021, I primarily referenced intentional teaching as per EYLF (DEEWR, 2009).

Play-based learning and intentional teaching necessitates educator involvement with children to support learning and achievement of children's Learning Outcomes. The term Learning Outcome refers to the skills, knowledge or dispositions that educators can actively promote in ECEC settings, in collaboration with children and families (AGDE, 2022). The achievement of Learning Outcomes is a requirement of a mandated curriculum in Australia, including the updated EYLF V2.0 (AGDE, 2022) and the Queensland Kindergarten Learning Guideline [QKLG] (Queensland Curriculum and Assessment Authority [QCAA], 2018). Both the EYLF V2.0 (AGDE, 2022) and the QKLG (QCAA, 2018) include five stated Learning Outcomes which are closely aligned. The use of digital technologies is directly referenced in Learning Outcomes mandated by the EYLF V2.0 (AGDE, 2022) where educators are recommended to add to children's multimodal play through the integration of popular culture, media and digital technologies. In this research, the Pedagogical Play Framework (Edwards & Cutter-Mackenzie, 2013) was used to support the development of children's Learning Outcomes through varying levels of educator involvement [in the form of open-ended play, modelled play and purposefully framed play] as intentional approaches to play-based learning to support ideas and play relating to popular culture, media and digital technologies. Moreover, uptake of digital technologies in ECEC pedagogy by educators is influenced by the value educators perceive in the types of play-based Learning Outcomes children can achieve through engagement in learning activities (Nuttall et al., 2015).

Despite the potential of children's tinkering with unplugged technologies as a form of play-based learning to support technology integration in ECEC, it is not yet known what Learning Outcomes educators are likely to identify as arising from children's tinkering experiences. Furthermore, within these Learning Outcomes, the extent to which young children's lived experiences in the post-digital are evident in or manifest in how they interact with tinkering materials, as a form of play-based learning, remains under-explored. This thesis offers an exploration of a multifaceted issue concerning the ongoing problem of digital technology integration in ECEC and the possibilities of tinkering with unplugged technologies in ECEC as a form of play-based learning relative to children's lived experiences in the post-digital.

1.3 Project Aim and Research Questions

In response to the research problem, the aim of this project is to understand how the integration of technologies in ECEC may be achieved via educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies as a form of play-based learning related to young children's lived experiences in the post-digital. There are two research questions which inform the research reported in this thesis:

1. What Learning Outcomes do educators identify in children's tinkering with unplugged technologies as a form of play-based learning?
2. How do young children's experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies?

1.4 Personal Orientation to the Research

My personal orientation to this research stems from a prior project I conducted as part of a Master of Education [Research]. During that research, I explored the role of outdoor, recycled, loose parts play materials in developing collaborative behaviours amongst primary aged school children (Mackley et al., 2022). Passionate about the benefits of loose parts play and supported by the findings in my own evidence-based research, I continue to advocate for and provide a loose parts play space for children in my current school of employment. This play space is utilised by Preparatory and Year One children [aged 5-6 years old] at lunchtimes where children engage with a range of loose parts materials including wood planks and blocks, plastic containers, pipes, tarp and crates [Figure 1.1] through open-ended child-directed free play.

Figure 1.1

Loose Parts Play Space

In this play space, around the time I was giving consideration to continuing my studies and pursuing a PhD, I frequently observed children participating in sociodramatic play informed by a range of different play themes. A commonly observed theme related to children's experiences of the digital. I noticed that many children used the loose parts materials to represent digital artefacts familiar to them from their home, community and school settings. For example, children were frequently seen to recreate digital games like Minecraft™ by using materials such as wood blocks and milk crates to build Minecraft™ inspired themes e.g., castles, animal farms, treehouses and bridges. Minecraft™ is a game accessed through digital devices which involves players creating and placing virtual 'blocks' to design and engage with imaginative worlds. Moreover, I noticed that some children used the loose parts materials to represent tablets and smartphones to 'record' Tik Tok™ videos. For example, children were engaged in 'recording' dances or obstacle challenges with their 'iPad' [rectangular shaped plastic tray] to 'upload' onto Tik Tok™. Tik Tok™ is a social media and video sharing application where users create and share short videos reflective of their interests.

Observing these play themes led me to ponder how even in this outdoor physical play space, tendrils of digitality were evident and seemed to infuse children's play despite the absence of actual digital artefacts. Familiar with the issues and debates around educator uptake of digital technologies in ECEC settings [detailed in Chapter Two], I wondered if I could extend my work in loose parts play to consider the relationship between play-based learning and digital technology integration but in the context of tinkering. Tinkering was an activity I was familiar with through a well-publicised local initiative of intergenerational tinkering at a nearby ECEC service. Through that initiative, members of a local Men's Shed [a community organisation where men of all ages come together to share skills, activities and common interests] worked closely with kindergarten aged children to share their tinkering skills [using real-world tools including screwdrivers, hammers, and saws] to design and create artefacts from woodwork from loose parts materials. This prompted me to consider that the notion of tinkering as a form of play-based learning could be applied to exploring technology related loose parts materials in response to the challenge of digital technology integration in ECEC.

1.5 Use of the First Person in this Thesis

Throughout this thesis, I have reported my involvement in the first person. This is because aligned with a post-qualitative worldview (St. Pierre, 2018) and the methodological commitment to principles of participatory co-design (Spinuzzi, 2005), I have considered myself as directly located within the research process. Detailed in Chapter Four, a post-qualitative worldview refers to an ontological and epistemological perspective which challenges conventional humanistic binaries of human/non-human and material/non-material to offer a more integrated re-assessment of how the world and social practices come into being together (Kuby, 2019; Mazzei & Jackson, 2012). From this perspective, ontological and epistemological distinctions are dissolved and instead considered as entanglements of being and knowing, co-constituting each other into existence (Barad, 2007). From a post-qualitative lens, throughout this thesis I considered myself a dynamic actant, afforded equal potential for agency along with every other actant [material, non-material and human participant] in the manifestations of children's lived experiences in the post-digital. Consequently, as fully entangled in the research assemblage (Kerasovitis, 2020; Østern et al., 2023), 'I' too needed to be recognised and identified.

Acknowledgment of my role in co-constituting the research also adheres to principles of participatory co-design which, detailed in Chapter Four, was selected as the methodological approach to this research. Participatory co-design in educational research is characterised by the development of new curricular materials or digital pedagogies in collaboration with a range of stakeholders including researchers, practitioners and children. Here, knowledge and workplace practices are jointly constructed with the role of each stakeholder illuminated and made visible in the design process (Westbroek et al., 2019). Discussed in detail in the methodology chapter, this necessitated that I paid close attention to the dynamic relationships which came into being between myself as participating actant and other participants [e.g., educators and children] as well as material actants [e.g., unplugged technologies] and non-material actants [play-based learning and children's funds of knowledge]. Again, using first person in my writing and analysis helped me to describe when other actants may have been influenced by my presence and action, and conversely when actants may have influenced me (Yin, 2016).

1.6 Theoretical Framework

This thesis is located in the theoretical work of Actor-Network Theory [ANT] (Latour, 2005). ANT is a theoretical perspective emerging from Science and Technology Studies [STS] which considers the mutual influence of people and technologies as agential actants in social processes and knowledge production. Consequently, ANT positions material, non-material and human actants as ontologically level, affording all actants equal potential for generating agency. According to ANT, actants connect to each other and act on each other to form dynamic shifting webs of associations called actor-networks. In this project, three broad types of actants were identified: 1) material actants; 2) non-material actants; and 3) participant actants. Material actants were defined as entities that were physical and tangible in nature [e.g., unplugged technologies, playdough]. Non-material actants were defined as abstract or conceptual actants which did not have physical form [e.g., play-based learning, Learning Outcomes]. Participant actants were defined as human participants, including educators, children and myself-as-researcher. ANT is useful for understanding how children's experiences in the post-digital manifest in educator identified Learning Outcomes following participation in tinkering with unplugged technologies because it acknowledges the non-binary perspective inherent in descriptions of the post-digital as constituting networks of social practices comprising various material, non-material and participant actants. Some of the core concepts from ANT used in this thesis include actants, actor-networks, generalised symmetry, translation [including mediators and intermediaries] and translation in action [Obligatory Passage Points], concepts which are further elaborated in the Chapter Three.

1.7 Summary of Main Chapters

There are seven chapters in this thesis, including this first Introduction Chapter. Chapter Two, the literature review, is structured into six bodies of literature related to the thesis: 1) Educator integration of technologies in ECEC; 2) History of research relating to digital technologies in ECEC; 3) Play-based learning and intentional teaching in ECEC; 4) Tinkering and making; 5) Funds of knowledge in ECEC; and 6) Assessment, documentation and Learning Outcomes in ECEC. These bodies of literature frame the ongoing research problem around how integration of technologies could be supported by using tinkering with unplugged technologies as a play-based approach to learning. This chapter also canvasses literature which recognises the potential of children's funds of knowledge derived from their own lived experiences in the post-digital, and how these lived experiences might manifest as representations of the post-digital in ECEC. The relevance of assessment and documentation in ECEC is also detailed in this chapter. This is because, as is described in the Chapter Four of this thesis, the educator identified Learning Outcomes associated with the children's participation in play-based tinkering were used to trace what the post-digital in ECEC might look like in practice.

Chapter Three discusses the theoretical framework adopted by this thesis. Social constructivism derived from Science and Technology Studies [STS] in the form of Actor-network theory [ANT] was selected as a viable lens to examine educator integration of technologies in ECEC and problematise technological determinism. In response to the research problem, ANT as a theoretical framework provided understandings of tinkering with unplugged technologies as networked by a range of interconnected material, non-material and participant actants, including play-based learning, children's funds of knowledge [e.g., lived experiences in the post-digital], and educator identified Learning Outcomes. By illuminating the range of actants comprising these networks, ANT as a theoretical framework suggests potential for understandings how ECEC educators may navigate the post-digital with children in practice.

Chapter Four examines the methodological design of this research project. An overview of the philosophical assumptions underpinning post-qualitative research is first presented, situating ANT as aligned with this worldview. Next, participatory co-design is discussed as a research method which originally problematised the limitations of technological determinism, foregrounding human representation in understanding the relationship between people and technologies. As such, participatory co-design is argued as a viable approach for this research project. Details of participants, recruitment and ethics are then presented, including the participation of educators Julia, Emily and Stacey as the primary participants. Children's Learning Outcomes, as identified by educators, are justified and detailed as the unit of analysis following children's participation in tinkering as a form of play-based learning. Data analysis is then elaborated to facilitate mapping of children's Learning Outcomes to the range of actants which jointly co-constitute manifestations of children's experiences in the post-digital. ANT's concept of actants [including material, non-material and human] as interconnected and ontologically entangled in ECEC settings is particularly helpful in the analysis as reported in Chapter Four.

Chapter Five presents the findings of this thesis. In answer to Research Question One, this research found that the educator identified Learning Outcomes were 'Showing interest in technologies' and 'Being imaginative and creative' (QCAA, 2018). Both Learning Outcomes are derived from 'Active Learning' as a key learning area in the QKLG (QCAA, 2018) where children as active learners develop understandings of themselves and the world, creating their ideas through imaginative and dramatic play (QCAA, 2018). Active Learning aligns with

Outcome 4 in the updated EYLF V2.0 ‘Children are confident and involved learners (AGDE, 2022). In response to Research Question Two, children’s lived experiences in the post-digital were found to manifest as iPad, computer and gamer stemming from educator identified Learning Outcomes, following their participation in tinkering with unplugged technologies. Manifestations were represented by children creating own versions of technologies which contained material, non-material and participant actants.

Chapter Six provides an in-depth discussion of the findings in relation to the two research questions through the illustration of the three manifestations [relative to the educator identified Learning Outcomes] as networked maps of interconnected actants. Through the lens of ANT, each identified actant was examined according to how it influenced the flow of the network and exerted force on other actants as either mediators or intermediaries to progress through continuous stages of Translation (Callon, 1984). Detailed in Chapter Three, mediators are actants which dynamically work on other actants to bring about change, whilst intermediaries, on the other hand, work to maintain stability and consistent practices in an actor-network. Translation is a central concept in ANT and is used to describe what happens when actants come together and connect to grow actor-networks.

A number of mediators and intermediaries was identified, with some of these emerging more dominant than others in the form of Obligatory Passage Points. Obligatory Passage Points are more influential actants which impact the growth of actor-networks. In this research, two important Obligatory Passage Points were identified which were significant to the three manifestations of iPad, computer and gamer. These were play-based learning; and children’s funds of knowledge [derived from their lived experiences in the post-digital] which induced actants to perform as mediators [e.g., educators, children, purposefully framed play] or intermediaries [e.g., Learning Outcomes, unplugged technologies]. Play-based learning and children's funds of knowledge as Obligatory Passage Points emerged as indispensable to the growth, stabilisation and the mobilisation of the network which potentially could help to address the ongoing problem of digital technology integration in ECEC.

In the final chapter of this thesis, Chapter Seven, ANT is used to provide insight into how the range of actants and their operations involved in children's tinkering with unplugged technologies, as a form of play-based learning, could address the ongoing problem of digital technology integration in ECEC. Three stages of Translation [Problematisation, Interessement, and Enrolment] were detailed to show how various actants [e.g., children, unplugged technologies, learning materials, educators] were brought into relationships that created networks of mapped activity to manifest children experiences in the post-digital. Mobilisation, an important fourth phase in Translation, was discussed and argued as theoretically possible for extending tinkering with unplugged technologies, as a form of play-based learning, to other locations and domains, and therefore core to addressing the problem of digital technology integration in ECEC.

Mobilisation of mapped tinkering networks was reasoned to have potential to direct educator attention to the various ways in which practitioners might work with material, non-material and participants actants within a given network, thereby alerting educators to entry points for technology integration in ECEC, and consequently unravel perceptions of post-digital play as convoluted and complicated. In doing so, this chapter presented new understandings of the post-digital in ECEC arguing that by recognising children's lived experiences in the post-digital via their funds of knowledge within the mapped and mobilised networks, the notion of the post-digital play as messy and entangled can be tested.

1.8 Conclusion

This chapter has provided the rationale for the research presented in this thesis, noting the problem of digital technology integration in ECEC and young children's lived experiences in the post-digital. My personal orientation to the research has been explained and the primary aim of the research and research questions have been presented. The theoretical framework guiding the work has been defined as ANT (Latour, 2005) and a summary of the main chapters outlining the substantive work of the thesis provided. The next chapter of the thesis, Chapter Two, provides a detailed account of the extant literature related to the topic of this thesis, including educator integration of technologies in ECEC, play and play-based learning, intentional teaching, assessment and documentation of children's learning outcomes, and children's funds or knowledge [or lived experiences in the post-digital].

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter of the thesis examines the extant literature related to young children's tinkering with unplugged technologies as a form of play-based learning aligned with intentional teaching directed towards supporting the integration of technologies in Early Childhood Education and Care [ECEC]. The first section of this chapter reports on educator integration of technologies in ECEC, including how beliefs and attitudes about technologies and barriers using technologies in ECEC shape the extent to which technologies are made available to young children as learning opportunities. This is followed by a brief review of the history of technologies in ECEC more generally, including the historical value placed on play as a mode of learning in ECEC shaping how technologies have been viewed as learning opportunities for young children. This history notes the current post-digital moment in time in which social practices enacted by children are viewed as related to their use of technologies at home and in their communities, if not in their ECEC settings. Next the literature review covers play in ECEC, and ongoing debates about play-based learning and intentional teaching, noting that in contemporary ECEC pedagogy dual interactions between children and adults are considered important for learning. Tinkering and making is then considered in terms of viable option for play-based learning in ECEC, offering opportunities for child and adult interactions with material and digital objects. Children's funds of knowledge as a basis for play-based learning are also examined. Finally, this chapter briefly touches on assessment and documentation in ECEC. For the purpose of this research project, educator assessment of children's Learning Outcomes arising from participation in play-based tinkering with unplugged technologies was used as the central unit of analysis for entering into an understanding of what the post-digital might look like in ECEC and as a response to educator approaches to integrating technologies in ECEC.

2.2 Search Strategy

Literature reported in this chapter was selected using a number of search strategies from primary sources conducted through databases including ProQuest Education, JSTOR, ERIC (EBSCOhost), A+ Education and Google Scholar. In the first section, empirical and theoretical research was selected regarding educator integration of digital technologies in ECEC, including concepts of teacher hesitancy and barriers to integration. Literature was sourced using a range of Boolean operators such "barriers to integration" OR "teacher hesitancy" AND "technologies" OR "computers" AND "Early Childhood Education" OR "Preschool" OR "Kindergarten".

The next set of literature reported in this review was sourced from studies and theoretical literature focusing on play-based learning and intentional teaching in ECEC. Literature was selected using ProQuest Education, JSTOR, ERIC (EBSCOhost), A+ Education and Google Scholar. In addition, a concept map of key search terms was designed and revised throughout the literature search, resulting in a search strategy that incorporated the following terms using Boolean operators and truncation to cover any variations in keywords: 'play*' OR 'learn*' AND 'preschool*' OR 'kindergarten*' OR 'early childhood' AND 'play based learning' OR 'play-based learning' AND 'intentional teaching'.

The next body of reviewed literature was sourced using ProQuest Education, JSTOR, ERIC (EBSCOhost), A+ Education and Google Scholar, including a variety of search terms such as: 'tinkering'; 'tinkering AND learning'; 'tinkering AND education' OR 'preschool' OR 'early childhood education'; and 'tinkering' AND 'play'. Returned search results incorporated references to terms such as 'makerspaces', 'making culture' and 'makers'. As a result, further searches were progressively refined using Boolean operators and truncation to cover any variation in search terms including 'tinker*' AND 'making' and 'tinker*' OR 'making' in peer reviewed empirical research articles.

Empirical research regarding 'funds of knowledge' was explored using ProQuest Education, JSTOR, ERIC (EBSCOhost), A+ Education and Google Scholar with the primary search terms "Funds" AND "of Knowledge".

Literature relating to assessment and documentation in ECEC was selected using ProQuest Education, JSTOR, ERIC (EBSCOhost), A+ Education and Google Scholar. Search terms and modified variations such of: 'documentation' AND 'assessment' AND 'early childhood' OR 'preschool' OR 'kindergarten' were incorporated into the search. A further expansion of the literature search focused on 'digital platforms AND 'documentation' AND 'early childhood', and various combinations and modifications of similar search terms.

2.3 Educator Integration of Digital Technologies in ECEC

The ECEC literature reports an increasing focus on the pedagogical importance of using digital technologies in ECEC settings (AGDE, 2022) with young children (Hatzigianni et al., 2023). Although the more recent literature suggests that the once robust debate about whether digital technologies should be used at all with young children in ECEC is not as polarised now as it was in previous decades (Nikolopoulou & Gialamas, 2015a, 2015b), current literature suggests that educator integration of technologies in ECEC remains a significant challenge for the sector (Kewalramani & Havu-Nuutinen, 2019; Vidal-Hall et al., 2020). This challenge is characterised by two main issues, including educator beliefs and attitudes about using technologies with children, and known barriers to using technologies in ECEC, especially as these align with play-based learning and intentional teaching (Burnett & Merchant, 2020; Edwards et al., 2018; Hatzigianni, 2018).

2.3.1 Educator Beliefs and Attitudes About Using Technologies with Children

Educator beliefs and attitudes about using technologies with children have been identified in the literature as a challenge to the effective integration of technologies in ECEC. Educator beliefs and attitudes are considered in terms of the perspectives educators hold about the influence of technologies "on student learning and achievement and impact on classroom instruction and learning activities" (Inan & Lowther, 2010, p. 141). The available literature suggests that the decisions educators make about the integration of digital technologies in the ECEC classroom can be constrained by the alignment between their beliefs about digital technologies in relation to their understandings of ECEC pedagogy, especially as this pertains to the role of play-based learning (Tsitouridou & Vryzas, 2003; Vidal-Hall et al., 2020).

For example, through the use of semi-structured interviews and online questionnaires, Gjelaj and colleagues (2020) examined eight preschool teachers' attitudes and practices towards the integration of digital technologies in Early Childhood Education in Kosovo. Findings suggest that teacher attitudes towards using digital technologies in pedagogy were affected by four factors: 1) previous experience with regards to technology use; 2) availability of digital technologies in current workplace; 3) beliefs about how technologies effect children's learning and development; and 4) professional development opportunities. Regarding beliefs about technologies and pedagogy, the majority of teacher participants expressed opinions that preschool aged children should interact "with their surrounding environment and engage with concrete tools (toys)” (Gjelaj et al., 2020, p. 175) in preference to interacting with digital technologies in the learning environment. Teachers also felt that children engaged with digital technologies sufficiently at home and that while at preschool, children “should only play and learn in interaction with the environment, other children, and other adults” (Gjelaj et al., 2020, p. 177). Accordingly, this study suggests that integration of digital technologies in some parts of southeast Europe can be constrained by teacher negative beliefs.

In a recent qualitative study in the United Kingdom, Vidal-Hall and colleagues (2020) examined how a technology-focused intervention resulted in changes to a preschool teacher’s beliefs around integrating digital technologies into child-centred pedagogies. Over an 18-month period, the teacher was supported by the lead researcher to include different types of digital technologies [a desktop personal computer, interactive whiteboard and a set of 15 LearnPad™ touch screen tablets] into their pedagogy. Data included video observations of the teacher and 24 children [aged 3-4 years old] engaged in different activities with the range of intervention technologies. Data also included teacher-initiated unstructured discussions and researcher-led semi-structured interviews which “provided time and space for reflection on how and what children learned” (Vidal-Hall et al., 2020, p. 172) and on the teacher’s role in their learning. Prior to the intervention, observations and interviews showed that digital technologies were not included as part of the teacher’s pedagogical decision-making, and that the teacher was sceptical about the use of digital technologies in play and learning. Findings suggest that the teacher shifted their thinking regarding the value of digital technologies in pedagogy and that professional development opportunities should be provided in Early Childhood education to address teacher beliefs about digital technologies and play-based pedagogy “including providing time and space for teacher reflection” (Vidal-Hall et al., 2020, p. 178).

Literature reports that educator pedagogical beliefs, philosophy, and attitudes towards the value of technologies in play-based approaches to learning as traditionally used in ECEC can present challenges to effective integration with concerns that digital technologies can be socially isolating and addictive (Colliver et al., 2020; Disney & Geng, 2022; Plowman & McPake, 2013), impact negatively on young children's behaviour (Fenty & Anderson, 2014), and impede imagination and creativity and free play (Nikolopoulou & Gialamas, 2015a; Palaiologou, 2016b, 2016a; Zabatiero et al., 2018) with many of these beliefs presenting as barriers to effective integration of digital technologies in ECEC.

2.3.2 Barriers to Using Technologies in ECEC

Plumb and Kautz (2015) in an extensive review of literature confirmed many barriers to using technologies in ECEC. In their review of 19 studies, they identified fourteen barriers to integration. The first of these confirmed the significance of educator beliefs and attitudes as impacting the integration of digital technologies in ECEC, followed by lack of knowledge and skills, and lack of equipment and resources [the remaining eleven barriers included: lack of training; classroom condition restraints; educator lack of confidence; lack of appropriate educational software; lack of support; IT technical problems; lack of funding; physical environment constraints; lack of time; early childhood curriculum and guidelines; and the nature of the early childhood sector]. Their review of the literature categorised all 14 barriers utilising a tri-perspective framework developed in previous work (Plumb & Kautz, 2014). These perspectives were: 1) individualist perspective; 2) structuralist perspective; and 3) interactive perspective. The individualist perspective related to the challenge of integration based on educators' beliefs and attitudes pertaining to the value of digital technologies for young children's learning, lack of knowledge and skills informing integration and as well as lack of confidence about using technologies “in a way that it is developmentally appropriate for an early childhood setting” (Plumb & Kautz, 2015). The structuralist perspective related to organisational characteristics and aspects of the environment within the ECEC setting. This included a lack of access to digital equipment and resources, a lack of support to use technologies with children in practice, limitations in training in how to use technologies with children, and the play-based nature of ECEC in Western-European approaches to pedagogy. The interactive perspective described how technology integration in ECEC occurred as a process involving all fourteen barriers relative to their status as either individualist or structuralist.

The individualist or structuralist barriers to integration are evident in earlier literature concerning the integration of digital technologies in ECEC. For example, Veen (1993) identified ‘teacher’ and ‘institutional’ levels as barriers. Teacher level barriers refer to obstacles specific to individual practitioners and include lack of professional development about how to include technology in their pedagogy, as well as lack of technical understandings of technologies. Institutional level barriers refer to obstacles perceived at a wider organisational level and included supportive ECEC service policies, technical and financial support, and time allocation for use. Technical and financial support are especially difficult in the ECEC sector, especially in Australia, where the funding of ECEC services is ad hoc, complicated by not-for-profit and for-profit provision, such that dedicated technical support and financial commitment to resourcing digital materials is exceptionally limited (Gibson et al., 2023).

Highly cited in the literature, Ertmer et al. (2012) discuss first-order extrinsic barriers and second-order intrinsic barriers to the integration of technologies by teachers (Ertmer, 1999). Although this work is not specifically directed towards ECEC, it does identify first-order barriers as obstacles “extrinsic to teachers” (Ertmer, 1999, p.50) and like Plumb and Kautz (2015) and

Veen (1993) includes factors such as lack of availability of technological resources and lack of professional training and development. Second-order barriers are characterised as internal factors "typically rooted in teacher's underlying beliefs about teaching and learning" (Ertmer, 1999, p.51) and include pedagogical beliefs and perceived values of digital technologies for student learning. Similar to Plumb and Kautz (2015) with regards to their interactive perspective, Ertmer (1999) argues that first and second order barriers will continuously "ebb and flow" (Ertmer, 1999, p. 52) with at times external barriers at the forefront of the problem of integration, while at other times internal barriers will present more critical challenges. Regarding, first order barriers, Blackwell and colleagues (2013) argue that educators may well have the skills and training necessary to integrate technologies into their practice, but that these skills and training do not necessarily lead an educator to believe in the value of technologies for young children's learning in the first instance. This concern regarding the value of technologies for young children's learning is evident in the history of research regarding technologies in ECEC from their first appearance in ECEC services in the early 1980's to the most current thinking about ECEC as a post-digital moment in human history.

2.4 History of Research About Digital Technologies in ECEC

There is long history of research about technologies in ECEC. The literature started with the first appearance of desktop computers in ECEC classrooms in the early 1980s as desktop computing became more mainstream in society, especially in workplaces and in family homes (Stephen & Edwards, 2017). This was followed by the high uptake of technologies by very young children with the advance of touchscreen computing by 2010. Now, the contemporary literature talks about technologies as so integrated with daily life for children that descriptions of the post-digital are becoming evident (Hood & Tesar, 2019; Marsh et al., 2019; Nansen et al., 2019; Stevenson, 2020). Edwards (2022) talks about the history of technologies in ECEC in terms of three main generations of thinking following these digital advances. First generation thinking stems from traditional theories of play and pedagogy in ECEC where technologies were viewed as too abstract to support young children's learning. Second generation thinking positioned technologies as pedagogically viable and available to young children in ECEC settings in the form of digital play. Finally, third generation thinking has come to recognise technologies as enmeshed in the lived experiences of young children and the families during a post-digital moment in human history.

2.4.1 First Generation

Early literature regarding the use of technologies in ECEC by educators reported on challenges associated with long-held pedagogical beliefs about the nature of play and its importance for young children's learning and development. Pedagogy in the Western-European ECEC tradition is typically play-based in nature where play is consistently positioned as a basis for learning and development (Fleer, 2011). Developed before computers existed, ECEC pedagogy was largely informed by developmental and constructivist thinking (Piaget, 1951) which situated children's learning as maturational, occurring in sequential developmental stages through exploration of physical worlds through play (Nolan et al., 2022). From a developmental and constructivist perspective, play was largely considered as providing young children with hands-on opportunities for learning through exploration of ideas, tangible materials, and active participation in social interactions (Rogers, 2015).

Literature indicates that use of computer technologies in ECEC in the late twentieth century was viewed with both support (Plowman & Stephen, 2005) and concern by educators and researchers in the ECEC sector (Wood et al., 2008). Prior to the advent of touchscreen technologies and mobile devices, research mainly investigated the relationships between children's cognitive and social development when using technologies such as desktop computers (Stephen & Edwards, 2017). Whilst early literature suggested educator beliefs in the benefits of computers in ECEC settings such as computer skills and familiarity with technologies would be valuable for future schooling and employment (Plowman & Stephen, 2005), other literature suggested that some educators viewed learning with and about technologies in opposition to learning through play – especially hands-on, exploratory based play (Edwards, 2013).

Concerns centred around the use of technologies with young children as overly abstract for hands-on learning and the associated cultural value placed on play as mode of learning within ECEC itself [e.g., learning as a hands-on active process, rather than overly symbolic]. For example, literature indicates that some educators perceived technologies as rendering young children passive learners (Cordes & Miller, 2000), inhibiting exploratory learning with tactile materials, limiting potential for motor skill development (Clements, 1987; Yelland, 1998), as well reducing potential opportunities for social interactions and imaginative play (Cordes & Miller, 2000; Singer & Singer, 2005; Wood et al., 1998) and consequent cognitive development (Cordes & Miller, 2000; Pierce, 1994). There was a strong sentiment that children should play and learn with objects and materials that are tactile and tangible in nature (Yelland, 1998, 2011) instead of engaging in 'abstract academic' computer-based learning (Cordes & Miller, 2000) which took children away from 'real life' and inhibited the development of positive social skills (Yelland, 2011), potentially leading to a 'toxic childhood' (Palmer, 2006).

In a qualitative study in Jordan (Ihmeideh, 2009), interviews conducted with pre-school teachers and principals suggested that most participants did not consider technologies important for “real and constructive learning” (Ihmeideh, 2009, p. 335), instead limiting technology use by children to breaktimes from the daily teaching routines. Concerns centred around the cognitive, social, and motor skills of young children, with participants describing young children as not sufficiently developmentally skilled and mature enough to use computers (Ihmeideh, 2009). Moreover, literature of that era commonly reported computer technologies as overtly physically challenging for young children necessitating precise levels of fine motor skills to manipulate input devices including keyboards and mice (Wood et al., 1998, 2008). Such motor skills were not always feasible for young children, thereby requiring direct adult assistance which infringed upon traditional beliefs about child-led free play as core to ECEC pedagogy.

In a mixed methods study of Hong Kong ECEC principals, Li (2006) investigated the challenges and opportunities associated with the introduction of information and communication technologies [ICT]. Thirty-one principals first completed questionnaires before implementing a new curriculum initiative plan which embedded ICT into children’s learning activities. After the implementation, participants repeated the same questionnaire and were subsequently interviewed. This study found that although most ECEC principals were positive about the integration of ICT, some expressed concerns about ICT in the curriculum fostering individualism instead of cooperation, leading to addictive tendencies towards IT games and not beneficial for children’s overall holistic development. Moreover, participants spoke of concerns that ICT could be an “alienating force ... reducing opportunities for social interactions [with a] risk of misuse or abuse” (Li, 2006, p. 479).

When technologies were used in the ECEC classroom, literature suggests they were considered as ‘add-in’ activities separate from traditional play-based learning activities, reflecting continued thinking around digital technologies as separate and distinct from play. For example, in a Canadian qualitative study (Wood et al., 2008) educators indicated that ‘computer technology’ served as an alternative or additional activity separate from learning. The authors of this study first surveyed 50 Early Childhood Teachers and then engaged them in focus group interviews to assess their perspectives on the integration of computer technology into their classrooms. The study found educators reported both positive and negative attitudes to integrating computers into their classrooms, with many educator concerns relating to second order intrinsic barriers such as individuals’ confidence with technology and alignment with teaching philosophy, as well as more extrinsic barriers such as access to physical and financial resources. All educators interviewed followed a child-centred philosophy of teaching by encouraging children to independently choose their activities based on individual interests. However, some educators reported that computer use did not foster child independence because many children tended to need one-to-one support from a teacher, which restricted opportunities for child-led and directed activities. Moreover, other educators reported that at times children needed to be directed away from the computers as they seemed to become consumed with the technologies and “focus on it even when they are to be doing something else” (Wood et.al., 2008, p. 221). In addition, educators felt that use of computer technology inhibited opportunities for social development by limiting social interactions and by “having too much interaction with an inanimate object” (Wood et al., 2008, p. 216).

2.4.2 Second Generation

Educator concern around the appropriateness of technologies for young children in ECEC settings continued into the 21st century. However, technological advances from 2010 onwards in the form of tablet computers, mitigated some concerns particularly around accessibility for young children and independent child-directed learning. Tablet computers facilitated nonexperts, including young children, to easily navigate text and images on a screen to manipulate computers (Stephen & Edwards, 2017) through touch screen technologies, enabling young children to engage in technologies more independently without formal reading skills or adult help. This included the embedded use of voice, audio, and video in such devices. Such advancements changed how digital technologies could be integrated into home, community, and education settings by literally putting “computing at the fingertips of babies, toddlers and pre-schoolers” (Stephen & Edwards, 2017, p. 26). Consequently, the literature reported a very rapid uptake of technologies amongst this age group (Chaudron, 2015; Chaudron et al., 2018; Marsh, 2019b) since the 2010 launch of the Apple iPad, with 75% of children aged 3 to 8 years reported to access technology [tablets and/or mobile phones] on a daily basis (Office of Communications [Ofcom], 2017).

Advancements in user-interface design prompted a revaluation of the way in which educators organised their learning environments to support young children to learn with and about digital technologies in ECEC settings (Lindahl & Folkesson, 2012; Palaiologou, 2016a). From this point in time, many ECEC curriculum and learning frameworks around the world began to include specific references to the use of digital technologies by young children as necessary for learning. This marked a distinct change from the earlier generation of thinking debating whether or not technologies were appropriate for children (Murcia et al., 2018). In Australia, for example, the first version of the national EYLF (DEEWR, 2009) advocated for the use of digital technologies by preschool-aged children. The later revised version of the EYLF V2.0 (AGDE, 2022) made clear that digital technologies, digital media, and children’s popular culture should be provided as basis for learning and furthermore, that educators should offer online safety education to young children. Likewise, England’s Statutory Framework for the

Early Years Foundation Stage (Department for Education [DfE], 2012) and Sweden's Curriculum for the Preschool (Skolverket: Swedish National Agency for Education, 2010) provided advice to the ECEC sector on using digital technologies with young children.

Whilst updated ECEC policy documentation includes recognition of the importance of technologies in terms of skill acquisition (AGDE, 2022) and as useful tools for achieving children's Learning Outcomes (AGDE, 2022), early curriculum documents continued to position technologies as separate and distinct from descriptions of children's play (Edwards, 2013). This separation suggested allegiance to pedagogical beliefs associated with traditional developmental and constructivist thinking (Piaget, 1951) while attempting to integrate technologies in the curriculum, rather than thinking about digital technologies as affording new types of play relevant to children's direct lived experiences of the digital in their homes and communities (Edwards et al., 2018). During this time, many scholars began to explore emerging gaps between pedagogical conceptions of play in ECEC and young children's day-to-day engagements with digital technologies, digital media, and popular culture (Bird & Edwards, 2015; S. Edwards, 2013, 2014, 2015; Marsh, 2010, 2017; Marsh et al., 2016; Nolan et al., 2022; Nuttall et al., 2015). As a result, early research on digital play initially applied existing theories of play to digital technologies (Stephen & Edwards, 2017). For example, Marsh (2010) drew from traditional theories of play, specifically the works of Broadhead (2006), Pellegrini (1991), and Sutton-Smith (1997) to conceptualise primary aged children's online engagement in virtual worlds where play was viewed as a complex, multi-faceted and context-dependent activity. In this qualitative study, 175 children [aged 5–11] first completed an online survey with 15 of those children further participating in group interviews to explore their use of virtual worlds [Club Penguin™ and Barbie Girls™]. Findings suggest that these virtual worlds mediated child participants with a wide range of opportunities for play including “fantasy play, socio-dramatic play, ritualized play, games with rules, and what might be called ‘rough and tumble’ play” (Marsh, 2010, p. 30), and that these types of play related closely to types of offline play. Thereby, this early exploration of work in the digital play space resulted in descriptions of digital play that could be aligned with traditional notions of play.

Verenikina and Kervin (2011) also incorporated existing theories of play (Piaget, 1951; Singer & Singer, 1990; Vygotsky, 1987) to examine children’s use of iPads in their home settings. The authors developed a definition of play which could be applied to children’s use of touchscreen technologies, specifically their engagements with a variety of applications. Using case-study as research methodology, data was generated through video observations and semi-structured interviews of three families with pre-school aged children [aged 3-4 years] to analyse digital play experiences of participating young children. This study categorised play as “spontaneous, self-initiated and self-regulated activity of young children, which is not necessarily goal-oriented” (Verenikina & Kervin, 2011, p. 6) with particular emphasis on criteria for spontaneous traditional play as including: dimensions of pretend [an action and interaction in an imagined situation]; the use of object substitutes; spontaneous, self-initiated and self-regulated activity; not goal-oriented; relatively risk free; intrinsically motivated; and child in control. Findings from this study suggested that positive experiences of digitally mediated imaginative play with tablets could provide the pre-schoolers with opportunities for active and sustained engagement with imaginative play.

As scholars attempted to describe digital play, a major line of research which focused on Vygotskian (1967, 1987) inspired socio-cultural descriptions of play mediated by specific materials [e.g., apps on computers] rather than more traditional constructivist developmental interpretations of play emerged. For example, Edwards (2013) argued that digital technologies provided opportunities for the promotion of digital or converged play that emanates from children's everyday digital experiences as cultural activities. In this study traditional hands-on play with toys 'converged' with digital play, particularly newer forms of digital play such as virtual applications and games. Converged play relates to playful activities linked to children's interests in popular media, cultural artefacts and texts which can lead to imaginative, creative, and complex pretend play, and therefore could be positioned alongside more traditionally accepted play activities in ECEC. According to Wood and colleagues (2019), converged play occurs when children use digital technologies, digital media and popular culture to participate in traditional play activities, for example "by watching a Bob the Builder™ DVD and then digging and building in the sand pit with trucks" (Wood et al., 2019, p. 216). Converged play is also said to occur when traditional play activities are enacted using technologies, such as using craft, painting, and drawing apps on a tablet or computer. Moreover, the notion of convergence also suggested that the boundary between technologies, digital media and children's traditional hands-on play as increasingly blurred (Stephen & Edwards, 2018).

The notion of converged play was further developed in relation to educator's professional development opportunities by Nuttall and colleagues (2015). As part of a larger study on ECEC professional development which focussed on educator motivations for participating in research about digital play, Nuttall and colleagues (2015) found that educators can be motivated by evidence of children's learning outcomes arising from play-based activities, especially in relation to digital technologies and popular culture. In this study, seven kindergarten aged children were videoed engaging with and sequentially progressing through three types of play: traditional play [using a farm set or wooden train set], consumerist play [using thematically related consumer physical artefacts: Peppa Pig ™ or Thomas the Tank Engine™], and related digital play on an iPad [using apps including the Peppa Pig™ Happy Mrs Chicken™ app and the Thomas and Friends: Engine Activities™ app]. Three participating educators were then invited to review the video data and engage in individual semi-structured interviews followed by focused group interviews. Using the videos as stimulus for interviews, the researchers posed questions which were generally themed around what each participating educators recognised as play as per early childhood curricula.

Findings suggested that the educators acknowledged the ubiquity of digital technologies in the lived experiences of the children they taught, and that consequently they felt children's play was increasingly characterised by combinations of traditional and digital activities, or converged play. Educators expressed enthusiasm and commitment to the provision of learning contexts linked to children's experiences of family, home and community, but they felt "adrift when trying to understand and mobilise children's home digital participation through play-based learning" (Nuttall et al. 2015, p. 228). Using conceptual tools offered by Cultural Historical Activity Theory [CHAT], particularly the notion of motive object, this study suggested that children's learning and development, mediated by digital technologies, acted as motive objects to the educators [e.g., children's development of imagination, children's development of content knowledge and children's development of process skills]. Moreover, the study argued that play-based pedagogies informed by pre-existing theories of play have been sedimented by a preoccupation in ECEC with the technological artefacts themselves. However, a re-focus on children's learning outcomes as motive objects can provide opportunities for educators to foster children's play-based learning outcomes "in new ways for new times" (Nuttall et al., 2019, p. 798) with regards to integration of digital technologies and popular culture.

Despite increased research and growing understandings around the legitimacy of digital play in ECEC, literature indicates that challenges associated with integrating digital technologies in ECEC has persisted amongst educators due to enduring concerns about digital technologies limiting children's abilities to initiate and direct learning activities, and to impeding imagination and creativity (Blackwell et al., 2014; Plowman et al., 2010; Plowman & McPake, 2013). Developmental and constructive thinking has thus continued to maintain a strong hold over the ECEC sector in terms of technology integration, with research showing that educators still grapple with the supposed immateriality of the digital as opposed to traditional modes of play-based learning [such as construction, socio-dramatic, and rough and tumble play] (Sakr & Oscar, 2022). For example, in a large mixed methods study conducted across five countries, Palaiologou (2016b) reported that few ECEC teachers included digital technologies in their pedagogy despite acknowledging the technology rich lives that many of their children led. A total of 920 educators were first surveyed to examine their beliefs and attitudes towards digital devices in their personal and professional lives. Focus group interviews were then used to gain more depth and understandings around teachers' responses. Data suggested participants viewed play-based pedagogy as providing children with active, hands-on, and child-led experiences in physical environments, beliefs and attitudes closely associated with traditional approaches to play and learning. In contrast, digital technologies were not considered by participants as offering such experiences, and were viewed instead as controlling children's creativity, motivation, and capacity for exploration. Participants expressed concern that use of digital technologies in ECEC could lead to passive learning and curtailment of social interactions.

2.4.3 Third Generation

As developmental, constructivist and socio-cultural theories were applied to ongoing research about digital play from 2000s onwards, more recent thinking suggests that society more broadly has arrived at a post-digital moment in time. The post-digital encompasses the idea that social practices enacted by people are today so interwoven with digital technologies that it is no longer possible to point to what is entirely non-digital or digital. Within ECEC, the post-digital is indicated in research through arguments that the boundaries between children's play practices have become more fluid and less demarcated, with digital technologies "informing and transforming play in new profound ways" (Pettersen, Arnseth, et al., 2022, p. 181). Moreover, literature proposes that digital technologies have now become so embedded and coalesced into everyday social practices, and by extension young children's day-to-day lives, that this necessitates a change in theoretical orientation to enhance understandings about the ontological relationship between children, technology, and learning (Hood & Tesar, 2019; Pettersen, Silseth, et al., 2022; Tesar & Hood, 2019) beyond whether or not children should use technologies, towards how digital technologies are evidenced in ECEC pedagogy.

Previous studies viewed from developmental, constructivist and socio-cultural perspectives, have recognised that digital play "sometimes bleeds into the non-digital" (Pettersen, Arnseth, et al., 2022, p. 20). These studies arguably focussed on the human experience of play given their location in developmental, constructivist and socio-cultural thinking (Marsh, 2017). However, more recent studies, especially drawing on socio-materialism (Orlikowski, 2007; Orlikowski & Scott, 2008) and sometimes posthumanism (Latour, 2005) propose that the post-digital does not a priori define the human as more important than the digital in the first instance. Post-digital thinking moves away from reality as comprising discrete independent domains [e.g., the physical and hands-on versus the digital], towards embracing entanglements or assemblages of things [e.g., technologies and social practices] which are merged and continuously shifting (Hood & Tesar, 2019). Consequently, ‘post’ in the term post-digital does not signify a break or termination from the digital nor does it suggest a new state or reality after the digital, rather the term captures the notion of social practices as emerging and becoming with technologies - of humanity living and evolving alongside the digital (Edwards, 2022; Fuller & Jandrić, 2019; Hood & Tesar, 2019; Matthews, 2021; Tesar & Hood, 2019). The post-digital then represents the digital as “integrated and imbricated with our everyday actions and interactions” (Feenberg, 2019, p. 8) with the digital no longer situated as ‘other’ to the everyday and separate to human and social life (Knox, 2019).

In ECEC literature, the post-digital is now being used to describe the manner in which the digital is so embedded in everyday practices that it is no longer meaningful to consider the digital in contrast to non-digital, especially in terms of children’s play as a mode learning (Marsh et al., 2019). For young children, the post-digital represents “part of the texture of life itself which can be walked around, touched, manipulated, and interacted with in a number of ways and means” (Berry, 2015, p. 3). This is especially the case as mobile technologies, internet of toys and voice activation devices circulate in and through young children’s everyday life and play (Nansen, 2020; Nansen et al., 2019). For example, during the Coronavirus Disease of 2019 [COVID-19] pandemic, Quick Response [QR] codes became daily mandated practices where mobile digital devices were used to scan entry and exit into public places, including ECEC services. Young children observed and often participated in QR activities where digital and non-digital enactments are merged into one fluid practice. Similarly, reduced opportunities for in-person social contact during the pandemic resulted in the increased use of video-calling amongst children and their families. Increased frequency of video-calling in many homes and communities during the pandemic (Watson et al., 2021) are now making such forms of digital communication intrinsic to many young children's social connections. Zoom and Facetime, examples of well-known video-conferencing applications, are reported to facilitate social connection between socially distant friends and family (Tarasuik & Kaufman, 2017), as well as enabling virtual playdates between friends (Strouse et al., 2021). Here, young children move between in-person and screen-enabled person-to-person interactions as they operate as participants in the post-digital (Cormier et al., 2019).

Likewise, voice driven interfaces such as Siri and Alexa (Cheng et al., 2018) are increasingly embedded in some young children's everyday home life through smartphones, tablets, speakers, and smart home devices (Purington et al., 2017). Requiring language-based interaction to function, these interfaces are inherently socially interactive, with many such technologies becoming personalised and anthropomorphised by young children (Purlington et al., 2017), resulting in a coalescing of the digital and non-digital in practice. Smart watches too form part of many adults' lives, and by extension young children's experiences of what may be considered post-digital. Such devices are digitally paired with smartphones and mirror phone notifications on a person's wrist as well as GPS tracking, fitness and wellness tracking along with assorted media apps. Many young children, even if they do not have direct access to such devices, observe significant adults or older siblings react to the digital pings, swooshes and multiple digital alerts which tread through everyday life. Thus, the digital in a post-digital world "operates while one walks around, is touched and touchable, manipulated and manipulable and interactive and operable through a number of entry-points, surfaces and veneer" (Berry & Dieter, 2015, p. 3).

Young children are now increasingly reported as engaging in post-digital play practices (Marsh, 2019b; Nansen et al., 2019) which intersect digital and real-world categories of activity, blurring traditional physical and virtual domains (Marsh, 2017). The proliferation of smart toys, which connect electronically to digital devices and to the internet, also referred to as the Internet of Toys [IoToys] (Mascheroni & Holloway, 2019) further coalesces the "virtual/physical world, online/offline, and digital/nondigital boundaries" (Marsh, 2017, p. 5), and in doing so manifests assemblages in which young children interact with digital hardware and software along with physical toys. Young children's post-digital play can also include non-video connected games, augmented reality apps, computer augmented board games and specialised input devices, all of which add material elements to digital contexts, extending the digital beyond the screen and entangling children's physical play spaces with the virtual (Nansen, 2020; Nansen et al., 2019).

Third generation thinking encompasses conceptualising post-digital play through the alternative theoretical frameworks. For example, in a case-study of three five-year-old children playing Minecraft ™ with wooden and synthetic blocks in a Norwegian preschool setting, Pettersen and colleagues (2022) employed socio-materialism to advance an understanding of post-digital play. In their project, the term post-digital refers to how digital and non-digital materiality become entangled in contemporary early childhood play "unsettling the notion of the digital as a discrete category" (Pettersen, Arnseth, et al., 2022, p. 1). As part of a larger multi-sited naturalistic ethnographic research project, video-observations of child participants in their preschool setting showed children merging traditional block play with play themes associated with Minecraft™ despite the absence of any digital artefacts, tablets, or playthings.

In another study in Norway, Lafton (2019) explored digital technologies as an activating force in young children's play and meaning making in a preschool setting. Using Actor-Network

Theory [ANT] (Latour, 2005) as an ontological framework, this study suggests that play can be understood as located within and emerging from various digital and non-digital networks where, in the case of this study, digital technologies and traditional toys overlapped with each other in their use by children. Employing ethnographic fieldwork as methodology, data was collected from observation notes of children [aged two years-old] using tablet technologies to play a 'Lotto' game [app on a tablet], alongside transcriptions of meetings with practitioners reflecting on the children's play. Using ANT, Lafton (2019) applied "a flattened ontology to understand how humans, non-humans and transcendental ideas relate to one another as equal forces" (Lafton, 2019, p. 233) within networks of the digital and non-digital and then proceeded to follow the actors in an analysis seeking to understand how children's play is constituted in the post-digital. Findings suggest that play and learning are co-constructed by children in relationships with the non-digital and digital to create Learning Outcomes that were not predicted by the teacher, but upon reflection and deeper analysis were recognised by that teacher as valid and significant learning. This study points to key area of focus for this thesis in the identification of manifestations of the post-digital in children's play-based learning in ECEC via tinkering with unplugged, especially in the identification of Learning Outcomes by educators following such play.

Third generation thinking around the integration of technologies suggests that educators are recognising that social practices are now post-digital in nature, and that technologies need to be embedded in play-based learning and intentional teaching, however they are not necessarily sure how to achieve this pedagogically (Havu-Nuutinen et al., 2017; Kewalramani & Havu-Nuutinen, 2019; Nuttall et al., 2015). This challenge can be further exacerbated by accounts of children's play and social activities in the post-digital as forming messy relations (Apperley et al., 2016; Jandrić et al., 2019; Pettersen, Arnseth, et al., 2022) where it is hard for educators to see where any point of action and/or interaction involving children and the digital begin and end. Given the influence of play-based learning in the history of technology use in ECEC, and the ongoing commitment of ECEC to understanding children's play with technologies in the post-digital, this review of the literature now considers the role of play in ECEC, especially in terms of a pedagogical approach to teaching and learning.

2.5 Play-Based Learning and Intentional Teaching in ECEC

Developmental, constructivist (Dewey, 1997; Piaget, 1951), and socio-cultural thinking (Vygotsky, 1967, 1978) have strongly influenced understandings about play in ECEC in many Western-European societies. As Bautista and colleagues (2019) discuss, Piaget (1951) identified play as a crucial process for children to integrate new knowledge into their prior schemas, while Vygotsky (1967) positioned play as a leading activity advancing children's development. The significance of play in ECEC has also been developed by scholars including Frederick Froebel, Maria Montessori, Rudolph Steiner and Susan Isaacs (Rogers, 2015), including the ongoing significance of children's participation in play relative to their developing social, language, cognitive and emotional capacities. Play in its many forms and interpretations arguably forms the pedagogical bedrock of ECEC in the Western-European tradition (Stephen, 2010).

Defining characteristics, classifications and types of play have long been debated in the literature (Smith et al., 1985). According to Pellegini (2009), play as an area of scholarship "has been subjected to an enormously rich variety of theory and methods" (Pellegrini, 2009, p.1). Play can be conceptualised in multiple ways depending on the particular lens through which it is viewed. Some literature focuses on the content characteristics of play including: functional or practice play (Piaget, 1951); symbolic play (Miller & Almon, 2009); imaginative play (Vygotsky, 1967); socio-dramatic play (Hughes, 2002); play with rules (Rubin et al., 1983), construction play with or without objects (Smilansky, 1968); and rough and tumble play (Hughes, 2002). Other literature views play in terms of social participation. Parten, (1932) for example, offered categorisations or stages of play where young children progress from solitary play participation [playing alone] to onlooker [observing other children at play but not engaging with them in play], parallel play [playing beside rather than with others], associative play [playing with others but without coordinated purpose] through to cooperative play [playing with others to achieve a goal].

Characteristics of play, based on types of Learning Outcomes, are also discussed in the literature. Prominent work suggests that through play, children develop learning relating to social, emotional, cognitive, physical and language skills (Parten, 1932; Piaget, 1951; Vygotsky, 1967). Some discourse positions play according to broad types of learning, for example: developmental learning and academic learning (Danniels & Pyle, 2018; Pyle & Alaca, 2018). Developmental learning refers to acquisition of social-emotional skills, general cognitive development, and self-regulation abilities (Pyle & Danniels, 2017), while academic learning focuses on aligning with curriculum related outcomes (Pyle & Alaca, 2018). Developmental Learning Outcomes such as lifelong learning, creativity, and well-being (Bennett et al.,1997; Wood, 2007) are posited to emerge from spontaneous free flowing play (Brooker, 2017). Free play in this developmental context is viewed as intrinsically motivating and freely chosen by children (Rubin et al., 1983) devoid of externally set rules and adult engagement. In the late 20th century, ECEC placed much emphasis on the notion of child-led, child-directed free play as a means to developmental learning in young children (Bubikova-Moan et al., 2019).

Some literature however challenges the role of child-directed free play in ECEC settings suggesting that the extent to which knowledge can be constructed by young children through free play alone may be limited (Hedges et al., 2011). In more recent decades, academic learning and subsequent academic outcomes arising from play have gained focus in ECEC settings around the world. Play "as a vehicle for teaching as well as learning" (Dockett, 2010, p. 32) to achieve academic benefits has been advanced by researchers, policy makers and educators around the world. In some Asian and English-speaking countries (Bubikova-Moan et al., 2019), education has become an economic instrument towards developing children as "human capital and future workers" (Nyland & Ng, 2016, p. 472). Consequently, market driven educational agendas where curricula design is "strongly influenced by the impositions of employer-identified knowledge and skills" (Bautista et al., 2019, p. 717) have gained prominence. ECEC policy documentation in many countries thus endorses academic Learning Outcomes, increased educational accountability and improved academic standards (Organisation for Economic Co-operation and Development [OECD], 2015; Weisberg et al., 2013) through a focus on school readiness and direct adult engagement (Bubikova-Moan et al., 2019).

Some discussions point to the "alarming disappearance of play" (Nicolopoulou, 2010, p. 1) implying play can be displaced by an overemphasis on academic outcomes through direct adult instruction. Moreover, research on ECEC educator beliefs show that some educators position themselves as proponents of adult-led play in formal learning, whilst others view themselves as opponents (Sumsion et al., 2014). Such polemic positions hint at fundamental differences between opinions on the integration of play as a pedagogical practice for formal Learning Outcomes (Bubikova-Moan et al., 2019, p. 791). As Tzuo (2007) describes much of the discourse around educator control or child control of learning is influenced by different theoretical perspectives. On the one hand, Piaget (1951) postulated that children should have "the freedom to explore and construct knowledge through their own participation in learning" (Leggett & Ford, 2013, p. 41). Vygotsky (1967), however, advocated social support for learning in the form of adult guidance to assist children in constructing knowledge and understanding (Tzuo, 2007). According to Tzuo (2007), Dewey (1997) argued for teacher guidance in a democratic learning environment which can nurture children's freedom. Furthermore, literature points to a lack of consensus around combining concepts of play with concepts of learning, despite a general recognition of play having a role in learning (Brooker, 2017; Fesseha & Pyle, 2016).

2.5.1 Play-Based Learning as Pedagogy

Much literature has advocated for integration of developmental and academic approaches to play through forms of play-based learning (e.g., Danniels & Pyle, 2018; Weisberg, 2013). Compatibility between play and learning have been identified by many ECEC educators through recognition of learning "as something occurring naturally during play" (Bubikova-Moan et al., 2019, p. 785). Consequently, play-based learning has been embraced as a viable pedagogical practice with potential to combine traditional benefits of developmental play with formal curricula expectations through guided adult engagement (Pyle & Alaca, 2018; Pyle & Danniels, 2017; Danniels & Pyle, 2018). Broadly described as learning while at play (Danniels & Pyle, 2018), play-based learning currently forms a dominant pedagogy in ECEC curricula in industrialised nations (OECD, 2015). Pedagogy has been broadly defined in the literature as including processes to initiate or maintain learning and to achieve education goals (Siraj-Blatchford, 2009). According to Siraj-Blatchford and colleagues (2002), pedagogy is a set of instructional techniques and strategies which "enable learning to take place and provide opportunities for the acquisition of knowledge, skills, attitudes and dispositions within a particular social and material context" (Siraj-Blatchford et al., 2002, p. 28). Pedagogy can therefore be implemented to achieve Learning Outcomes.

Play-based learning incorporates levels of educator involvement with children during play to support learning (Pyle & Danniels, 2017; Weisberg et al., 2013) and achievement of Learning Outcomes. Different play-based pedagogies can advocate for different levels of educator engagement dependent on valued Learning Outcomes. Some literature promotes a play-based learning approach that is playful and predominantly child-directed with limited adult involvement (Weisberg et al., 2013). Other literature suggests that play-based learning should incorporate higher levels of educator engagement, where adults merge academic goals with children's interests to bridge "different kinds of formal and informal knowledge in the context of play" (Rogers, 2015, p. 597). When viewed along a spectrum of engagement, play-based learning can offer a variety of child and adult intersections within play. These can range from child-directed and child-controlled at one end to adult-directed and adult-controlled at the other dependent on planned learning goals. The middle of the spectrum is generally identified as mutually controlled where both adult and child co-direct the play (Pyle et al., 2017) with potential for educators to respond to, engage with and build onto children's interests and rich funds of knowledge.

Recent literature suggests that traditional perspectives on the role of play in ECEC in the form of free or child-controlled play have shifted towards play with increased adult intervention. Increased adult intervention implies play with a purpose (Rogers, 2015) and focus on achieving learning goals. Play-based learning in many parts of the world has become a widely adopted form of pedagogy in ECEC as means to integrating developmental benefits of play with expectations of academic curricula (Pyle & Alaca, 2018; Weisberg et al., 2013; 2016). This is also the case in Australia, the country in which the research reported in this thesis was conducted. Australia has mirrored shifting international trends in perspectives around play. In 2009, the creation of National Quality Framework [NQF] (Australian Children's Education & Care Quality Authority [ACECQA], 2020) included the introduction of the EYLF (DEEWR, 2009). The EYLF acts as a national guide or curriculum for educators of early childhood in all states and territories (Leggett & Ford, 2013), detailing curriculum for young children from birth to five years of age. Updated in 2022, the EYLF V2.0 (AGDE, 2022) continues its focus on play, defining play-based learning as "a context and a process for learning through which children organise and make sense of their social worlds, as they engage actively with people, objects and representations" (AGDE, 2022, p. 67).

2.5.2 Play-Based Learning and Intentional Teaching

Play-based learning from a pedagogical perspective assumes educator engagement with children through forms of intentional teaching dependent on what the educator intends to achieve with a child or group of children. As mentioned in Chapter One Section 1.2, the updated version the EYLF V2.0 (AGDE, 2022) replaces the term 'intentional teaching' with 'intentionality', where being thoughtful and purposeful in actions and decision making is extended to both educators and children (AGDE, 2022).

> "Children are intentional in their thinking, ways of communication and learning and at times lead their own learning and the learning of others. Educators are intentional in the roles they take in children's play and the way they intentionally plan the environment and curriculum experiences" (AGDE, 2022, p. 66).

This thesis acknowledges the now broader conceptualisation of intentionality as encompassing children as well as educators, however given that this project was carried out in 2021, I have primarily referenced intentional teaching as per EYLF (DEEWR, 2009). The EYLF V2.0 (AGDE, 2022) advocates for a range of intentional teaching strategies to extend children's learning through asking questions, explaining, modelling, speculating, inquiring and demonstrating to extend children's knowledge, skills and enjoyment in thinking and learning (AGDE, 2022). Literature employs different ways of referring to intentional teaching in play-based learning including for example: integrated play (Danniels & Pyle, 2018); facilitating play (Bubikova-Moan et al., 2019); purposeful play (Bautista et al., 2019); pedagogical play (Wood & Attfield, 2005); and instructional play (Siraj-Blatchford, 2009). Models of continuums of play presented in the literature can be useful for understanding potential educator roles (Rogers, 2015) for intentional teaching. This section looks at some of the literature which examines potential roles for educators to support learning in play-based environments.

A view of play-based learning as a continuum offers multiple entry points for educator engagement with play as a pedagogy (Pyle & Danniels, 2017). Most continuums position free, opened-ended, child-directed play (devoid of adult instruction) at one end of a play spectrum (Wood, 2010) while at the opposite end, play is generally characterised as adult-directed and controlled with an emphasis on curriculum outcomes (Bautista et al., 2019). Along many continuums of play there are varieties of intermediate perspectives which offer combinations of child-directed play with adult-directed play, sometimes referred to as mutually directed (Danniels & Pyle, 2018). Weisberg and colleagues (2013) discussed guided play as an approach to learning that is positioned midway between free play and direct instruction. The authors argued that guided play "allows for teaching rich content in a way that incorporates elements of free play, discovery learning, and traditional pedagogy" (Weisberg et al., 2013, p.105). They presented guided play as a strategy to combine child autonomy with adult guidance where children direct their own discoveries within play. In this context, educators followed a child's lead and subtly guided discoveries through ranges of engagement such as making comments, open-ended questioning, co-playing with the children and/or encouraging new explorations of the materials, amongst others. Weisberg et al. (2013) proposed that guided play offers a pedagogical approach which combines the "child-directed nature of free play with a focus on Learning Outcomes and adult mentorship" (p.177).

Framed by socio-cultural concepts of tool mediation and zone of proximal development, Stephen (2010) discussed findings from empirical studies in the United Kingdom that looked at play-based learning and 'pedagogy in action' to support preschool children's learning with technology. Stephen (2010) conceptualised pedagogy relating to learning as guided interaction between the learner and an adult or more able peer. They reported findings that educator-guided interactions can support learners through distal and proximal guidance. Distal guidance was described as indirect adult engagement which includes planning and provisioning of the learning environment prior to child participation and monitoring from a distance during child participation. Proximal guidance involved direct adult interactions with children during learning activities where educators employed strategies such as demonstrations, instructions, feedback and support.

In a large mixed-methods study of ECEC settings in the United Kingdom, Siraj-Blatchford & Sylva (2004) explored the concept of sustained shared thinking to jointly create knowledge during pedagogical interactions between children and adults. Framed by socio-cultural ideas, sustained shared thinking was described as when two or more individuals work together to solve a problem or clarify a concept, for example. Sustained shared thinking was reported to extend children's thinking and produce improved Learning Outcomes. Here, the primary role of the educator was to balance child-led and educator-led learning activities through preplanning and provisioning the physical and 'intellectual' environment (Siraj-Blatchford & Sylva, 2004, p. 727). The educator had an active role in modelling and demonstrating when necessary, and in extending of children's understandings through questions, discussions and reflections.

Purposeful play as a form of play-based learning in pre-schools was examined by Bautista and colleagues (2019) in a large Singaporean study. Positioning purposeful play as midway between free and structured play (Pyle & Danniels, 2017), this research described how children were purposefully guided to complete pre-planned academically focused learning activities with prescribed materials and resources. Purposeful play in this context was observed to be constrained and rigid, with the educators controlling all processes of the learning activities.

Through classroom observations and educator interviews, Pyle and Danniels (2017) conducted a study of 15 Canadian kindergarten classes to examine the use of play-based learning by educators. They identified five forms of play-based learning reflecting educator's levels of engagement. These were: 1) free play; 2) inquiry play; 3) collaboratively designed play; 4) playful learning; and 5) learning through games. These approaches to play-based learning approximately positioned child-directed learning at one end (free play), child/educator collaboration in the middle (collaborative play) and educator-directed learning at the other end (learning through games). During free play, children initiated and directed their own play, deciding on resources or materials to be used. Inquiry play was also child-initiated; however, educators extended the play towards integration of academic standards within a child's particular area of interest. Both children and educators exhibited shared control of learning in collaborative play, and co-designed context, themes, and resources. In playful learning, educators directed academic outcomes through structured activities within play. Learning through games was viewed as the most prescriptive, involving child/educator engagement of games with pre-set rules to meet curricula standards, such as spelling and maths. This study provided insight to potential "roles and levels of involvement of educators" (Pyle & Danniels, 2017, p. 277) within play-based learning, dependent on intended Learning Outcomes.

Wood (2010) argued for an integrated pedagogical approach to play-based learning through a combined mix of child-initiated and educator-initiated pedagogies. Wood (2010) proposed four approaches to child and adult engagement in play: 1) child-initiated and child-directed play; 2) child-initiated and adult responsive play; 3) adult-initiated and child responsive play; and 4) adult-initiated and adult-directed play. These four approaches were highlighted by Wood's (2010) model of integrated play which presented a continuum of child-controlled activities at one end, and adult-controlled activities at the other. In this model, children had complete choice of play activities and materials (free play) in the free zone of the continuum with little direct intervention from adults, unless requested (by the child). At this end of the continuum, outcomes and goals were entirely child-initiated and child-directed. Structured play activities were positioned in the middle of the continuum (structured play zone) and involved pre-set activities including games with rules, for example play with computers, reading/writing activities. Activities in the structured zone were described as adult-initiated and child responsive. At the other end of the continuum, adult-directed activities defined as 'work' engaged children with specific curriculum content. Here, choice of activities was entirely adult-initiated and directed incorporating focused instructional strategies towards pre-set goals. This model allowed for flexibility through a blended mix of child-led and educator led pedagogies “to respond to children’s interests and activities” (Wood, 2010, p.10) in order to maximise children’s learning.

Trawick-Smith (2012) described three approaches to educator-child play in ECEC in a continuum of pedagogies. The first approach, trust-in-play, suggested that play without adult intervention naturally developed a range of educational outcomes in children including social competence, familiarity with people and objects, and problem solving, amongst others. The educator’s role in this approach was to prepare the play environment and observe. A second approach to adult’s involvement in child’s play, suggested by the authors, was the facilitate-play approach. This approach proposed adult intervention as a means to elaborating and enriching emergent outcomes from play, through active educator support of the play. A third approach was enhance-learning-outcomes-through-play. In this approach, educator’s interactions with children during play were always intentional towards achieving specific academic goals. Based on these, Trawick-Smith (2012) proposed an integrated model which offered flexible approaches to educator intervention. In this model, the educator could choose the most appropriate level of engagement with children after a period of initial observation. In some cases, no engagement was deemed necessary [trust-in-play approach] when a child was playing “in meaningful and independent ways” (Trawick-Smith, 2012, p. 266). In other cases, an educator could include the facilitate-play approach, and/or enhance-learning-outcomes-through-play intervention approach dependent on the individual child. Thus, this study presented a range of flexible options for educator engagement with children during play-based learning activities.

In a large qualitative study of sustainability education, Edwards and Cutter-Mackenzie (2011; 2013) proposed a Pedagogical Play Framework to integrate play-based learning and intentional teaching, further refining both Wood’s (2010) model for integrated play and Travick-

Smith's (2012) approaches to play. Drawing on Vygotsky's (2004) ideas relating to imagination, the Zone of Proximal Development and mature concepts, this study examined educator use of three distinct forms of play-based learning in ECEC: 1) open-ended play; 2) modelled play; and 3) purposefully framed play. The authors described open-ended play as involving exploration of provided materials [relating to concepts of environmental education] by children with minimum engagement by educators, allowing children to create their own understandings of concepts (Edwards, 2017). In modelled play, prior to the children interacting with provided materials, educators showed the children how to use the materials though demonstrations and explanations relating to a learning concept or content knowledge. The educator then stepped back and encouraged playful exploration of materials. In purposefully framed play, the children were first provided with the materials in a provisioned open-ended play context. The educator then modelled how the materials could be used relative to the learning concept and engaged in teacher and child interactions using a range of strategies such as discussions, explanations, open-ended questions, use of support materials [i.e., books and posters] among others. In the Pedagogical Play Framework study (Edwards & Cutter-Mackenzie, 2011), the educators were directly involved in the designing of play experiences using all three play-types. The pedagogical play-types were presented in a series of cluster groups and the educators self-selected the order of implementation of each play-type to support intentional teaching around a concept of sustainability.

Findings suggested that all three forms of play were equally valued by the educators, with no one type of play considered more important than another as each offered different pedagogical strengths and functions to support children's learning (Edwards & Cutter-Mackenzie, 2011). Open-ended play was valued because it provided exploratory opportunities for children to directly manipulate materials and explore associated properties (Edwards, 2017). Open-ended play was also valued because it enabled educators to observe how children were thinking about ideas relating to the materials and then incorporate the children's thinking into subsequent planning and pedagogy. Modelled play was also considered important by educators because it provided opportunities for educators to directly show concepts to children and illustrate content knowledge. Purposefully framed play served to "build across, and within children's experiences" (Edwards, 2017, p. 8) as well as facilitating new ideas through discussions and use of teaching aids such as books and songs amongst others. Therefore, each play type was valued pedagogically for what it could offer both children and educators in terms of learning and teaching.

Findings from this study further suggested that all three types of play could be combined in multiple ways to support and benefit deeper learning as a form of intentional teaching. Participating educators reported that consecutive implementations of open-ended, modelled and purposefully framed play (regardless of the order of implementation) "operated as a combined pedagogical approach" (Edwards & Cutter-Mackenzie, 2013, p. 63) thus offering children a range of rich experiences for accessing content knowledge and generating new ideas. It was found that combining the play-types supported and increased learning about sustainability as the children developed, consolidated and "carried" learning from one play type to another. For example, educators noted that concepts embedded in open-ended play were supported through modelled play. Likewise, purposefully framed play was reported to extend children's thinking and improve quality of open-ended play (Edwards, 2017). Analysis of educator interviews showed that the three play-types acted as a "way of connecting the learning and teaching from one experience to the next so that the children had opportunities to explore the content and then have some explanation of the content" (Cutter-Mackenzie & Edwards, 2013, p. 205). Overall, it was found that educators benefitted from using the Pedagogical Play Framework because it enabled a balance between open-ended play and intentional teaching, as well as providing "multiple experiences for supporting learning, including exploration, experimentation, educators modelling, discussion, conversation and access to information resources (e.g., books, posters, video-footage)" (Edwards et al., 2017a, p. 15).

In Australia, the Pedagogical Play Framework (Edwards et al., 2017a) has been adapted to successfully support young children's second-language learning using digital technologies. This has occurred via the Early Language Learning Australia (ELLA) program which is a federally funded and nationally implemented set of language learning applications (apps) designed to foster interest and engagement in second language learning in preschool children. Implemented by 4,962 ECEC services to date (AGDE, 2023), the Pedagogical Play Framework underpins the conceptual design of the ELLA apps through integration of touchscreen technologies with play-based learning. The program encourages children to create their own combinations of the three pedagogical play-types (open-ended, modelled and purposeful play) within the app. Educators then have opportunities to complement and support the children's experiences of play in the apps with tangible play-based activities. Evaluations of the ELLA program concludes that the apps, in combination with educator support through play-based learning, successfully supports second language exposure within ECEC, without teachers requiring specialist language (Kaufman et al., 2017).

In the next section of this review, the literature about tinkering and making is considered. Tinkering and making represents a form of play-based learning, focussed on the potential for children's learning through the exploration and recombination of physical materials.

2.6 Tinkering and Making

Research refers to tinkering as a physical, hands-on activity relating "to direct, creative, and iterative experimentation on materials" (Parisi et al., 2017, p. S1169). Tinkering, in an inquiry-based context, can involve participants taking artefacts apart, rebuilding, repairing or improving objects or artefacts (Bianchi & Chippindall, 2018; Heroman, 2017). This approach to tinkering implies physical deconstruction of existing artefacts into smaller loose parts materials, followed by reconstruction of those materials into similar or new artefacts (Marsh et al., 2018). In tinkering, exploration of available materials is strongly emphasised through "creative, improvisational problem solving" (Bevan et al., 2015, p. 99) where the end point or goal is open-ended and emergent (Çelik & Özdemir, 2019). From this perspective, tinkering starts with an exploration of ideas without specific pre-set plans (Resnick & Rosenbaum, 2013) and is well aligned with open-ended play.

Participants who engage in the act of tinkering have also been referred to in the literature as 'makers' and 'inventors' (Vossoughi & Bevan, 2014). Honey and Kanter (2013) posit making as a hands-on activity to build or adapt objects "for the simple personal pleasure of figuring out how things work" (p.4), therefore ascribing making similar characteristics as tinkering. Martin (2015) also associates making with the design, creation, modification or repurposing of materials to build artefacts for a playful or useful purpose. Towards this end, tinkering as a term has been used interchangeably with that of making. Other literature suggests that tinkering differs to making in terms of planned outcomes. Making, according to Martinez and Stager (2019), involves active intentional construction on a planned product. Tinkering, on the other hand, may not necessarily adhere to or follow specific goals, suggesting more open-endedness and flexibility in outcome (Martinez & Stager, 2019). Martinez and Stager (2019) view tinkering as a playful activity encompassing open-ended discovery and experimentation with available materials, while making suggests compliance to planned outcomes and goals in a manner aligned with intentional teaching. According to Bevan et al. (2015), goals need not be assigned in a tinkering setting as they naturally evolve though initial exploratory engagement with the available materials, tools and people.

There is a historic relationship between tinkering and traditional practices of craftsmen and artisans dating back to prehistory (Connor, 2015). Through manual acquisitions of craft and artisan skills, ordinary everyday people tinkered with tools and materials to expand knowledge in science and arts (Conner, 2005; Gabrielson, 2015; Hatch, 2014; Parisi et al., 2017; Schrock, 2014; Vossoughi & Bevan, 2018). In more recent times, the emergence of a Do-It-Yourself (DIY) culture (Niederhauser & Schrum, 2016) has resulted in grassroots movements of backyard and kitchen tinkerers, designers and inventors enabled by technological developments of the digital age. In other words, the craftsmen and artisans of the past have been seceded by scientists in garages and artisans of the information age (Conner, 2005). Stemming from this trend in self-sufficiency and resourced by new technological tools, the 'Maker Movement' originating in the United States, has become popular around the world. An umbrella term for a social movement of inventors, makers and designers, the Maker Movement is characterised by informal community hubs known as Makerspaces. In these spaces, people gather to tinker, share ideas, make and invent (Halverson & Sheridan, 2014; Sheridan et al., 2014). Makerspaces are said to offer a model for learning by-doing (Marsh et al., 2018) motivated by fun and self-fulfilment (Bianchi & Chippindall, 2018).

Processes of creativity and innovation are central to Makerspaces, enabling the building of products or artefacts using specialist tools, materials and resources, with a recent focus on new digital tools and practices (Marsh et al., 2017). According to Sheridan and colleagues (2014), makers in these spaces include people of different ages and experiences who work with a range of materials to “develop an idea and construct it into some physical or digital form” (p.507). Some Makerspaces focus on innovation and entrepreneurship (Vossoughi & Bevan, 2018) and are generally located in informal community accessed sites attracting youths and adults. Other informal maker settings include after school care locations (Vossoughi et al., 2013), museums (Gutwill et al., 2015) and libraries (Bowler & Champagne, 2016). These informal settings frequently focus on Science, Technology, Engineering and Maths (STEM) related activities (Sheridan et al., 2014; Vossoughi & Bevan, 2014) and can include design in creative arts. Such inquiry-based environments generally feature open-ended learner driven pedagogies designed to foster interest, engagement and skills around STEM activities. Many tinkering and making activities are interdisciplinary in nature (Peppler, 2013; Sheridan et al., 2014), and integrate STEM, art and literacy education.

The worldwide growth of the Maker Movement has also extended into more formalised education settings, capturing the imagination of teachers and educators (Niederhauser & Schrum, 2016) in preschools, primary schools and secondary schools (Wohlwend et al., 2017). Pedagogical practices associated with tinkering and making are acknowledged to align strongly with play-based learning, thus legitimising the uptake of tinkering and making activities for young children as a mode of learning.

2.6.1 Tinkering, Making and Pedagogy

The works of Dewey (1997), Piaget (1951), Papert (1993), and Vygotsky (1967) amongst others align closely with tinkering and making pedagogies and embed many key theoretical principles relating to knowledge construction. Constructivism (Piaget, 1951) and

Constructionism (Papert,1993) are cited in the literature as core conceptual principles underlying tinkering and making (Bers et al., 2014; Çelik & Özdemir, 2019; Martin, 2015; Martinez & Stager, 2019). Developmental theorists, such as Piaget (1951) used concepts relating to constructivism to convey how knowledge is actively constructed by individuals (Resnick, 1998). Papert (1993) expanded on concepts in constructivism to focus specifically on the potential for physical constructions of external artefacts, such as computers and robotics, to develop knowledge. Engagement in physical construction can lead to rich contexts for learning (Vossoughi & Bevan, 2014) through building, making and sharing ideas and materials with others (Çelik & Özdemir, 2019), particularly if that engagement is personally meaningful (Papert, 1993; Vossoughi et al., 2013). Other literature focuses on socio-cultural understandings of tinkering and making, positioning tool mediation and the zone of proximal development (Vygotsky, 1967) as approaches to understanding the social, relational and cultural dimensions of tinkering and making (DiGiacomo & Gutiérrez, 2016; Schwartz et al., 2015). Moreover, tinkering practices often involve novices and experts working side by side and assisting each other, where roles continuously shift during processes of exploration and invention (Vossoughi & Bevan, 2014).

For example, using individual case studies and comparative analysis of differing Makerspaces, Sheridan and colleagues (2014) analysed features of three different tinkering and making settings as learning environments. The first setting comprised of an informal site made up of a range of makerspaces in a museum, including introductory hands-on art, engineering workshops, industrial sewing, 3-D printing, and computer programming. These spaces catered for children and novice adults and were informally facilitated by experts in each related discipline. The second setting was described as a community workshop where people of all ages gathered to make, tinker and learn together. This site was also made up of a collection of makerspaces with participants focusing on diverse areas including transportation, food, digital tools and electronics, design and fabrication, music, and art. In these spaces, novices and experts worked side by side to guide each other during activities. The third setting focused on an out of school hours care environment and included young participants of mixed ages. This setting supported learning in making with digital [coding] and physical materials such as woodwork tools. Activities were guided by adults, with specialist experience in each of the knowledge areas. This study suggested that guided tinkering and making activities with a range of digital and physical materials helped participants to identify problems, build models, learn and apply skills, revise ideas and share new knowledge with others. Improvement of fine motor skills was also noted in museum space in activities which focused construction with tangible materials. All sites were provisioned with specialist resources, and two of the settings were facilitated by paid facilitators to support learning.

Bers et al. (2014) built on previous studies in robotics and engineering to look at conceptual development in computational thinking and problem solving. In this mixed methods study, four-year-old children were progressively guided through construction activities using robotic manipulatives as part of a TangibleK™ robotics program. Over six lessons, the children shared ideas, explored and tinkered with robotic parts and then built their own robot constructions. Participants were then guided through a series of programming instructions of their robots. Bers and colleagues (2014) found that in addition to conceptual development of processes in robotics, the tangible nature of the learning activities led to sharing and negotiating of materials, collaborating on ideas and as well as improvement of fine motor skills. This study incorporated adult engagement in the form of direct instruction towards Learning Outcomes in addition to opportunities for open-ended exploration of materials. All materials were specialist resources provided to the learning environment.

In a less formal context, Bevan et al. (2015) described a study of 8-12-year-old children in a tinkering program in a museum setting. They defined tinkering as a branch of making that emphasizes creative, improvisational problem solving. They examined a set of learning dimensions with related indicators. Through this study, Bevan et al. (2015) proposed a learning framework which included four major learning dimensions: 1) engagement; 2) initiative and intentionality; 3) social scaffolding; and 4) development of understanding applicable to a range of disciplinary areas such as computational thinking, engineering, media literacy.

Tinkering and making pedagogies are also recognised as beneficial to developing literacy education. In a study involving early childhood preservice teachers, Wohlwend et al. (2018) described maker literacies as sets of practices for making/remaking artefacts and texts through playful tinkering with physical materials (traditional craft objects and toys) and technologies (puppetry apps, iPads and video software). They presented four types of maker literacies involving: 1) collaborative play; 2) toy hacking; 3) digital film making; 4) video editing; 5) remixing. The aim was to expand preservice teacher's personal definition of literacy to include technology related making literacies for preschool.

Peppler and colleagues (2019) proposed an interdisciplinary approach to tinkering and making through the introduction of 'playshops' to preschools including literacy and design playshops. Playshops were workshops with strong curricular alignment to the common core standards in the United States with the aim of integrating play, in the form of hands-on crafting, with technologies (Wohlwend & Peppler, 2015). As part of a larger investigation into how to introduce STEM materials in ECEC, this study created a design playshop with Squishy Circuits

™ - an electronics kit for creating circuits with ‘playdough’ wires. Through open-ended play, 45 children [aged 3–5 years old] collaboratively engaged with tools, materials, and Squishy Circuits toolkits in a preschool setting for seven one-hour sessions over a period of two weeks. Children were invited to explore and play with the toolkits and crafting materials to investigate a wide range of concepts relevant to circuitry learning including current flow, polarity, and connections. Two main sources of data were employed in this qualitative study: whole-class discussions at the start and end of the study, and videotaped observations. Findings showed that play mediated the development of rigorous concepts and sustained shared thinking around circuitry in the playshop, where children made “toy snakes and glowing necklaces” (Wohlwend & Peppler, 2015, p. 24) and other crafts from playdough, while designing working electronic circuits (Wohlwend & Peppler, 2015). Guided playshops were thus reported to benefit learning in STEM, inventive playing, design and creative learning and collaborative learning in diverse participation.

In a large international study conducted between 2017-2019, the MakEY project [Makerspaces in the early years: Enhancing digital literacy and creativity] explored the value of makerspaces for fostering young children’s learning, with particular focus on the development of children’s digital literacy and creative design skills (Marsh, 2017; Marsh et al., 2018, 2019). Studies were carried out in seven EU countries [Denmark, Germany, Finland, Iceland, Norway Romania, UK] and the United States where teachers and educators collaborated with academics to identify the benefits and challenges of conducting makerspaces in formal and informal education settings. As part of the wider MakEY project, Marsh and colleagues (2019) drew from data extracted from four case studies to examine principles of pedagogy and practice of early childhood makerspaces in increasingly technologized societies. The case studies were conducted in Northern England in two preschools [approximately 1300 3–4-year-olds] and two primary schools [approximately 88 aged 6–8-year-olds]. The four school settings each offered different making and tinkering activities which children could freely choose to participate in, leading to the production of a range of artefacts through play and experimentation with materials. For example, in one preschool, participants were introduced to circuitry concepts using cardboard boxes, playdough, flashlights and digital apps. In one of the primary school settings, participants created imaginary playscapes using virtual reality apps as well as making tangible clay models of their imagined playscapes. Data was collected through video observations [including Go-Pro™ chest cams worn by some child participants], field notes and semi-structured interviews with educators and teachers.

Using Rogoff's planes of analysis (Rogoff, 2003), findings from this study suggest that children develop 'maker agency' as they make choices and follow their own interests and goals, and that consequently makerspaces facilitate children to draw upon rich 'maker funds of knowledge' [discussed in the next section] which they collectively shared. The authors suggested that through tinkering and playing in makerspaces children can bring their previous experiences of making in the home, which frequently include digital media (Marsh et al., 2018), to develop maker knowledge. Moreover, play in this study is considered in relation to children's direct experiences in makerspaces which suggest that they move fluidly between digital and physical worlds during social interactions in a type of 'post-digital' maker play. According to Marsh and colleagues, the term emphasizes "the way in which the digital is so embedded in everyday play practices that it is no longer meaningful to consider the digital in contrast to nondigital" (Marsh et al., 2019, p. 224) and that this type of play can occur when practitioners recognize that traditional and digital play coexist, with the latter not displacing the former. According to the authors, makerspaces have the potential to contribute to contemporary theories of learning that place children's prior experiences and funds of knowledge (Moll et al., 1992), discussed in the next section, at the root of pedagogical practice and in doing so, facilitate spaces of emergent post-digital possibility thinking. Given the extent to which the post-digital is increasingly an integral element of young children's play, Marsh (2019b) calls for changes in theoretical orientations which recognises the ontological entanglements of children and technology.

The literature reviewed in this section of the review on tinkering, making and pedagogies suggests that participation in tinkering and making activities by children can result in knowledge construction around design processes and problem solving in STEM areas (Bers et al., 2012; Blikstein, 2013; Peppler, 2013; Sheridan et al., 2014; Wohlwend & Peppler, 2015). Other tinkering and making literature reports on design in creative arts (Marsh et al., 2017; Wohlwend et al., 2018). Some studies indicate opportunities for interdisciplinary learning across subject areas. Many of the studies suggest benefits which include creation of shared meaning between experts and peers, and the development of collaborative learning practices between participants (Sheridan et al., 2014; Bevan et al., 2015). Consistent with current thinking about play-based learning and intentional teaching, all the reviewed studies incorporated levels of adult engagement with learners to provide guidance towards achieving intentional outcomes.

The next section of this review considers how children's lived experiences, or funds of knowledge are pedagogically positioned in ECEC, especially in terms of play-based learning, and more recently with reference to children's at-home and in-community experiences with digital technologies.

2.7 Funds of Knowledge

Moll and colleagues (1992) define funds of knowledge as "historically accumulated bodies of knowledge and skills essential for household functioning and well-being" (p. 133) which are dynamic, changing and evolving with new contexts and cultures (Moll, 2019). Informed by socio-cultural perspectives of learning and development, concepts relating to funds of knowledge situate everyday language, activities, and social interactions as resources with which to co-construct knowledge (Vygotsky, 1978). Funds of knowledge then represent a child's everyday informal 'know-how' contributing to foundation knowledge shaped by their interests and passions. Consequently, funds of knowledge are important forms of prior knowledge based on children's personal and informal family and community experiences (Hedges, 2007). Funds of knowledge thus offer potential for educators to intentionally connect play-based learning with children's rich out-of-school experiences (Gonzalez et al., 2005).

According to Mawson (2011) and Chesworth (2016), young children enter early childhood settings endowed with rich funds of knowledge upon which they develop the complexity of their play and co-construct meaning. Children's funds of knowledge relate to their interests which can reflect their choice of activities and subsequent engagement levels in activities in ECEC settings (Chesworth, 2016). Hedges and colleagues (2011) suggest that young children generate their own funds of knowledge through family routines and activities [including familiarity with parent occupations and domestic tasks], community practices [including cultural events] and school practice [including peers' interests and teacher's interests]. Children's engagement with digital media and popular culture is also reported in the literature as generating significant funds of knowledge that manifest in children's play in ECEC settings (Andrews & Yee, 2006; Chesworth, 2016; Hedges, 2011; Marsh, 2000). Marsh (2000) described popular culture as relating to the influence of television programs, movies, computers, advertising, and associated artefacts, which generate sources of pleasure and interest for many young children in the global north. Literature indicates that play-based learning which recognises children's existing funds of knowledge can enhance language and literacy development (Marsh, 2000) and strengthen curriculum and pedagogical decision making by educators directly informed by children's interests and play choices (Chesworth, 2016). Funds of knowledge can also help educators to engage intentionally with children's technology-based interests to extend knowledge in relation to their social and cultural experiences (Hedges, 2011; Marsh et al., 2019; Mawson, 2011), and by doing so support the integration of technologies in ECEC settings.

For example, in a New Zealand study based in two Auckland early childhood settings, Mawson (2011) investigated the nature of young children's independent collaborative play. Using a case-study approach documented through field notes, video observations, digital photographs and audiotape recordings, the author reported that young children [aged 3-4 years old] came into early childhood settings with rich prior experiences that they used to develop and increase the complexity of their collaborative play scenarios. The children were observed to incorporate a wide range of technological funds of knowledge and understandings gained from their out-of-centre experiences which included prior knowledge about health and medicine, transport systems, and information and communication technologies [ICT]. With regards to children's funds of knowledge around ICT, computers and mobile phones were incorporated into their play in ways that mirrored children's use in the wider community, along with frequent references to popular media. The author concluded that technological references "provide insight into the content knowledge needed by early childhood educators" (Mawson, 2011, p. 31) and offer potential avenues of interest that could be further explored within an extended learning experience.

As outlined in Marsh and colleagues' study of makerspaces (2019) [detailed in Section 2.5.1], the authors reported that a key source of young children's funds of knowledge is acquired through experience with digital technologies. In that study as part of the MakEY project (Marsh et al., 2019), children brought their experiences and knowledge of digital making from home into the preschool-based makerspaces. Findings suggested that by drawing on funds of knowledge, children developed maker agency where their prior knowledge of and experience with digitally related making activities from home meant "that they quickly grasped the process involved in a particular maker activity, such as digital animation or photography" (Marsh et al., 2019, p. 227). Moreover, children were then observed to support the learning of peers through sharing those digital maker funds of knowledge, thus demonstrating a type of relational agency as they tried "to help each other out and share expertise in the makerspaces" (Marsh et al., 2019, p. 228). The authors suggest that makerspaces can facilitate young children to draw on their maker funds of knowledge, developed through rich creative experiences with digital technologies acquired in the home.

2.8 Assessment, Documentation and Learning Outcomes

Global focus on the institutionalisation of early childhood education and development of national reform frameworks in the last two decades has led to increased accountability for assessing and documenting processes of learning (Nyland & Alfayez, 2012) through "more differentiated and systemic ways" (Knauf, 2020, p. 11). Assessment and documentation of learning have become key professional responsibilities of ECEC centres and educators around the world (Fleet et al., 2017; Knauf, 2015, 2020; OECD, 2015; Vallberg-Roth, 2012) and are integral to the quality of learning in ECEC settings (OECD, 2015). In many countries, assessing and documenting learning and pedagogy is a regulatory requirement and is explicitly referred to in national ECEC frameworks. For example, New Zealand (W. Lee & Carr, 2001), Ireland (Dunphy, 2010), Germany (Knauf, 2015) and Sweden (Liljestrand & Hammarberg, 2017;

Vallberg-Roth, 2012) stipulate that assessment and documentation are mandatory. In Australia, assessment and documentation of children's learning are also key regulatory requirements (ACECQA, 2020).

Assessment may be interpreted as the evaluation and analysis of gathered information to provide a review or rating of someone or something (Vallberg-Roth, 2012). In educational settings, this can mean "teachers using their professional judgement to interpret and evaluate the educational activities or the children's learning, skills, and processes" (Vallberg-Roth, 2017, p. 3). In Australia, the EYLF V2.0 (AGDE, 2022) refers to assessment as "the gathering of information about children's learning, development and wellbeing, undertaken over time using a range of strategies" (AGDE, 2022, p. 25). This process is viewed from a range of perspectives gathered from a variety of documented sources, encompassing "a multi-purpose component of professional practice" (Fleet & Patterson, 2012, p. 35). In Australia, the EYLF V2.0 (AGDE, 2022) provides reference points in the form of five nominated Learning Outcomes and associated key indicators which "are designed to capture the integrated and complex learning and development of all children across the birth to 5 age range" (AGDE, 2022, p. 29). Learning Outcomes are defined as skills, knowledge or dispositions that educators can actively promote in early childhood settings in collaboration with children and families (AGDE, 2022). In the EYLF V2.0 (AGDE, 2022) these outcomes are: 1) children have a strong sense of identity; 2) children are connected with and contribute to their world; 3) children have a strong sense of well-being; 4) children are confident and involved learners and 5) children are effective communicators (AGDE, 2022). The Learning Outcomes are broad and holistic, and place strong focus on the development of lifelong learning dispositions, while acknowledging that children learn in multiple ways over time (Grieshaber, 2010).

Documentation refers to the collection and compilation of information (Vallberg-Roth, 2012) into a form of record-keeping (Fleet & Patterson, 2012). Documentation in ECEC settings refers to visual, written, and auditory recordings of learning and learning progress (Knauf, 2020) which make learning visible (AGDE, 2022; Miller, 2014; Mitchell, 2019). Such documentation incorporates children's and educator's thinking and experiences into forms of records that can be shared, revisited and extended over time (AGDE, 2022). Documentation thus creates evidence of learning upon which judgements or assessments about learning can be formed. When documentation in ECEC settings includes reflection, in the form of discussions and conversations about learning processes, this is often referred to as pedagogical documentation (Arthur et al., 2018). Pedagogical documentation is normally conducted through naturalistic observations of children in authentic, meaningful, and supportive contexts (AGDE, 2022; Dunphy, 2010; Vallberg-Roth, 2012). Originating from Italy's Reggio Emilia's approach to early childhood education, pedagogical documentation necessitates gathering data about children's learning through methods such as photographs, video recordings, handwritten notes, transcribed interviews, drawings and artefacts amongst others, and using these as stimulus for thoughtful discussion between children and educators (Arthur et al., 2018; Carr et al., 2015; Fleet et al., 2011; Knauf, 2020). Cycles of reflection and analysis, focusing on documented learning, facilitates educators' understanding of how and what children are learning, and also helps children to examine their own learning (Laski, 2013; M. Lee & Pohio, 2012). Pedagogical documentation also includes the educator's own reflective text or commentary on a child's activity, thus providing more holistic insights into a child's learning journey. Pedagogical documentation is characterised by an examination of the social construction of knowledge between children, and between children and the general learning community (Fleet et al., 2011;

Rintakorpi, 2016) thus corresponding closely to social constructivist perspectives on how children learn (Knauf, 2018).

In the past decade, a proliferation of digital programs and portals have emerged to support pedagogical documentation in ECEC (Beecher & Buzhardt, 2016; Dwyer et al., 2019; Goodman & Cherrington, 2017; McFadden & Thomas, 2016). Digital platforms are suggested to enhance the range of materials and information that can be compiled about children's learning in a succinct and mobile form (Boardman, 2007; Dunphy, 2010) as well as digitally promoting the visibility of a child's learning in a secure manner (Knauf, 2020). Digital platforms are noted as providing families with "access to additional insights, and finer details about their child's everyday routines" (Yost & Fan, 2014, p. 38). Online platforms which facilitate educators to create and share documentation and vignettes about children through text, photographs and/or audio and video recordings are referred to as Pedagogical Documentation Technology [PDT]. Another term for this technology is electronic portfolios or e-portfolios (Picher, 2019).

E-portfolios offer alternative resources to traditional hardcopy portfolios with added integration of a range of multimedia tools to organise learning and to effectively illustrate children's learning progress more over time (Habeeb & Ebrahim, 2019; Higgins & Cherrington, 2017). Thus e-portfolios are digital tools that educators can implement to more efficiently understand how young children develop and learn, and to assess and share a child's progress. Child engagement levels are suggested to increase through e-portfolio usage as such digital portals can tap into the established technological interests and habits of young 21st century learners (Habeeb & Ebrahim, 2019) and the 'state-of-the-actual' that children experience with families (Stephen & Edwards, 2018). In some early childhood settings, children are directly involved in the creation of e-portfolios by uploading digital content that highlights their own personal understandings of recently learned concepts, as well as providing opportunities [online or offline] for children to present their work in front of class peers and their education community (Habeeb & Ebrahim, 2019).

PDT is reported to enhance collaborative partnerships between children, educators, parents and extended family networks and is noted to initiate families in face-to-face conversations with educators (Beaumont-Bates, 2017). Literature suggests that digital platforms provide fast and more frequent communications between educators, families and children, enabling increased access to and higher visibility of a child's learning (Beaumont-Bates, 2017; Higgins & Cherrington, 2017; Hooker, 2019). Some research suggests stronger tendencies toward self-directed learning among young children who are provided with access to e-portfolios (Habeeb & Ebrahim, 2019). Some literature reports that engagement with e-portfolios can be limited by parent/family member proficiency levels in technological use (Boardman, 2007) as well as cultural barriers including language proficiency (Yost & Fan, 2014). Studies report that educator engagement with PDT can also be limited by a lack of technological proficiency and cite professional learning as important to supporting digital documentation (Dwyer et al., 2019; M. Li & Grieshaber, 2018; Wager & Parks, 2016).

An array of PDT exists to support educators in documentation, planning and communication with families. Australian examples include 'Educa' (Educa, 2020), 'Storypark' (Storypark, 2020), 'Kinderm8' (Kinderm8, 2020), 'Kindyhub' (Kindyhub, 2020), all of which provide subscription access to web-based software via desktops, laptops, with apps available for tablets and smartphones (Beaumont-Bates, 2017; Dwyer et al., 2019). These online portals provide many pathways to communicate and celebrate learning with families and children including through learning story templates, video and audio tools, digital conversations which "can streamline reporting processes and establish private communities to engage with families and other educators around children's development" (Dwyer et al., 2019, p. 93) as well as analysis and assessment tools/templates and links to EYLF V2.0 and state curriculums. Studies show that many educators in Australian ECEC settings now use some form of commercially available childcare software in their day-to-day professional practice (Boardman, 2007; Dwyer, 2019; Yost & Fan, 2019) while international research mirrors this trend (Beaumont-Bates, 2017; Habeeb & Ebrahim, 2019).

2.9 Conclusion

The literature presented in this chapter canvases research related to several areas of the thesis, including the integration of technologies in ECEC, the history of technologies in ECEC, play-based learning and intentional teaching, tinkering and making, funds of knowledge, and assessment, documentation and Learning Outcomes. These various bodies of research are necessary to frame the ongoing presentation of the approach to the research and the findings and discussion in this thesis. First, according to how the integration of technologies in ECEC may be supported by using a play-based approach to tinkering with unplugged technologies by educators, and second by recognising the potential of children's funds of knowledge in their own experiences with technologies and how these might manifest as representations of the post-digital in ECEC. In this chapter, attention is also directed towards assessment and documentation of children's Learning Outcomes because, as is described in the Methodology chapter of this thesis, the educator identified Learning Outcomes associated with the children's participation in play-based tinkering were used to trace what the post-digital in ECEC might look like in practice.

The next chapter of this thesis examines the theoretical framework for the study, identifying Science and Technology Studies broadly as the social constructivist framework responding to technological determinism as a way of thinking about the relationship between people and technologies. Within Science and Technology Studies, Actor-Network Theory [ANT] (Latour, 2005) is identified as the main theoretical framework guiding the study, and one which acknowledges the non-binary perspective inherent in descriptions of the post-digital as constituting networks of social practices and non-human materials and artefacts.

CHAPTER 3 : THEORY

3.1 Introduction

This chapter details the informing theoretical framework for this thesis as Actor-Network Theory [ANT]. To situate ANT within a body of existing thinking, the chapter first explains Science and Technology Studies [STS] as an approach to understanding the relations between people and technologies as socially constructed. This is in contrast to technological determinism as a theory of technology which postulates that technologies impact upon people. Within STS, three main perspectives are identified, including Social Construction of Technology [SCOT], Social Shaping of Technology [SST] and Actor-Network Theory [ANT]. The core components of ANT are introduced, explaining how human, non-human, and material actants can be related to each other within networks, acting upon each with relational agency to form particular manifestations or ways in which technologies are associated with and used by people. Examples of actants according to the extant literature related to this study and detailed in the previous Literature Review chapter [e.g., play-based learning, funds of knowledge] are used to illustrate these components. This chapter also provides a definition of unplugged technologies as used in the research reported in the thesis.

3.2 Science and Technology Studies

STS is a field of scholarship which at its origins, attempted to converge a multifaceted range of social sciences including history, philosophy, sociology, economics, and anthropology, as well as natural sciences (Hackett et al., 2007; Matthews, 2019) into understandings of the social structures and practices that constitute science and technology (Jasanoff, 2017; Matthews, 2021). A central premise underpinning STS is that scientific facts, technology, and objects are open to social analysis and are not in fact the result of privileged forms of knowledge about nature (Rohracher, 2015). Consequently, the focus in STS is on the inseparability of science and technology from social structures and practices (Hackett et al., 2007). This notion of inseparability draws from Thomas Kuhn's (1962) argument that the course of scientific activity is shaped by a scientific community's choice of a particular paradigm or belief system (Kukla, 2000). Kuhn (1962) advocated for a new approach to the history of science whereby scientific facts are interpreted as outcomes of scientists' communal knowledge generating effects, conditioned by specific social contexts of discovery (Jasanoff, 2017) rather than being objectively true in and of themselves. Kuhn's ideas established the groundwork for later scientific knowledge production, including the Sociology of Scientific Knowledge [SSK] and the Social Construction of Technology [SCOT].

STS is concerned with how things, for example inanimate objects [e.g., technologies], states and conditions, practices, events, relations, experiences, actions, and concepts are constructed (Sismondo, 2007). STS is strongly associated with the theoretical perspective of constructivism, specifically social constructivism (Kukla, 2000). Social constructivism as advocated by STS, differs from social constructivism as understood in educational theory. In educational theory, social constructivism refers to the joint construction of knowledge and understanding between two or more people over time. In STS terms, social constructivism is identified with and related to a critique of technological determinism inspired by early critical thought and the Frankfurt school of critical theory (Feenberg, 2017). Prior to the emergence of STS, the social study of technology was focused primarily on technology's impact on society, and associated with Marxism, pragmatism, Heideggerian phenomenology (Feenberg, 2017) [in this view, the focus on understanding technologies was largely on the impact of technologies on people and society]. Technological determinism promotes technological innovation as the primary cause of change in society. Consequently, technological determinism is a perspective which suggests that technological and material forces shape and determine social events (Sismondo, 2007), impacting behaviours and society in general. There are different types or degrees of deterministic views of technology but broadly these perspectives can be said to form around two influential concepts: firstly, that technology develops independently from society; and secondly that technology, when incorporated by society, determines the character of that society (Jameson & Johnson, 2008; Kline, 2001).

In the first idea, technological development is understood to emerge independently of social influences or forces. This view suggests that technological inventions and discoveries are the result of step-by-step scientific application, and that technology can then continue to develop from a logic of its own evolving from previous discoveries or inventions (Feenberg, 2009). This implies that technological inventions and developments can appear to be both the determinants and “the stepping stones of human development” (Wyatt, 2008). Here, the view is that technology develops beyond human control and is therefore autonomous (Feenberg, 2009). From this perspective, the technology itself is attributed agency, or can be viewed as forced upon society by controlling elites (Dafoe, 2015).

The second influential idea underpinning determinism suggests that technology is a powerful force which impacts social groups by determining behaviour and society (Jameson & Johnson, 2008; Sismondo, 2007). This was a prevalent view during the industrial revolution, when proliferations of technological development were viewed as driving forces of both every day and work life in a push towards efficiency (Kline, 2001), thus sacrificing human values to efficiency and unrestrained technological development (Feenberg, 2017). STS offers alternative theoretical perspectives to the limitations of technological determinism through developing empirically rich historical or ethnographic research to show the deeply social processes of technological development (Wyatt, 2008).

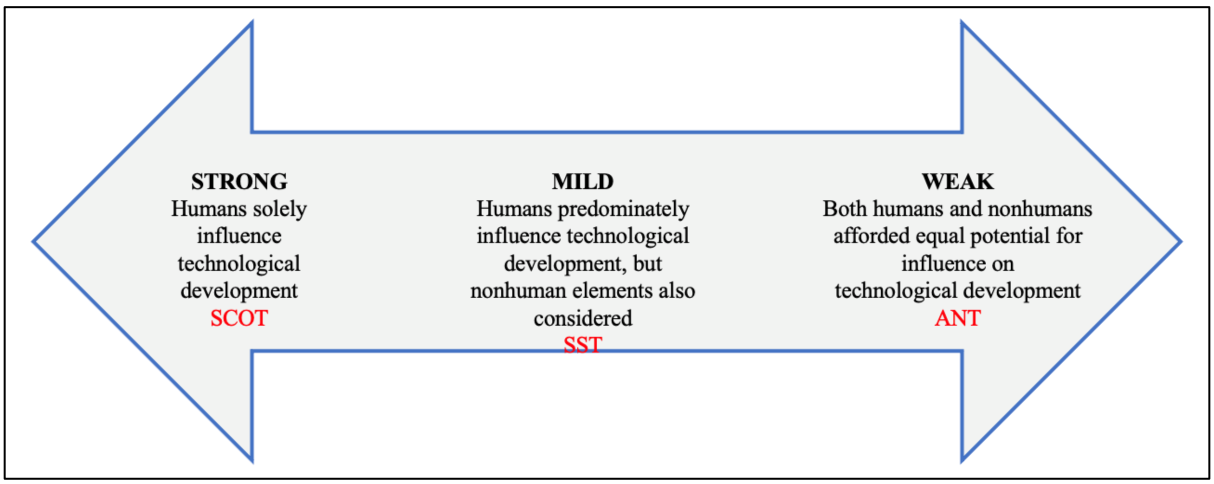
STS scholarship argues against technological determinism and provides a critical response to technological determinism, critiquing determinism for not acknowledging the influence of social groups and processes on technological development, while failing to recognise scope for human choice or intervention within the technological (Wyatt, 2008). Social constructivist models allow for detailed insights into how social groups can define technology, illuminating that technological innovation "does not take a linear path from theory to application to introduction of the technology into society, but is instead influenced by social choices at every point", thus bearing the imprint of the social processes that have brought them forth (Brey, 2009). Social constructivism encompasses a variety of related, predominately sociological approaches in STS (Baron & Gomez, 2016; Brey, 2009; Sismondo, 2004) which generally view technology from a more human-centred position, focusing on the ability of humans to engage critically with and socially shape technology.

When broadly viewed, social constructivism relating to technology can be positioned along a continuum, ranging from 'strong' social constructivism at one end of the spectrum, to 'mild' social constructivism in the middle, and to 'weak' at the other end with many variations in between (Brey, 2009; Matthews, 2021). Examples of strong social constructivism include the Social Construction of technology [SCOT] approach (Pinch & Bijker, 1984) which maintains that technological change or innovation should be explained strictly through social practices.

Mild social constructivism can be characterised by more moderate approaches, which do not abstract the role of non-social influences in technological change and are referred to as Social Shaping of Technology [SST] approaches (MacKenzie & Wajcman, 1985). Other forms of constructivism, such as Actor-Network Theory, completely omit the term 'social', focusing on relationships between networks of human actors in combination with natural and technical, inanimate phenomena (Latour, 2005) [Figure 3.1].

Figure 3.1

Strong, Mild, and Weak Variations of STS



3.2.1 Social Construction of Technology [SCOT]

The Social Construction of Technology [SCOT] attributed to and described by Pinch and Bijker (1984) argues that the development and success of technology is primarily the result of social processes achieving intersubjective or shared agreements (Lower, 2006; Sismondo, 2007). This form of social constructivism privileges individuals, groups, and institutions in the development of technology, and clearly offers a contrast to technical determinism where technology is viewed as shaping the social and determining human actions. Consequently, SCOT offers alternative ways of considering technology in relation to social processes where technology reflects the various processes of social negotiation and interpretation that have brought them forth (Brey, 2009). Thus, from a strong social constructivist perspective, social elements alone are responsible for the development of technology, with little agency or influence attributed to the technology itself.

A general theme in SCOT is related to principles of symmetry (Brey, 2009). The idea of symmetry here requires the researcher to remain impartial to both the opinions of individuals [or social groups] and the properties of the technology under analysis (Brey, 2009; Fenwick & Edwards, 2010). This necessitates the application of the same style of explanation or framework to competing beliefs during development of a technology (Kochan, 2006). The aim is to maintain symmetrical even-handed treatment of all social individuals during analysis of technological developments (Feenberg, 2017). This involves a research commitment to eschewing claims relating to, for example "the (in)operativity of artifacts, technological (in)efficiency, success or failure in technical change, the (ir)rationality of technological choices and procedures, technological progress, the real function of purpose of an artifact, and intrinsic effects of technology" (Brey, 2009, p.101). The principle of symmetry therefore in the study of technology is aimed at leveling any preconceived divisions or differences usually taken as foundational (Law, 2009).

Another key theme within SCOT is the idea of interpretative flexibility (Feenberg, 2017). Interpretative flexibility refers to the notion that social groups can attribute different values and meanings to technology, depending on their particular perspectives (Brey, 2009; Feenberg, 2017; Winner, 1993). This means that technology itself is not perceived as having fixed, objective properties but instead allows for different interpretations of those properties by relevant social groups or actors (Brey, 2009). For example, social media as a technology can be valued in different ways by different social groups. One social group may value social media for facilitating social interaction while another social group might value social media as a political platform. Thus, a flexible approach to interpretation considers different perspectives relating to technology's functional and social properties as well as different perspectives relating to a technology's technical content. Knowledge about a particular technology can be hence determined by the interpretations of relevant social groups and not by the technology itself (Brey, 2009).

3.2.2. Social Shaping of Technology [SST]

Positioned in the middle of the social constructivism continuum are mild or moderate forms of constructivism, which are sometimes referred to as Social Shaping of Technology [SST] approaches (MacKenzie & Wajcman, 1985). Here, along with social processes, the role of non-social elements in technological development are also considered (MacKenzie & Wajcman, 1985). Consequently, whilst strong approaches to social constructivism focus solely on social elements to explain the development and influences of technology [e.g., specific human social groups and processes of interpretation], moderate approaches in addition consider non-social elements [e.g., technical devices and natural forces]. Mild social constructivism acknowledges that technology can have effects although these effects are very much dependent on and influenced by the social context in which the technology is used (Brey, 2009). Mild forms of social constructivism, like the stronger variants, retain conventional distinctions between the social and the natural, and between the social and the technical (Brey, 2009).

3.2.3 Actor-Network Theory [ANT]

Actor-Network Theory [ANT] further extends concepts relating to social constructivism and can be traced back to prominent STS scholars Bruno Latour, Michael Callon, and John Law. Their work attempted to disengage social constructivism from an overemphasis of human influences on social processes through extending the constructivist approach of meaning making to non-human things and components (Feenberg, 2017; Sismondo, 2007). Consequently, ANT can be positioned on the 'weaker' end of the continuum of social constructivism (Baron & Gomez, 2016) and has been referred to as a type of pan-constructivist ontology (Lynch, 2016). This means that while technological determinism regards technology as the main cause of change, and social constructivism argues that people shape technology according to their needs (Lower, 2006), ANT considers the mutual influence of people and technologies in social processes and knowledge production. Thus, by highlighting the importance of material artefacts, ANT foregrounds technology as a significant focus of STS scholarship, arguing that society and technology constantly influence each other.

3.3 Beyond Technological Determinism and Towards ANT

STS, encompassing strong [e.g., SCOT], mild [e.g., SST] and weak [e.g., ANT] approaches to social constructivism, seeks to demonstrate the limitations of technological determinism through developing empirically rich historical or ethnographic research to show the deeply social processes of technological development (Wyatt, 2008). This incorporates a broad range of contemporary research interests including health, climate change, education, economic innovation, and political studies. Consequently, STS has become a recognised and respected domain of intellectual activity and an established field of scholarship in its own right (Jasanoff, 2017; Monberg, 2005). In education, especially ECEC, technological determinism remains an implicit starting point for much research concerning young children and digital technologies (Lindahl & Folkesson, 2012; Schriever et al., 2020). This includes framing studies in terms of the ongoing impacts of technologies on various aspects of children's development (Dong & Newman, 2016), or the positioning of technologies in education as tools used by educators in the achievement of particular Learning Outcomes (AGDE, 2022).

A limitation of technological determinism in ECEC research is that it fails to account for the complexity of the post-digital as lived by young children in their multiple interactions with technologies, for social purposes [e.g., communicating and playing] over the course of any given day. Social constructivism, centring attention instead on the social construction and manifestation of technologies, shifts attention to how, where and why young children interact with technologies. As the post-digital has arrived as a moment in human-history, technological determinism has reached the limits of theoretical usefulness in ECEC research, and alternative theoretical frameworks are now necessary to interpret young children's lives with technologies, and how they can be most appropriately supported via ECEC to live with and make sense of the digital. Within the context of this thesis, the selected theoretical perspective for this task noting the complexity of technology integration in ECEC [via tinkering with unplugged technologies as a form of play-based learning] is that of Actor-Network Theory [ANT].

3.4 Actor-Network Theory

Actor-Network Theory [ANT] primarily espoused by Bruno Latour (2005) holds that networks comprise both material and social agents and that these agents impose or act upon each other in various ways to manifest particular relationships between people [e.g., young children and technologies]. There are several core constructs relevant to understanding ANT, including Actors/Actants and Agency, Actor-Network, Generalised Symmetry and Translation.

3.4.1 Actors/Actants and Agency

In ANT, non-human things, along with humans are all called ‘actors’ or ‘actants’- terms which are often used interchangeably in the literature. Non-human encompasses any ‘thing’ which makes up reality such as technology, animals, plants, texts, architectures, and environments (Michael, 2017). Some scholars, including Latour (2005), advocate for using the term actant “to overcome the cultural anthropomorphic connotations of the term actor” (Loke & Kocaballi, 2016) to imply a sense of neutrality rather than that associated with the more human centred term ‘actor'. This thesis uses the term actant to refer equally to both humans and non-humans.

ANT at its core is based on a rejection of fixed essentialist dualisms and avoids making distinctions between the human and the non-human, as well as differentiating between the social and natural, the technical and the social, and between the material and the cultural (Latour, 1999). According to ANT scholars, non-human actants should not be viewed as separate or distinct to humans (Fenwick & Edwards, 2010) but instead afforded potential for equal agency (Feenberg, 2017). Agency in ANT terminology refers to an ability to exert influence or effects over others [e.g., human or non-human]. Consequently, any entity that makes a difference to or has an effect on something else can be defined as an actant (Loke & Kocaballi, 2016). Latour suggests that an actant “is what is made to act by many others” (Latour, 2005) postulating that actants can only act in combination with other actants (Cresswell et al., 2010) within heterogenous constellations that afford the possibility of action (Latour, 2005).

From an ANT perspective, agency is viewed as a distributed achievement “emerging from associations between human and non-human entities (the actor-network)” (Müller & Schurr, 2016, p. 218). According to Latour (2005), actants are described as having certain interests which they try to progress by forming associations or connections with other actants in order to influence them. ANT seeks to examine the formations of those associations between actants and views these associations as relational effects on social processes (Fenwick & Edwards, 2010). Consequently, tracing “the processes by which these associations are built, maintained and severed is at the heart of ANT” (Müller & Schurr, 2016 p. 218), providing insight or understanding into how technological and social relationships are mapped into action or being. ANT positions humans alongside technical and material objects within a complex web of associations (Bilodeau & Potvin, 2018) tracing how they all come to be connected and entangled (Fenwick & Edwards, 2011). Accordingly, the focus in ANT is on the socio-material and the relations between actants which constitute the social world (Fenwick & Edwards, 2011) where all actants can be viewed as relational effects. Understood from a relational perspective, within ECEC considering the problem of digital technology integration alongside historical beliefs about play, an educator could be viewed as an actant and be understood as a relational effect comprised of their professional learning, experience, beliefs and attitudes about technologies, approaches to play-based learning and intentional teaching (Fenwick & Edwards, 2011). At the same time, an educator as actant could be considered as being a relational effect of the digital resources available to them in the ECEC setting with children.

3.4.2 Actor-Network

ANT considers effects and associations constituted by ‘networks’ which are assemblages or entanglements of human and non-human/material actants as well as abstract non-material actants such as culture and values (Latour, 2011; Matthews, 2021; Michael, 2017). All actants have agency and try to influence each other so as to align with that agency. ANT thereby assumes that every actant needs a network of other actants to further their goals (Lower, 2006). Consequently, actor-networks are sometimes described as “logically grouped entities associated or linked with one another via some relations” (Luck, 2008).

In education research using ANT, an actor-network is viewed as a mode of inquiry which makes visible the associations and effects required for an entity to exist (Latour, 2011). An ECEC example is the work of Rissanen (2020) who explored preschool art education in an ECEC centre in Finland. Rissanen (2020) focused on the children’s photography talk as networks of human actants [e.g., children], non-human material actants [e.g., cameras], and a range of other actants such as the children’s language and feelings. This showed that young children’s photography is a practice of visual meaning-making whereby agency is considered distributed amongst the range of actants comprising the activity. In another ANT inspired study with young children, Moberg (2018) traced young children’s funds of knowledge as a concept acted through its relations between children, Minecraft™ figures, carpets, boxes, schedules, and teachers in a preschool in Sweden. This study made visible the ways which children’s funds of knowledge in a Swedish ECEC setting drew on and evolved from young children’s home-based interests and were manifest as doings in their preschool activities. In another study, Fenwick (2010), drawing on a range of ANT studies of education policy discussed the use of ANT as beneficial to illuminating education standards as networks of socio-material performances, where standards were conceptualised as relationally enacted in everyday practices, configuring multiple worlds and ontologies.

Tracing associations or webs of interconnections between actants is a key aim in ANT (Latour, 2005). In education research, ANT provides insights into how assemblages of actants constitute relational effects as they come together to produce knowledge, ideas, identities, rules, routines, policies, instruments, and reforms (Fenwick & Edwards, 2010; 2011). Moreover, it is not the actants themselves that tend to be the focus of inquiry in ANT, but the connections between them through which they act (Bilodeau & Potvin, 2018). ANT therefore can be used to understand the way that networks are configured and reconfigured over time, and how actants are enrolled in networks and 'act' (Cresswell et al., 2010; Fenwick & Edwards, 2010). In this thesis ANT, in terms of the actor-network, suggests potential for identifying the network of activity in which children's tinkering with unplugged technologies [defined in Section 3.6] as a form of play-based learning may manifest as an illustration of the post-digital. Thereby showing where the digital and non-digital are related, especially when educators use tinkering with unplugged technologies as an entry point into integrating technologies into ECEC.

3.4.3 Generalised Symmetry

The principle of symmetry whereby humans and non-humans are analysed within the same conceptual framework is important in ANT. Generalised symmetry means that all heterogenous actants within a network are afforded equal potential for agency by paying equal attention to and studying both humans and non-humans as they are connected within an assemblage (Feenberg, 2017). Agency refers to any influences of humans and those ascribed to non-humans which produce associations and relational effects (Stalph, 2019). As a result, agency is an outcome of an actor-network and not the "inherent (essential) property of any particular kind of agent, either human or machine" (Jones, 2018). Consequently, rather than thinking about non-humans as resources or passive entities to be acted upon by humans, such entities are positioned as capable of initiating and guiding social encounters and practices (Kind, 2013). Generalised symmetry is therefore applied to all actants with the intent of “levelling divisions usually taken to be foundational” (Law, 2007, p. 597). ANT scholars argue that human agency should not be privileged over the agency of non-material things that support the networks in which society exists (Feenberg, 2017). Consequently, both humans and non-humans are considered equal and ontologically flat actants (Stalph, 2019), making up a single layer of associations between human and non-human entities (Michael, 2017). By creating symmetry between humans and non-humans, ANT considers that humans assembled around and entangled with non-humans constitute society.

Latour (2014) extends the notion of generalised symmetry to concepts relating to the digital, arguing that digital and analogue are not separate discrete dimensions of reality but instead are part of an assemblage of heterogenous actants which incorporates the physical, material and tangible, as well as human. Similar to concepts of the post-digital, Latour (2011) refutes claims of a digital/analogue divide as fallacy arguing that the digital is fully dependent on the material condition, and that the expansion of digitality over the last decades has in fact increased the material dimensions of networks because,

> “the more digital, the less virtual and the more material a given activity become. Nowadays, everyone knows that there is no GPS without three satellites; collective games without fast connections; drones in Pakistan without headquarters in Tampa, Florida; bank panic without Reuters screens; and so on” (Latour, 2011, p. 802).

Moreover, Latour (1999) argues that digital technology and humans have developed a “deepened intimacy, a more intricate mesh” (Latour, 1999, p.196), and that these associations are tightly interwoven and interdependent within sociotechnical environments. The term sociotechnical suggests that "technology is never purely technological: it is also social. The social is never purely social: it is also technological" (Bijker & Law, 1992, p. 305). Sociotechnical environments then can be viewed through an ANT lens as assemblages of connected entities such as humans, non-humans, new ideas, values, interests, specialised knowledge, institutions, and regulations, in any given situation (Bilodeau & Potvin, 2018; Stalph, 2019).

Criticism of ANT in relation to concepts around generalised symmetry include that ANT fails to adequately take into consideration human intentions, interests, morals, learning, backgrounds, culture, and previous experiences when considering agency, and likewise fails to consider the inherent attributes of objects which reflect their history and shapes their roles in a network (Cresswell et al., 2010; Miettinen, 1999; Mills, 2018). Moreover, by adhering to concepts of generalised symmetry, ANT has been critiqued as overtly challenging because "the weight of history and culture is so great to privilege human intentions and agency, putting humans at the centre of things rather than being part of them" (Fenwick & Edwards, 2010, p. 9). Harman, (2007) however, argues that the principle of generalised symmetry provides a useful philosophy where 'a total democracy of objects replaces the long tyranny of human beings' (Harman, 2007, p.36). Within ECEC, especially pertaining to technologies in children's learning, the principle of generalised symmetry offers an important reminder not to overlook the presence of material [e.g., unplugged technologies] or non-material [e.g., children's funds of knowledge] in preference to human intentions [e.g., educator beliefs and attitudes about technologies].

3.4.4 Translation

Translation is a central concept in ANT and is used to describe what happens when actants come together and connect, "changing one another to form links" (Fenwick & Edwards, 2010, p. 9). Connections or links between actants bring them together as a network. Connections are often referred to as associations and represent any form of effect between actants (Payne, 2017). Consequently, to form connections, actants work upon other actants to translate or change the other into part of the network, thereby enrolling the actant into "a collective or network of coordinated things and actions" (Fenwick & Edwards, 2010, p. 9). During translation, different actant goals and interests are aligned or realigned. This means that the interests of all the various actants are 'translated' so that each actant understands its purpose in an actor-network. Translation involves the aggregation or generation of new connections between actants which did not exist previously, and which consequently can change those actants. According to Law (2009), translation can relate, define, and order humans and non-humans within networks. Latour (2005) offers an approach to understanding how translation works in an actor-network by distinguishing between intermediaries and mediators, each of which circulate or inscript themselves through networks to perform specific functions.

3.4.4.1 Intermediaries

An actant can function as a neutral intermediary to transport meaning or effects to other actants without changing or transforming that meaning (Caldwell & Dyer, 2020; Latour, 2005). Intermediaries therefore are actants which can translate thinking and behaviour required to perform specific and consistent practices in a network (Fenwick & Edwards, 2010), for example tinkering with unplugged technologies as a form of play-based learning. Callon (1990) refers to intermediaries as anything "passing between actants which defines the relationship between them" (Callon, 1990, p. 134) and cites examples including computer software, scientific articles, disciplined human bodies, technical artefacts, contracts, and instruments. Intermediaries then can take many forms and are vital to the construction of an actor-network because they "define and distribute roles to humans and non-humans" (Callon, 1990, p. 137).

A special type of intermediary is an immutable mobile (Nespor, 2002). Immutable mobiles are a self-contained objects where processes of translation and myriad negotiations between actants are rendered invisible to embed "a history of network constructions, struggles and mediations which have settled into one fixed representation" (Fenwick, 2010, p. 123). They are objects and in many cases technologies that act to standardise and reproduce actions in different places (Law, 2002). According to Latour (1987), as described by Law and Singleton (2005) immutable mobiles are actants that can circulate networks maintaining their physical and geographical shapes, while at the same time holding their relational and functional shapes to stablise a network of associations. They do this through transporting "reliable, routine and rule-bond interactions between actors" (Caldwell & Dyer, 2020, p. 953) to enact long-distance control and maintenance of constancy which enable networks to hold themselves together,

> "Codes, information, people such as technicians, soldiers or bankers, technological bits and pieces such as ships or scientific instruments, texts such as orders, newspapers or money orders—if objects such as these are able to hold their relational shape as they circulate around the globe, then long-distance control is a possibility" (Law & Singleton, 2005, p. 335).

Moreover, according to Michael (2018), immutable mobiles enforce particular rules of use to get them to function whereby specific capacities and skills need to be incorporated by other actants.

3.4.4.2 Mediators

Mediators also aid in translation and circulate throughout a network. Mediators can be human and non-human actants which actively work on other actants to modify meanings and relationships. Mediators can form new links or associations between actants and prescribe or prevent certain behaviours and actions, for example children's funds of knowledge about technologies derived from their lived experiences in the post-digital. Mediators, unlike intermediaries, can be more unpredictable and transform or modify meaning or relationships between actants (Baron & Gomez, 2016). For example, children's funds of knowledge modifying how educators perceive or understand the role of technologies in ECEC. Latour (2005) says there are many mediators circulating around any actor-network that can lead in multiple directions. According to Latour (2005), sometimes a mediator can turn into an intermediatory and vice versa. For example, when children's funds of knowledge prompt educators to view technological learning opportunities as necessary in ECEC. Funds of knowledge as mediator may then act as intermediary to transport pedagogical meaning into the integration of technologies in ECEC over and above educator beliefs and attitudes about technologies as insufficiently aligned with traditional understandings of play.

3.4.4.3 Inscription

Inscription can be understood as a type of intermediary which is circulated in practice through translation (Callon, 1990; Muniesa, 2015). Inscription requires the creation of artefacts that transport programmes of action required to achieve the interests of an actor-network that had previously been translated (Lower, 2006) [e.g., approaches to play-based learning that address intentional teaching in ECEC]. Consequently, inscription are forms of embodied translation that codify meaning critical to the development of an actor-network (Booth et al., 2016), but without necessarily changing that meaning. Inscription is generally viewed through entities such as texts or technical artefacts [e.g., curriculum mandated Learning Outcomes] which facilitate control and action over other actants from a distance, defining their roles in a network (Lower, 2006). Inscriptions can also be practices such as standards and regulations (Carroll et al., 2012) [e.g., assessing and documenting children's Learning Outcomes] which translate actants to undertake specific actions in a network [e.g., tinkering with unplugged technologies to action opportunities for children's play-based learning in the post-digital]. Inscription can therefore prescribe institutional practices, regulations, skills, and routines [e.g., Learning Outcomes] which direct actants to behave in certain ways.

3.5 Translation in Action

Translation enabled in action by intermediaries, mediators, and inscription expands and grows actor-networks. Translation can result in new sets of associations between actants as the interests and goals of those actants are adapted and aligned to join an actor-network (Lower, 2006). Translation can occur in different ways within actor-networks, however Callon (1984) posits that translations generally pass through several similar stages.

Problematisation is described by Callon (1984) as the first phase in a translation process and occurs when actants with a common interest are brought together [e.g., play-based learning and unplugged technologies] and the initial purpose for the formation of the network is defined [e.g., to examine the capacity of tinkering with unplugged technologies as form of play-based learning to support children's lived experiences in the post-digital]. In this stage, a more dominant actant [which can include mediators or intermediaries] may emerge to establish itself as a type of gatekeeper between other actants during the formation of the network. Callon (1984) refers to this gatekeeper role as an Obligatory Passage Point. An Obligatory Passage Point is an actant that positions itself as indispensable to that particular actor-network and modifies other actants to align with its own needs (Booth et al., 2016). For example, detailed in Chapter Six Section 6.3, play-based learning performs as a dominant actant [Obligatory Passage Point] indispensable to the achievement of children's Learning Outcomes within the EYLF V2.0 (AGDE, 2022). The Obligatory Passage Point invites and tries to attract other actants to "detach themselves from their existing networks and negotiate their connection and role in the emerging new network" (Fenwick & Edwards, 2010, p. 14). Generally, the process of passing through a passage point comprises the second phase in translation and is referred to as *interessment.* Interessment involves persuading other actants into accepting their various roles which have been defined for them by the Obligatory Passage Point in the new or extended actor-network.

If the stage of interessement is successful, then the next phase of translation, enrolment, can occur. Enrolment occurs when the actants align themselves to the new roles defined for them and thus become engaged in new behaviours in the actor-network (Booth et al., 2016; Carroll et al., 2012) [e.g., play-based learning and tinkering with unplugged technologies defined by funds of knowledge as opportunities for children to participate in post-digital forms of play]. Some actor-networks pass through a fourth phase of translation called *mobilisation*. Mobilisation is when the actants in the actor-network recognise and reaffirm that their roles and interests converge with the other actants in the actor-network (Booth et al., 2016). This can lead to the network becoming stable and durable enough to extend its translations to other locations and domains (Fenwick & Edwards, 2010) [e.g., the uptake of various forms of intentional teaching, such as sustained shared thinking, in diverse ECEC settings]. Mobilisation can eventually result in a network becoming stabilised and taken for granted, a situation called black boxing.

ANT thus offers potential to explore how actants persuade, resist, coerce or compromise each other as they come together “in ways that lock them into a particular association” (Fenwick & Edwards, 2010). In the context of the research reported in this thesis, ANT is utilised to understand the particular actants associated with educator integration of technologies in ECEC [via tinkering with unplugged technologies] as a form of play-based learning in response to young children’s lived experiences in the post-digital.

3.6 Defining Unplugged Technologies

Recent literature suggests that use of unplugged pedagogies with young children has become a popular play-based learning practice for supporting children’s computational thinking (Huang & Looi, 2020; J. Lee & Junoh, 2019; Metin, 2020; Sendurur, 2019). Unplugged pedagogies do not require educators and children to access the internet or other working technologies, thus addressing resources and technical support as barriers to technology integration in ECEC [e.g., Plumb & Kautz, 2015]. Instead, unplugged pedagogies involve the implementation of concrete objects and tangible materials with children that are easily accessible and sourced (Looi et al., 2018; Metin, 2020). Examples of unplugged pedagogies reported in the literature include sorting plastic cups from heaviest to lightest (Looi et al., 2018), manipulating objects such as beads into patterns (Otterborn et al., 2020), verbalising movement sequencing instructions to other children [dressed as robots] during role play (Otterborn et al, 2020) and patterning and sequencing with LEGO blocks (Saxena et al., 2020). Core aspects of unplugged pedagogies that are likely to resonate with ECEC educators are that they enable hands-on activity by children, offer high levels of engagement with peers and adults in playful contexts, are easy to implement and offer opportunities for storytelling (Nishida et al., 2009). For some early childhood educators, using unplugged pedagogies align with key developmental and constructivist (Piaget,1951), constructionist (Papert, 1987) and social cultural thinking (Vygotsky, 1967) and have been used to implement the foundations of basic computational thinking with children without relying on digital devices (Battal et al., 2021; Bell & Vahrenhold, 2018; Metin, 2020).

Aligned with thinking around unplugged pedagogies, unplugged technologies are materials offered to young children that may be representative of the digital, or manipulated as representations of the digital, but are not necessarily operational as technologies. The research reported in this thesis uses unplugged technologies to transcend the binary divide between the digital as real and virtual, instead offering [in a post-digital sense] "fluidity between 'real' and 'virtual', human and machine" (Tesar & Hood, 2019, p. 103). For the purposes of this research, the term unplugged technologies is therefore defined as formerly working digital artefacts which no longer function or have been decommissioned. Examples of unplugged technologies as used in the research reported in this thesis, include computer keyboards, computer mice, computer cases [chassis] as well as video gaming controllers. Unplugged technologies in this study are artefacts that are literally 'unplugged', nonoperational and disconnected; but which are figuratively responsive to young children's lived experiences in the post-digital.

3.7 Conclusion

In ECEC research involving young children and technologies, technological determinism has often been used as an implicit framework for defining technologies. This has resulted in research that examines the impact of technologies on young children or highlights the role of technologies as tools in teaching and learning with young children. As the post-digital has evolved as a time in human history where technologies are interlaced with social practice, the assumption that technologies are primarily determinant of what happens to children no longer holds as a feasible ontological distinction. The post-digital moves away from thinking about reality as comprising discrete independent domains with defined boundaries, towards embracing networks or assemblages of things [technologies, people, and culture] which are merged and continuously shifting (Hood & Tesar, 2019). While characterising a moment in human history, the post-digital does not signify a time in which people are considered beyond technologies. Rather, the post-digital acknowledges the continuous state of evolving human and non-human social contexts in which technologies have long been part (Cramer, 2014), and recognises how the digital is already “embedded in and entangled with existing social practices” (Knox, 2019, p. 358).

In this thesis, STS, noting ANT as a ‘weak’ version of this social constructivist way of thinking is used to examine how educator integration of technologies in ECEC is comprised or networked with a range of related actants, including play-based learning, children’s funds of knowledge [e.g., lived experiences in the post-digital], and educator identified Learning Outcomes associated with children’s tinkering with unplugged technologies. ANT, providing insight into these networks, suggests potential for understanding how ECEC educators may navigate the post-digital with children in practice. In the next chapter of this thesis, the methodology used to conduct the research, working closely with educators in the provision of play-based learning via children’s tinkering with unplugged technologies is detailed.

CHAPTER 4 : METHODOLOGY

4.1 Introduction

The chapter begins with an overview of conventional approaches to research methodology, and from there introduces ideas relating to post-qualitative inquiry. Post-qualitative inquiry is positioned as a pathway within which to frame research influenced by concepts derived from posthumanism and, by extension, ANT inspired ideas. ANT was used in this study to examine how educator integration of technologies in ECEC is comprised of a range of related actants, including play-based learning, children's funds of knowledge and educator identified Learning Outcomes associated with children's tinkering with unplugged technologies. Participatory co-design, a research approach which originally problematised technological determinism as a way of understanding the relationship between people and technologies and went on to foreground human representation within this relationship, is then introduced as the methodological design of this research. Details of the participatory co-design process adopted by this research are subsequently presented. The methods of data generation are discussed in detail, and the approach to data analysis generating the findings which inform this study is then presented.

4.2 Approaches to Research Methodology in Education

Approaches to research in education are underpinned by philosophical assumptions which serve as frameworks or paradigms to guide a researcher's journey of inquiry (Creswell & Guetterman, 2021; Jonker & Pennink, 2010). The term *worldview* is often used interchangeably with *paradigm* and *philosophical assumptions*, all of which refer to an orientation about the world (Creswell, 2018) or way of thinking (Kuhn, 1962). In research, a worldview acts as a basic set of beliefs informing action and methodological choice (Denzin & Lincoln, 2017). When embarking on a project, researchers bring their own worldviews [constituting their beliefs and principles which shape how they see the world] to an inquiry which influences the practice of that research (Creswell, 2018; Wahyuni, 2012). The research process is further strengthened by types of research designs which are related to and aligned broadly with these worldviews (Creswell & Guetterman, 2021). Consequently, worldviews, choice of research design, and selection of research methods are interconnected. In educational research, a researcher's worldview incorporates their perspectives on the nature of reality [ontology], their position on how they know what they know [epistemology], the values a researcher brings to the research [axiology], and how the researcher acquires that knowledge, i.e., the methods incorporated throughout the research process [methodology] (Creswell & Guetterman, 2019; Denzin & Lincoln, 2017; Hatch, 2002).

Ontology is related to how a researcher perceives the nature of reality (Creswell, 2003) and is concerned about the form and nature of that reality (Guba & Lincoln, 1994). The term defines what a researcher views as real in the world, whether that be physical and/or material and external to the researcher, and/or abstract concepts within the researcher's mind (Schuh & Barab, 2007). According to Crotty (2003), ontology refers to the kind of world under investigation, the nature of existence and the structure of reality. Ontology is consequently integral to the formation of a worldview because it provides an understanding of the things that make up the world as it is known by the researcher.

Epistemology is concerned with the philosophical theory of knowing (Denzin & Lincoln, 2017) and relates to how a researcher knows what they know (Creswell, 2007). Epistemology thus relates to the nature of the relationship between the researcher and what can be known (Guba & Lincoln, 1994), and forms the very basis of knowledge, exploring "its nature, and forms, and how it can be acquired, and how it can be communicated to other human beings" (Kivunja & Kuyini, 2017, p. 27). Consequently, epistemology focuses on what knowledge is and how it is obtained (Brinkmann, 2017; Creswell, 2007). It provides a philosophical grounding for deciding what kinds of knowledge are possible and for ensuring that knowledge is adequate and legitimate (Maynard & Purvis, 1994). Epistemology is a way of understanding and explaining how researchers know what they know (Crotty, 2003).

Axiology refers to the ethical considerations and role of values when conducting research (Creswell, 2007) and involves conducting a moral stance in the world (Kivunja & Kuyini, 2017). It relates directly to the examination of the nature of values and subsequent value judgement (Jonker & Pennink, 2009). Thus, axiology encompasses the role of values in research, positioning the researcher's stance in relation to participants studied (Wahyuni, 2012). Methodology refers to "the logic and flow of the systematic processes followed in conducting a research project, so as to gain knowledge about a research problem" (Kivunja & Kuyini, 2017, p.28). Methodology is related to how a researcher can go about finding out what they believe can be known (Guba & Lincoln, 1994), and can consequently be viewed as a model or approach within which to conduct research in the context of a specific worldview (Creswell, 2007; Wahyuni, 2012). In other words, methodology focuses on the best means for gaining knowledge about the world (Denzin & Lincoln, 2017) relating to a particular phenomenon.

A researcher's worldview thus encompasses four key elements: ontology, epistemology, methodology and axiology (Denzin & Lincoln, 2017; Guba & Lincoln, 2000) which influence how knowledge is discovered and analysed in systemic ways. Worldviews can be generally grouped into typologies, with each holding assumptions related to their stances on ontology, epistemology, and axiology. Those assumptions inform a researcher's methodological practice (Denzin & Lincoln, 2017) as quantitative, qualitative, or mixed methods. Quantitative research explains phenomena according to numerical data which is analysed through mathematically orientated methods such as statistics (Creswell, 2018; Yilmaz, 2013), and is viewed as a type of empirical research which tests objective theories consisting of variables which are generally measured by instruments. Researchers who engage in quantitative inquiry "have assumptions about testing theories deductively, building in protections against bias, controlling for alternative or counterfactual explanations, and being able to generalize and replicate the findings" (Creswell, 2018, p. 3). Informed by philosophical approaches relating to positivism and post-positivism, quantitative approaches incorporate numerical data, closed ended questions and close ended responses to test or verify existing hypothesis (Creswell, 2018). Historically, quantitative approaches dominated social and educational research "prioritising the ideal of the experiment, the use of standardised tests and 'systematic' observation, survey data, and statistical analysis" (Hammersley, 2012, Changing Paradigms section, para. 2) until the 1970s when growing debate challenged the prevailing quantitative hegemony steeped in quantification (Hammersley, 2014).

In the 1980s through processes of challenge to the dominance of quantitative methodologies there followed a growth in the influence of qualitative research which evolved "as a general style, approach, or 'paradigm' in social science (Hammersley, 2014, p. 11). Qualitative methodologies advocate for the importance of exploring phenomena in the 'real' world through observations and participant accounts enabling insights into multiple perspectives and realities. Qualitative research is generally characterised by "a set of interpretative, material practices that make the world visible" (Denzin & Lincoln, 2017, p. 10). Researchers using this approach tend to examine things in their natural settings, "attempting to make sense of and interpret phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2017, p. 10). This involves exploring emerging open-ended questions and procedures, collecting data in the participant's natural environment, and inductively analysing data from specific to general themes (Creswell & Guetterman, 2021). A qualitative approach is generally typified by narrative descriptions and open-ended questions to "identify meaning-relevant kinds of things in the world" (Denzin & Lincoln, 2017, p. 36).

Qualitative research can be viewed as an overarching category informed by a wide variety of philosophical paradigms, research designs and methodologies, and an array of methods (Creswell, 2013; Denzin & Lincoln, 2017).

Mixed methods research involves combinations of both quantitative and qualitative data to yield insights beyond using quantitative or qualitative data alone (Creswell, 2018; Tashakkori & Teddlie, 2016). In this approach statistical analyses are often combined with narrative descriptions based on interviews and participant observation (Creswell & Guetterman, 2021). Often philosophically underpinned by pragmatism, mixed method approaches generally tend towards either quantitative or qualitative methods as playing a more dominant role (Denzin & Lincoln, 2017).

The literature suggests that quantitative, qualitative, and mixed method approaches to research should not be viewed as strict dichotomies but should instead be conceptualised along a continuum of worldviews which evolve, change, and sometimes merge over time according to shifting philosophical debate (Creswell, 2021). For example, Creswell (2018) and Mertens (2019) highlight four worldviews that are often cited in the literature: 1) post-positivism knowledge claims; 2) constructivism; 3) transformative knowledge claims; and 4) pragmatic knowledge claims. Denzin and Lincoln (2017) offer a categorisation of major paradigms into positivism, post positivism, critical theory, constructivism, and participatory action frameworks. According to Denzin and Lincoln (2017), perspectives of feminism, critical pedagogy, cultural studies, critical race theory, queer theory, disability theories as well as posthumanist, materialist perspectives further align within this range.

The historical evolution of paradigms has been subject to periods of tension and flux over the decades as scholars, aligned to specific worldviews, have striven to assert their influence and champion their approaches (Denzin, 2010). This is often referred to in the literature as the ‘Paradigm Wars’ (Brinkmann, 2017; Denzin & Lincoln, 2017; Creswell, 2021; Hammersley, 2014) signifying intense debate about the compatibility between worldviews and research methods (Creswell & Guetterman, 2021). Over time, the shape and characteristics of these paradigm typologies have and continue to evolve, undergoing reconfiguration according to methodological debate and multiple discourses (Denzin & Giardina, 2017; Nespor, 2006). This has been particularly evident within qualitative worldviews where discourses have blurred to produce hybrid paradigms alongside new geographies of knowledge and new decolonizing epistemologies (Denzin & Giardina, 2017, p. 7).

4.3 Situating 'Post' Qualitative Inquiry

According to Denzin and Giardina (2017), qualitative inquiry is "an open-ended project moving in many directions at once, which leads to a perpetual resistance against attempts to impose a single, umbrella-like paradigm over the entire project" (p. 7). Such interpretative research is therefore often in a state of flux and reinvention (Denzin & Giardina, 2017), and in more recent times has proliferated into "a rainbow coalition of racialized and queered post-isms" (Denzin & Lincoln, 2017, p.ix). This coalition reflects an emerging movement towards what scholars are calling *post-qualitative inquiry* or post-qualitative thinking, a term originally coined by Elizabeth St. Pierre (2014b). Post-qualitative thinking provides an alternative approach to social inquiry strongly influenced by perspectives of posthumanism (Lupton & Watson, 2021) which expand the possibilities for qualitative research beyond only seeking the perspectives of participants as an entry point into 'reality' (Nordstrom & Ulmer, 2017). According to St. Pierre (2014a), post-qualitative thinking accommodates "the 'new' work coming out of recent ontological, and material turns, work that has organized itself differently as, for example, actor network theory" (St. Pierre, 2014a, p. 13). Here, concepts in 'post' theories are used to critique conventional humanistic ontologies, epistemologies, and methodologies historically used in research (Giardina, 2017;

Nordstrom & Ulmer, 2017; St Pierre, 2014b). Post-qualitative thinking challenges traditional worldviews that uphold divisions between, for example, the human/non-human, and nature/culture (Mazzei & Jackson, 2012) and consequently call for an ontological reassessment of how the world comes into being (Kuby, 2019) via multiple realities, truths, and voices (Hodgens, 2019).

In conventional approaches to research, ontology [being] and epistemology [knowing] can be considered distinct practices. Post-qualitative thinking however offers a more integrated perspective where ontological and epistemological binaries are dissolved and considered as an entanglement of being and knowing (Barad, 2007; St Pierre, 2013). This notion of entanglement is based on the post-qualitative worldview [aligned with concepts relating to ANT] of ontology and epistemology as not isolated but enmeshed and co-constituted through actor-networks. Actor-networks are considered as assemblages or connections of elements which produce effects and associations, or webs of interconnections (Fenwick & Edwards, 2010; Latour, 2005). From an ANT perspective, every ‘thing’, be that human, non-human, concepts, ideas, processes and/or practices, can be viewed as a relational effect. According to Latour (2011), actor-networks represent modes of inquiry which illuminate the specific effects and associations required for an entity to exist. Consequently, tracing those associations and the interconnections occurring between actants is a key aim in ANT (Latour, 2005). This process of tracing associations and interconnections is core to the research reported in this study, seeking to identify the particular actants associated with educator integration of technologies in ECEC via tinkering with unplugged as a form of play-based learning in response to young children’s lived experiences in the post-digital.

From an ANT perspective, ontology and epistemology are not positioned by the researcher as distinct separate ‘things’ and external to the world because “ ‘we’ are of the world” (Barad, 2003, p. 828). Instead, ontology and epistemology are considered relational, emerging from enactments of associations, where humans and non-humans are "already entangled with each other in becoming, in making, in creating realities (the world)" (Kuby & Rowsell, 2017, p. 288). Within the realm of ANT, entanglement suggests a 'flat' ontology where subject, object, human, non-human, researcher, and theory are always evident and come into existence via non-hierarchical assemblages (Kerasovitis, 2020; St Pierre, 2014a; St Pierre, 2013). According to St Pierre (2014a), "we cannot separate out the human subject in posthuman, new empirical, new material, post-qualitative inquiry. Our responsibility is no longer to the privileged human but to the assemblage" (p. 22). Here, agency is constituted as an enactment of the assemblage as a whole "not something that an individual possesses, nor something that relies on a demarcation between human/non-human" (Mazzei & Jackson, 2017, p. 133). Instead, agency is seen as a togetherness "an in-between, a force, a flow with humans, non-humans, and more-than-humans" (Kuby, 2019, p. 133). Agency from a post-qualitative perspective can be understood as relational through its associations with other actants. It is not created or held by any one actant, instead it is collectively generated (Jackson, 2013).

Agency as a relational effect repositions the human in ways that acknowledges the fluidity of all actants, thereby ensuring careful consideration of elements within research-identified assemblages. Post-qualitative thinking replaces notions of an individual human to non-human binary with understandings of the collective assemblage of heterogenous actants co-constituting matter (Wells, 2021). This decentres humans "as the origin of all knowing and being" (Kuby, 2019, p. 133) and extends notions of the human subject beyond a "singular branding" (Wells, 2021, p. 173). The post-qualitative space, as a result, shifts traditional theories of the human subject "from an epistemology of human consciousness to a relational ontology" (Lather, 2016, p. 125).

Post-qualitative thinking has been embraced by some ECEC scholars to offer a "paradigmatic shift from thinking of human subjects as biological beings to considering them bound in a technological totality" (Marsh, 2017, p. 79). Adopted within variants of the ECEC digital technologies literature, post-qualitative perspectives have been utilised to explore young children's multimodal and digital literacy (Kuby, 2019), play with digital apps (Holloway et al., 2019; Marsh, 2019a), and young children's creativity in digital contexts (Stevenson, 2020). Post-qualitative thinking, used in this manner provides an alternative approach to traditional monolithic paradigms such as constructivism (Dewey, 1997; Piaget, 1951) and social constructivism (Vygotsky, 1967, 1987) which have informed many approaches to ECEC education, including young children's play and interactions with digital technologies for decades. More recently however young children's day-to-day life experiences have become increasingly enmeshed with technology (Hood & Tesar, 2019; Jayemanne et al., 2015; Nansen et al., 2019a) bringing children and their adults to the point of living in the post-digital. Post-qualitative thinking provides an opportunity for researchers to move beyond relying on what was once considered a stable ontological position (Stevenson, 2020), towards better understanding young children's lived experiences in the post-digital (Kuby, 2019; Marsh, 2017; Marsh et al., 2016). In this manner, post-qualitative thinking helps researchers to "address, respond to and engage with the realities of 21st-century children" (Hodgens, 2019, p. 1).

4.4 Participatory Co-Design

Originating in Scandinavia in the 1970s and 1980s, participatory co-design has a rich history in the development of workplace technologies and arose in response to worker concerns about increased automation and new technologies in the workplace. At that time, proliferations of technological development in the workplace were viewed as deterministic forces towards economic productivity, sacrificing human values to unrestrained technological development. Consequently, feelings of worker disempowerment fostered cultures of social democracy and strong trade unionism in many Scandinavian countries, which advocated for increased participation of workers in technological development and decision making in the workplace.

Such advocacy resulted in the formation of partnerships with academics, trade unions, corporate entities, and software developers to empower workers to determine the shape and scope of new technologies in their places of work (Foth & Axup, 2006; Sanoff, 2007; Spinuzzi, 2005). Collaboration between diverse groups of people enabled social and technical research to focus on understanding the influence of communities and technologies in a manner that was “authentic, useful, fair, ethical and relevant” (Foth & Axup, 2006, para. 2) to both social and technological transformation. Collective decision making was both highly valued and decentralised throughout all sectors of the workplace (Sanoff, 2007) to enable researchers, developers, and workers to collaborate in the development and refinement of new technologies in their workspaces. In Norway, for example, technology experts and union leaders collaborated to enable workers to have more influence on the design and integration of computer systems into their workplaces (Spinuzzi, 2005).

Consequently, participatory co-design can be considered as a research approach which originally problematised the limitations of technological determinism and foregrounded human representation in understanding the relationship between people and technologies. Technological determinism suggests that technological and material forces shape and determine social events impacting behaviours and society in general (Sismondo, 2007). In rejecting technological determinism, participatory co-design is an approach to research which considers people and technology [e.g., heterogenous actants] in the co-development and co-determination of workplace practices, and in doing so provides nuanced understandings or insight into sociotechnical environments [e.g., the post-digital].

Participatory co-design focuses on “reassembling the social and building a common world, where democratic, ecological and political issues permeate everyday life, and design and technology are an integral part of it” (Storni et al., 2015, p. 149).

Participatory co-design can be viewed as an umbrella term capturing a broad approach to research (Robertson & Simonsen, 2012; Smith & Iversen, 2018). However, all approaches within this umbrella term acknowledge the participation and involvement of all actants in the design process (Steen, 2013). In recent decades, participatory co-design has expanded into a multitude of areas including community arts design, services design (Steen et al., 2011), public health (Ospina-Pinillos et al., 2018), engineering (Cockbill et al., 2019), and social research and education (Gros & López, 2016; Rauch et al., 2014; Robertson & Simonsen, 2012). Within education research, participatory design can include a range of non-human and human actants in design processes (Penuel et al., 2007), “for the creation of innovative teaching and learning practices, technological artefacts, and tools under educational reform goals” (Cober et al., 2015, p. 205). Participatory co-design in particular recognises students and teachers “as participants in the design of technology enhanced learning” (Matuk et al., 2016, p. 80) and curriculum innovations in real classroom contexts (Penuel et al., 2007). It is an approach to research characterised by the collaborative development of new curricular materials or digital pedagogies in co-operation with teachers and specialists in educational research (Westbroek et al., 2019).

Literature suggests that digital innovations in pedagogy can be strongly influenced by teachers’ beliefs and attitudes about their own classroom contexts and student needs (Cober et al., 2015; Penuel et al., 2007; Roschelle et al., 2006) as well as understandings of how these innovations can align with curriculum standards (Means et al., 2001). From an ANT perspective, teachers as actants can be viewed as relational effects comprising their training, experience, values, decisions about play-based learning, intentional teaching, children’s

Learning Outcomes and digital technologies – in addition to the effects of the relationships that have emerged with the children in their care. Consequently, teachers carry a wealth of relational associations, connections and insights which can be made accessible for examination through participatory co-design. Literature also suggests that when teachers contribute their tacit knowledge (Spinuzzi, 2005) and unique perspectives to pedagogical innovations involving technologies (Penuel & Gallagher, 2009), that the successful integration of the digital into the classroom settings is more likely (Matuk et al., 2016). Teachers as actants are therefore instrumental participants in the flat ontology regarding the integration of technologies into educational settings (Voogt et al., 2019) [e.g., ECEC].

Participatory co-design is typically characterised by cyclical phases of design and redesign (Barbera et al., 2017) where teachers as actants share practices with other teachers, and often in collaboration with researchers. Through processes of design, implementation and redesign, co-design is orientated towards the implementation of pedagogies [e.g., play-based learning and intentional teaching] within a network of actants involving humans [teachers, children, and researchers] and non-humans [e.g., unplugged technologies] (Westbroek et al., 2019). In educational settings such as ECEC, participatory co-design can be initiated and facilitated by a researcher [such as myself] who has overall responsibility and accountability for the project (Penuel et al., 2007). Key decision making generally rests with the researcher with levels of teacher participation varying according to the overall aim of the project (Matuk et al., 2016). There are a range of methods which are employed for data generation in participatory co-design, such as workshops, interviews, discussions and focus groups (Bergold & Stefan, 2012; Cook, 2012; Matuk et al., 2016). These methods are used to provide insight into how a network of heterogenous actants in any given situation operates [e.g., identifying the network of actants associated with educator integration of technologies in ECEC via tinkering with unplugged as a form of play-based learning in response to young children's lived experiences in the post-digital].

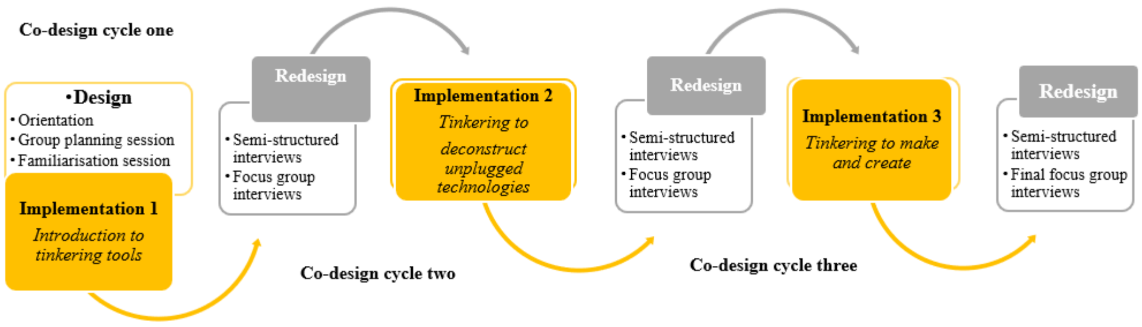
In the design process, the knowledge and perspectives held by participants are highly valued for generating insight (Eckhoff, 2019; Spinuzzi, 2005) into how and why digital technologies can be used by people. Participants in co-design bring together contextualised interpretations and their practical lived experiences (Cook, 2012) to construct new ways of doing and being in education, with these interpretations and experiences situated in an assemblage "of artifacts, practices and interactions" (Spinuzzi, 2005, p. 165). Thus, dialogue and interaction are central to participatory co-design where children, teachers, researchers and materials jointly build webs of association which emerge through shifting relations, directions, and interests. From an ANT perspective, participatory co-design is ideally placed for making visible, or helping to identify, the associations and effects where people [e.g., children and teachers] and things [e.g., unplugged technologies] as actants come together to produce knowledge, ideas, and new ways of being and doing (Fenwick & Edwards, 2010) [e.g., living and learning in the post-digital].

4.5 Methodology

The approach to participatory co-design used in this research involved three repeated cycles of design, implementation, and redesign [Figure 4.1]. Each cycle involved incorporating a range of materials with children using an intentional approach to play-based learning. Co-design cycle one focused on introducing children to tinkering tools; co-design cycle two focused on children tinkering to deconstruct unplugged technologies; and co-design cycle three focused on children's tinkering to make and create.

Figure 4.1

Three Co-Design Cycles



4.5.1 Co-Design Cycle One

Co-design cycle one in the design phase comprised of an orientation meeting with educators, a group planning session with educators and a familiarisation session conducted with children resulting in Implementation 1: Introduction to tinkering tools.

4.5.1.1 Orientation

To commence the project an orientation meeting was held with three participating educators. The orientation was conducted on Zoom and supported by a PowerPoint presentation detailing all aspects of the project [Appendix A]. The orientation was of approximately 60 minutes duration. The purpose of the orientation meeting with educators was to:

- Introduce and explain the research aims.
- Provide an understanding of how tinkering is defined in this research.
- Introduce the Pedagogical Play Framework as an intentional approach to play-based learning (Edwards & Cutter-Mackenzie, 2013).
- Describe the organisation and timeline of the study.

- Provide opportunities for educators to contribute feedback or ask questions.

Data was not collected during this session because the intention was solely to provide information to the educator participants. In line with the National Statement on Ethical Conduct in Human Research's [hereafter referred to as the National Statement] principle of 'Respect' for participants (National Health and Medical Research Council [NHMRC], 2007 - updated 2018), I as the researcher highlighted that educators could choose to withdraw at any time from the project without adverse consequences.

4.5.1.2 Group Planning Session

Following the orientation meeting, the educators and myself-as-researcher participated in a group planning session. This session introduced the actants, including human actants [e.g., educators and myself], material non-human actants [e.g., tinkering tools, unplugged technologies and playdough] and conceptual non-human actants [e.g., play-based learning and intentional teaching] into the participatory design process. The group planning session was conducted in a meeting room provided by the ECEC service of the participating educators. It was completed in one hour. The educators and I gathered around a long meeting table which facilitated social distancing, and in line with COVID-19 regulations, we all wore masks. The purpose of this workshop was to:

- Introduce the tinkering tools and unplugged technologies to the educators.
- Organise a time for familiarisation sessions with children in each of the educator's rooms where I introduced myself to the children and outlined the nature of the research.
- Facilitate discussion and generate ideas about how the educators would conduct 'Implementation 1: Introduction to tinkering tools' with the children.

During the group planning session, educators were first invited to explore the tinkering tools, unplugged technologies and playdough. Educators were encouraged to examine the physical properties [weight and feel] of the materials and their appropriateness for each class group of children during the Implementations. In addition, the educators and I discussed safety protocols for the children's tinkering with unplugged technologies in each of their classrooms. These protocols included the mandatory use of safety goggles by each participating child. Educators were then invited to discuss and plan how the conceptual non-human actants [e.g., play-based learning, intentional teaching, Learning Outcomes] could be integrated into Implementation 1. During this discussion, educators chose and planned for a type or combination of pedagogical play-types [open-ended play; modelled play; and purposefully framed play] to support the children's tinkering with unplugged technologies in the Implementations. Discussions relating to assessment, documentation and children's Learning Outcomes also formed part of the planning session, with educators explaining to me their usual approaches to assessing and documenting children's Learning Outcomes.

4.5.1.3 Familiarisation with Children

Familiarisation sessions with participating children occurred in each educator's classroom prior to Implementation 1: Introduction to tinkering tools. The purpose of familiarisation sessions was to:

- Introduce the children to myself-as-researcher.
- Familiarise the children with the video equipment [iPads] and tripod stand.
- Describe the nature of the research to the children and invite their participation in the research [following parental/guardian consent].

It was anticipated that an informal familiarisation session with myself-as-researcher would help the children feel more confident with my presence in the three cycles of Implementation and desensitize them to the video equipment and tripod. The familiarisation sessions with children did not form part of data generation because the intention was to introduce the children to myself-as-researcher, to the video recording equipment, and to describe the project and invite their participation. In line with the National Statement's principle of Respect for human participants (NMCRC, 2018), it was clearly articulated that any child could choose at any time to withdraw from the full-scale research project without negative consequences.

4.5.1.4 Implementation 1: Introduction to Tinkering Tools

Following completion of the familiarisation session with children, the research progressed to Implementation 1: Introduction to tinkering tools. During this implementation, children were invited to engage with the available tinkering tools [e.g., screwdrivers, metal screws, nuts, bolts, and metal brackets, detailed in Section 4.8.1.1] along with playdough. Children were invited to explore the tools and materials, using the playdough as a base to experiment with different ways of manipulating and combining the resources. These engagements were supported by a range of pedagogical play-types, predominately an open-ended play-type in which children were invited and encouraged to explore the available materials according to their own interests.

4.5.2 Co-Design Cycle Two

Co-design cycle two in the redesign phase comprised semi-structured interviews with individual educators and a focus group interview with all three educators, leading to Implementation 2: Tinkering to deconstruct unplugged technologies.

4.5.2.1. Semi-Structured Interviews and Focus Group Interviews

Semi-structured interviews in co-design cycle two were conducted face-to-face with each individual educator one week after the first tinkering implementation [Implementation 1: Introduction to tinkering tools]. Interviews of approximately 30-minutes were conducted in either a meeting room or in quiet corridor at the service and were video recorded. Detailed in Section 4.9.3, the purpose of these interviews was to examine educators' unique perspectives on children's Learning Outcomes arising from Implementation 1, as well as to provide insight into the network of material and conceptual non-human actants which evolved during Implementation 1.

Focus group interviews were then conducted with all three educators in the week following the one-to-one interviews. Focus group interviews lasted for approximately 45-minutes and were video recorded. Detailed in Section 4.9.4, the focus group interviews served two purposes: 1) to prompt educators to share highlights of children's learning during Implementation 1; and 2) to provide opportunities to refine planning and share ideas for Implementation 2. Focus group interviews during refinement of planning also included discussions around the incorporation of support learning materials [described in Section 4.8.1.4] as part of purposefully framed play as a way to support basic concepts relevant to computer systems [e.g., inputs-processing-outputs] during Implementation 2.

4.5.2.2. Implementation 2: Tinkering to Deconstruct Unplugged Technologies

During Implementation 2, through purposively framed play, children were introduced to unplugged technologies [e.g., computer keyboards and computer mice] as input devices of computer systems, along with provocations to use the tinkering tools to explore, investigate and deconstruct the technologies [input devices] into smaller parts.

4.5.3 Co-Design Cycle Three

Co-design cycle three in the redesign phase comprised semi-structured interviews with individual educators and a focus group interview with all three educators leading to Implementation 3: Tinkering to make and create. The third cycle was completed with one final set of semi-structured interviews and a focus group interview.

4.5.3.1 Semi-Structured Interviews and Focus Group Interviews

Semi-structured and focus group interviews during co-design cycle three followed the same format as the previous cycle with the main purpose being to examine educators' perspectives on children's Learning Outcomes arising from Implementation 2, as well as to provide insight into the network of material and conceptual non-human actants which evolved from Implementation 2. During refinement of planning for Implementation 3 in the focus group interviews, educators and myself-as-researcher decided to introduce additional support learning materials in the form of YouTube™ videos to further children's concept development around basic computer systems [inputs-processes-outputs]. In addition, and detailed in Section 4.8.1.2, it was decided to introduce unplugged gaming controllers [as input devices] as well as computer cases containing various miscellaneous technology-related loose parts materials to children during Implementation 3.

4.5.3.2 Implementation 3: Tinkering to make and create.

During this final Implementation, through purposefully framed play, all deconstructed loose parts along with the screwdrivers, screws, metal brackets and playdough were provided to the children with the open-ended invitation to create, make and innovate according to their own individual interests. As mentioned previously, unplugged gaming controllers and computer cases were also introduced during this Implementation and children were invited to experiment with combining the materials in imaginative ways.

4.5.3.3 Final Semi-Structured Interview and Focus Group Interview

The final round of interviews with educators were conducted approximately one week after Implementation 3, and again followed similar formats and aims as previously employed during co-design cycle one and two.

4.6 Setting

This research was conducted in an independently operated early learning education centre in Brisbane, Queensland. The service was located approximately 12km northwest of central Brisbane [Meanjin] in the suburb of Ferny Grove and is located on the lands of the Turrbal and Jagera tribal nations. According to Australian Bureau of Statistics (2016), Ferny Grove has a population of approximately 5609 and is ranked on the 9th decile for socioeconomic advantage in Australia. According to the 2016 census, 73.3% of the suburb's resident population were born in Australia with the other 26.75 of the population originating from England 5%, New Zealand 2.6%, South Africa 1.6%, India 1.2%, and Scotland 0.7%. Households are predominately couples with children, and the median age of the population is 38 years (Australian Bureau of Statistics, 2016).

At the time of conducting this research, the centre had a total enrolment of 288 children with 17% of children speaking languages other than English at home. 0.7% of enrolled students identify as Aboriginal or Torres Strait Islander people. The student population was spread across four programs: 1) Nursery [aged birth- 12 months]; 2) Toddler [aged 12 – 48 months]; 3) Prekindergarten [aged 3-4 years]; and 4) Kindergarten [aged 4-5 years]. Programs were offered in 11 rooms, with two rooms accommodating the Nursery program, three rooms accommodating the Toddler program, three rooms accommodating the Prekindergarten program, and three rooms accommodating the Kindergarten program. In total, there were 51 staff members at the service [including managers], 22 of whom were qualified educators. Of the qualified educators, seven were qualified Early Childhood Teachers [ECTs] holding a recognised early childhood teaching qualification (ACECQA, 2020).

This study took place in the three Kindergarten rooms, each of which provided an approved Kindergarten Program funded by the Queensland Government. In Queensland, approved Kindergarten programs offered by ECEC services provide structured, play-based learning programs delivered by an ECT. Approved Kindergarten programs are intended for children in the year before they start full-time schooling at approximately 4-5 years old and can be offered in long day care centres or as stand-alone facilities (Australian Institute of Health and Welfare [AIHW], 2020). Each Kindergarten room at this service accommodated approximately 22 children on any given weekday, and learning experiences were designed and provided by two registered ECTs.

Two of the Kindergarten rooms provided an emergent curriculum. According to the service, an emergent curriculum is one which emerges primarily from the interests of the child and is based around each child's capabilities and focus. The curriculum is planned to align with key elements of the approved learning frameworks, the QKLG (QCAA, 2018) and the EYLF V2.0 (AGDE, 2022).

The third Kindergarten room provided an approved Montessori program which was also aligned to the EYLF V2.0 (AGDE, 2022) and the QKLG (QCAA, 2018). According to the service, their Montessori program focuses on the education of the whole child, involving an integrated curriculum of Practical Life, Sensorial, Language, Mathematics, Culture and Music.

4.7 Sampling

Sampling refers to the selection of suitable populations for study so that the focus of the study can be appropriately researched (Adler & Clark, 2008; Lopez & Whitehead, 2013). Researchers can employ either probability or non-probability sampling. Probability sampling is an approach where each potential participant "has an equal chance or probability to be selected" (Rahi, 2017) and is generally the method of choice for quantitative investigations (Merriam & Tisdell, 2015). Probability sampling involves randomly selecting representative individuals, and then generalising findings from those individuals to the overall population (Creswell, 2021; Merriam & Tisdell, 2015). Probability sampling approaches are seldom utilised for qualitative research because generalisation, in a statistical sense, is not a focus of qualitative inquiry (Merriam & Tisdell, 2015; Onwuegbuzie & Leech, 2005). Instead, qualitative researchers tend to utilise non-probability or non-random approaches to sampling (Onwuegbuzie & Leech, 2005) where specific populations are recruited to provide detailed understanding a specific phenomenon of interest (Creswell, 2015; Lopez & Whitehead, 2013). In non-probability sampling the participants are selected because they can enable the exploration of particular behaviours or characteristics relevant to the research (Gray, 2022).

This study used a non-probability approach to sampling, the most common form of which is referred to as purposeful sampling (Guest et al., 2017; Patton, 2002). Purposeful sampling is a strategy in which certain settings, people, things, or events are intentionally and carefully chosen for the important information they can provide (Creswell, 2018; Creswell, 2013; Maxwell, 2009). Purposeful sampling assumes the researcher wants to discover, understand, and gain in-depth insight into a phenomenon and as a result, selects a population sample from which the most can be learned (Merriam & Tisdell, 2015). Consequently, purposeful sampling techniques seek out groups, settings, practices, and individuals where [and for whom] the processes being studied are most likely to occur (Denzin & Lincoln, 2017; Suri, 2011). This involves selecting participants who are knowledgeable and informed about the research area of interest, and who can communicate experiences and informed opinions in an articulate manner (Spradley, 1980).

To effectively guide the selection of information rich participants, purposeful sampling necessitates the identification of specific eligibility or selection criteria for inclusion into a study (Guest et al., 2017). The criteria directly reflect the purpose of the research and act as a guide to choosing participants on the basis of their matched criteria to the ones required to answer the study’s research questions (Merriam & Tisdell, 2015; Wahyuni, 2012). There are many techniques detailed in the literature which are used to achieve purposive sampling, each of which is intended to serve specific purposes (Suri, 2011). For example, Patton (2002) and Miles and Huberman (1994) identify a range of techniques under the broad umbrella of purposeful sampling, some of which include: extreme of deviant case sampling; intensity sampling; maximum variation sampling; homogenous sampling, snowball sampling;

and convenience sampling. In this study, two of the techniques were used including homogenous sampling and convenience sampling. Homogenous sampling was used in the selection of educator participants, while convenience sampling was employed for the recruitment of child participants associated with each participating educator.

Homogenous sampling "is the strategy of picking a small, homogeneous sample, the purpose of which is to describe some particular subgroup in depth" (Patton, 2002, p. 235). This approach to purposeful sampling involves targeting individual people, groups, sub-groups, or settings because they all hold comparable characteristics or attributes. In this study, homogenous sampling was used to select a small group of educators who met three key eligibility criteria and who were willing and available to be participate in this co-designed research (Creswell & Guetterman, 2021). Eligibility criteria included: 1) holding a recognised bachelor's degree in early childhood education; 2) current employment as an ECT at an ECEC service; 3) minimum of two years teaching experience in a registered Kindergarten program. Given the aim and research questions of this study, the goal of this sampling approach was to select educators who possessed in-depth knowledge and experience of intentional approaches to play-based learning. It was anticipated that educators who met the eligibility criteria would hold significant views, ideas, and insights regarding the integration of technologies in ECEC, and young children's tinkering with unplugged technologies.

A sample size of three educators was chosen as a manageable means of achieving data saturation (Onwuegbuzie & Leech, 2007) following the convenience sampling of children. Data saturation occurs when little or no new information is forthcoming from participants or extracted from the data (Lincoln & Guba, 1985). Three educators, involved in every aspect of the co-design process, were determined as sufficient for providing comprehensive insights into their children's learning arising from tinkering with unplugged technology. Thus, this project aimed for depth of insights through the engagement and collaboration of a small number of educators.

Convenience sampling is an approach to purposeful sampling where participants are selected because they are available for invited participation and “represent some characteristic the researcher seeks to study” (Creswell, 2015, p. 144). In this case project, I sought to invite preschool aged children [4-5 years old] engaged in the approved Kindergarten programs facilitated by each participating educator. Consequently, children were selected because they were under the care and education of each participating educator. A minimum sample size of eight children per educator [24 children in total] was determined for child participants to engage in the tinkering implementations.

4.7 Recruitment

Following ethics approval from the Australian Catholic University (HERC 2021-57H) [Appendix B], four ECEC services in different geographical locations were selected as potential sites for recruitment of educators and associated children. All four services offered approved Kindergarten programs facilitated by qualified ECTs. Invitation emails [Appendix C] were sent to the Directors of each service enquiring if they would be interested in allowing research to be conducted at their centres. Two services expressed interest in obtaining further information about the project and invited me to meet with them face to face. One service, due to staffing limitations and time constraints participated in a modified pilot-study which informed the conduct of the research project, in which the second service participated in full.

4.7.1 Pilot-Study Service

One service expressed interest in participating in the project and invited me to meet with the Centre Director to provide an overview of the research project. This service facilitated a small, registered Kindergarten program consisting of eight enrolled children [aged 4-5 years] and one ECT who also acted as the Centre director. This Centre Director was highly experienced with over 30 years teaching experience. The Centre Director expressed strong interest in participating in the project because tinkering programs were offered at that service throughout the year. Consequently, the Centre Director was very knowledgeable and experienced in conducting tinkering related activities with young children, and keen to be involved in the project. Due to staffing limitations and time constraints, the service could not commit to participating in the full project. Adhering to the National Statement's guideline for 'Justice' (NHMRC, 2007-updated 2018), the Centre Director and the eight children in their care were invited to participate in a much shorter modified pilot-study in order to accommodate their time constraints and not place a burden on the service.

The pilot-study informed the conduct of the project in full and was established to test the methodology, and especially to develop and trial safety protocols around the use of tinkering tools with young children. It was anticipated that the Centre Director's experience in tinkering related activities would provide invaluable insights into testing the methodology and establishing tinkering protocols which could then be implemented during the full-scale project. In consultation with the Centre Director, the pilot-study was conducted over a 3-week duration.

Ethics approval was sought and granted by the Australian Catholic University (HERC 2021-57H) [Appendix D], including a modification to include the pilot-study. The Centre Director was provided with a Participant Information Letter: Pilot-Study [Appendix E] and Consent Form: Pilot-Study [Educators] [Appendix F]. Upon return of the signed consent form, children and parents were subsequently invited to participate. Parents/guardians received a hardcopy Parent/Caregiver Information Letter: Pilot-Study [Appendix G], Parent/Caregiver Pilot-Study Consent Form [Appendix H] and a Pilot-Study Child Assent Form [Appendix I]. It was clearly explained to parents/guardians that before every tinkering session, each child could decide whether or not to take part in tinkering by indicating their assent on a Pilot-Study Daily Assent Form [Appendix J]. In addition, in line with the National Statement's value of respect for human participants (NHMRC, 2018), it was clearly articulated that any child could choose at any time to withdraw from the pilot-study without negative consequences. Parents/guardians were invited to meet directly with the researcher at the service in the event of any unanswered questions or queries, this did not eventuate. Eight families returned signed pilot-study Consent Forms.

The pilot-study consisted of one planning session with the Centre Director [one hour duration], conducted face to face at the service, and two subsequent tinkering sessions [one hour duration for each] conducted with the Centre Director and children at the service. These pilot-study sessions were conducted three weeks prior to the start of the full-scale study. During the pilot-study sessions, I completed observation notes based on both the planning session and two tinkering sessions. I did not take photographs or make video observations of the children or Centre Director during the pilot-study. Data was only recorded relative to the planning and conduct of the tinkering sessions. Important information relating to three key areas: safety protocols, set-up, and the feasibility of materials was obtained through the pilot project. The development of clear protocols around safety, set-up and the feasibility of materials also adhered to the principle of 'Beneficence' as stated in the National Statement (NHMRC, 2007-updated 2018) to minimise the risks of harm and discomfort to the welfare of participants throughout the pilot and full-scale studies.

4.7.1.1 Safety Protocols

Both the Centre Director and I felt it important to discuss with participating children the distinction between unplugged technologies and any 'working' technologies that they might see around their homes. Consequently, prior to directly interacting with unplugged technologies, the Centre Director led discussions with the children highlighting that unplugged technologies were ‘old’, ‘not working’, ‘not used anymore’ and ‘not plugged into electricity’. Working technologies, on the other hand, were used by adults and children, and were connected to power supplies like electricity or batteries. It was clearly articulated to children that it was not safe to tinker with or take apart working technologies, and that they should always ask an adult’s permission before engaging with either unplugged technologies or working technologies. The Centre Director also led discussions with the children relating to the importance of wearing safety goggles throughout all tinkering sessions, and children were reminded to reapply goggles if they removed their eye shields at any stage of the tinkering activities. Safety protocols, including explaining the distinction between working and non-working technologies to children, and the wearing of goggles was used in the full study by educators at the start of each Implementation phase across all three cycles of co-design.

4.7.1.2 Set-up

During the pilot-study, children were organised into small groups with approximately four children per working table. The unplugged technologies [e.g., decommissioned computer keyboards and computer mice] was distributed between tables with approximately two computer keyboards and two computer mice per table. This meant that there was one computer keyboard and one computer mouse for every two children. Each child was provided with a screwdriver and a playdough pot, whilst metal brackets, screws, nuts, and bolts were placed on the table for use by any child at any time. Both the Centre Director and I felt that one artefact of unplugged technology per two children was a manageable ratio of resources, and facilitated peer-to-peer discussion, problem-solving and sharing of ideas. It was felt that an alternate provision of one unplugged technology artefact to every one child would clutter the working table and potentially overwhelm children. This set-up was consequently adopted by the participating educators in the full-scale study.

4.7.1.3 Feasibility of Materials

During the pilot-study all children demonstrated competence and ease of manipulation of the tinkering tools. Children were comfortably able to hold and use the screwdrivers to turn screws, manipulate the playdough, and engage with the metal brackets, screws, nuts and bolts. Consequently, the materials were considered feasible for use, and incorporated into the full-scale project. Children were also able to ‘open up’ the computer keyboards and computer mice and deconstruct the unplugged technologies into smaller loose parts materials. Unplugged technologies were also deemed feasible materials for inclusion in the subsequent full-scale study.

4.7.2 Full-Scale Service

I first met the Centre Director who was also the nominated Educational Leader of a service that would go on to become the service participating in the full-scale project. The service provided three Kindergarten programs. The purpose of this initial meeting was to provide an overview of the research project, and to provide the Centre Director with an ‘Invitation to be Involved in a Research Project – Early Childhood Centre’ (Appendix K). I carefully read through the documentation with the Director to clarify the project aims and design, and to answer all questions and queries. The Director expressed strong enthusiasm about the project and suggested that I return to the service at a later date to meet with ECTs who may be interested in participating. I subsequently organised a time to meet with three interested ECTs and during that meeting detailed the project, carefully explaining the full-scale study Participant Information Letter [Educators] [Appendix L] and the full-scale Consent Form [Educators] [Appendix M]. I then invited each educator to take time to consider the information discussed and, if they would like to participate, return the consent forms. All three ECTs returned consent forms.

In accordance with the National Statement (NHMRC, 2007-updated 2018), and adhering to principles relating to participant privacy and confidentiality, the three participating educators were invited to self-select pseudonyms for their participation in this research project. The self-selected pseudonyms chosen were Julia, Emily, and Stacey. Julia held a Bachelor of Education [Early Childhood] and was aged between 30-35 years. Julia had 10 years of experience working in the ECEC sector and had been employed at the current service for four years. Emily held a Bachelor of Education [Early Childhood] and was aged between 25-30 years. She had five years of experience working in Early Childhood and had been employed at the current service for two years. Stacey also held a Bachelor of Education [Early Childhood] and was aged between 25-30 years old. Stacey had two years of experience working in the sector and had worked at her current service for those two years. All three educators were interested in the project because they were keen to explore ways of incorporating technologies for learning and communications into their pedagogies because they felt that these outcomes were often overlooked in ECEC settings.

It is important to note that in the context of this project, the educators and not the children were the primary participants in the co-design. This was due to the focus of the research being on understanding how the integration of technologies in ECEC may be achieved via educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies. In this project, as described in Section 4.11, the unit of analysis is educator identified Learning Outcomes, and not the activities or perspectives of the children per se. This means that while children did participate in the project, I was not concerned with capturing children's perspectives on tinkering. Instead, I focussed on educator perspectives of children's Learning Outcomes within the network of actants comprising tinkering as a form of play-based learning related to young children's lived experiences in the post-digital.

Once signed educator consent forms were returned by Julia, Emily and Stacy, information about the project was sent by the Centre Director via email to parents/guardians of children within their respective Kindergarten groups. The email provided an overview of the project, along with attachments to the full-scale Parent/Caregiver Information Letter (Appendix N), full-scale Consent Form [Parents/Caregivers] (Appendix O), full-scale Child Assent Form (Appendix P) and a copy of a full-scale daily Child Assent Form (Appendix Q). The daily child Assent Form was used prior to each tinkering Implementation to confirm children's assent to tinker, be videoed and photographed. It was clearly explained to parents/guardians and children that before every tinkering session, each child could decide to participate in tinkering or not. In addition, and in line with the National Statement's principle of respect for human participants (NHMRC, 2007-updated 2018), it was verbalised to children during the initial familiarisation session that they could choose at any time to withdraw from the full-scale research project without negative consequences. Hardcopies of all letters and forms were also available at the reception desk of the service. Parents/guardians were invited to meet directly with myself at the service in the event of any unanswered questions or queries, however this did not eventuate. In total, 29 signed parent/guardian consent forms and 29 child assent forms were returned to the service. Of those participants, children were evenly spread across the three rooms with 10 children in the first room, 10 others in the second room and 9 children in the third room. There were 14 girls and 15 boys, and all children were aged 4-5 years.

4.8 Actants

ANT explains how networks of actants impose or act upon each other in various ways to manifest particular relationships between material, non-material, and human actants. In this project, both material and non-material actants were evident and used throughout each of the three cycles of co-design.

4.8.1 Material Actants

4.8.1.1 Tinkering Tools

Tinkering tools comprised screwdrivers, metal brackets, screws, nuts, bolts and safety goggles. Tinkering tools were used throughout all three Implementations. All tinkering tools were sourced from a reputable hardware retail outlet and adhered to Australian safety standards. Philips head screwdrivers were selected to accommodate ease of motor control by children [Figure 4.2]. The screwdrivers were lightweight and had a thick textured handle for a sturdy grip by children. Screws comprised a mixed range of machine and self-drilling screws with flat bottoms and Phillips and slotted drive types. Nuts included a range of Hex and Jam types. Metal brackets comprised a selection of zinc plated angle and flat brackets with screw holes. Child sized safety googles [one per child] were light weight with clear lenses. The safety googles were specifically designed to provide eye protection to children and suitable for indoor activities.

Figure 4.2

Overview of Tinkering Tools

In total there were 23 screwdrivers, 40 metal brackets, 250 flat bottomed screws, 60 nuts and bolts, and 23 safety goggles. All tinkering tools were cleaned with warm soapy water prior to and after each Implementation to maintain general hygiene standards and to comply with the service's COVID-19 regulations.

4.8.1.2 Unplugged Technologies

Unplugged technologies were introduced to children during Implementation 2. Unplugged technologies included discarded technological artefacts such as computer keyboards, computer mice, computer cases, as well as video gaming controllers [Figure 4.3 and Figure 4.4]. Computer cases included the physical external chassis but excluded power supplies, motherboard, hard drive, and memory – as these contained potentially harmful components incurring safety hazards. Instead, computer cases contained various miscellaneous technology-related loose parts materials such as coloured wires and plastic computer fans. Gaming controllers also had microprocessors, batteries and other safety hazards removed. Buttons, direction pads, rubber navigation sticks and triggers were not removed, and where necessary were affixed with sticky tape to the gaming controller case.

These unplugged technologies were selected because they were easily obtainable in quantities which facilitated sharing or independent use by children, thereby minimizing potential for conflict amongst participants. In addition, these artefacts were considered to be easily identifiable by children, being commonly located in homes and education settings. It was anticipated that if children recognised the unplugged technologies, this may stimulate children's curiosity and interest when engaging in the 'deconstruction' phase of the tinkering implementations.

Figure 4.3

Keyboards as Unplugged Technology

Figure 4.4

Mouse as Unplugged Technology

Unplugged technologies were sourced from e-waste recovery centres or were donated following a local community Facebook post requesting decommissioned technological artifacts. In total, there were 33 computer keyboards, 33 computer mice, 15 computer game controllers, 6 computer cases containing assorted components. All unplugged technologies were cleaned with warm soapy water and closely inspected by me prior to use. During inspection, I located and removed potentially harmful components to eliminate risk to children and educator safety. For example, batteries and power packs were discarded, circuit and memory boards removed, alongside any sharp metals or plastics. In addition, I adapted the unplugged technologies for easier access children and by removing some screws and loosening others.

4.8.1.3 Traditional Craft Materials

Traditional craft materials in this study comprised readily accessible craft resources in ECEC settings such as playdough, cardboard and/or paper materials and sticky tape. Playdough, sourced from a reputable education retail outlet, was incorporated into each Implementation. Small individual playdough pots were allocated to each child at the start of the first Implementation. Each pot was labelled to facilitate reuse by children during the subsequent Implementations. This minimised sharing of the playdough thereby reduced the risk of COVID infection. The playdough was non-toxic to children and easily washed off hands and other materials. There were 66 playdough pots in total. Cardboard and/or paper materials were introduced by some educators in Implementation 3 and included kitchen roll pipes and cupcake paper trays. Sticky tape was also incorporated during the third Implementation.

4.8.1.4 Support Learning Materials

Support learning materials were visual images including hardcopy laminated images and posters, texts in the form of picture books and YouTube™ videos which were used by educators to support the development of children’s concepts about technologies. Support learning materials were discussed and decided by educators during the second cycle of focus group interviews. During the second cycle focus interview, educators requested laminated visual images of computer keyboards and computer mice, as well as images showing basic concepts relevant to computer systems [e.g., inputs-processing-outputs] [Figures 4.5 – 4.7]. Educators deployed these visual images with children during Implementations 2 and 3.

Figure 4.5

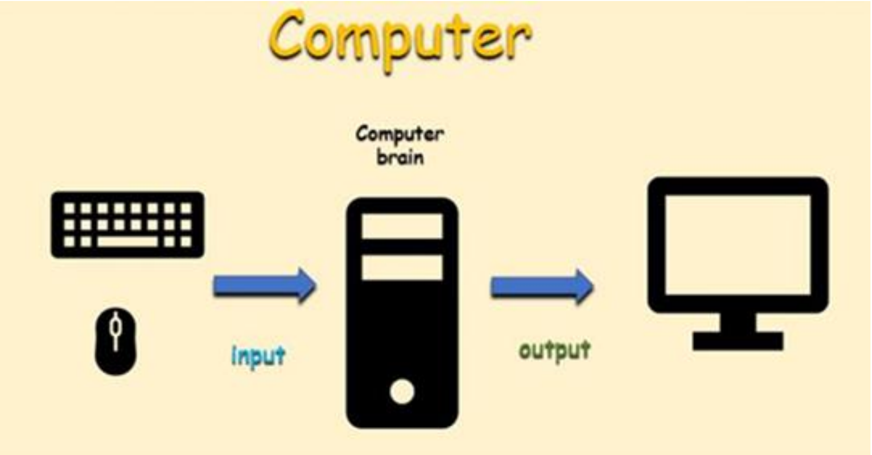
Image of Computer Keyboard

Figure 4.6

Image of Computer Mouse

Figure 4.7

Computer Systems Diagram



I provided the educators with copies of these support learning materials, along with a link to a YouTube™ video showing a clip from an episode of an animated educational series called 'Ask the StoryBots™' from Netflix Junior™ [Figure 4.8]. This featured an episode from season two ['How do computers work?'] where the main characters climbed inside a computer to learn about computer systems [e.g., inputs, processing, and outputs]. Some educators choose to show the full-length Netflix™ episode to children [24 minutes in total], whilst others decided on a shorter version [7 minutes in total] available on YouTube™ (www.youtube.com/watch?v=ax6bUF_8txM).

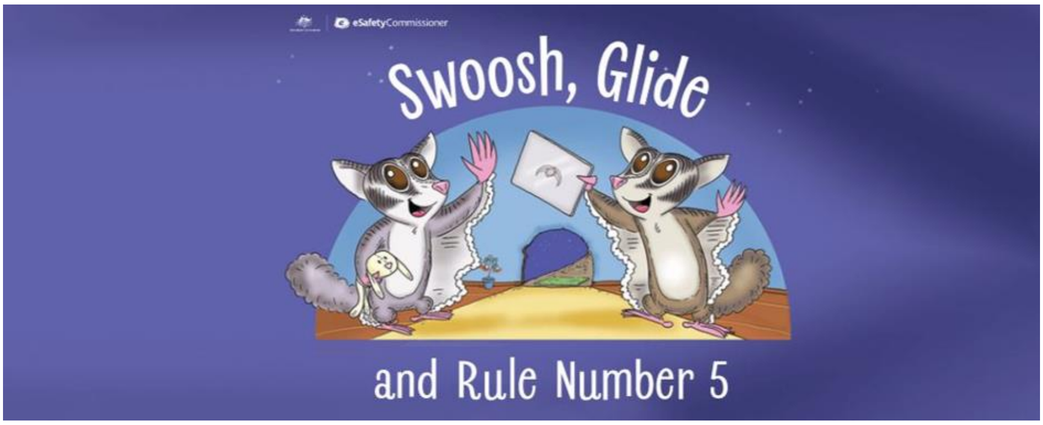
Figure 4.8

Ask the StoryBots™

In addition, some educators incorporated the use of a children's book 'Swoosh, Glide and Rule Number 5' (Uecker & Visaka, 2020) [Figure 4.9], developed and released by the eSafety Commissioner to facilitate online safety messages for children under five years old.

Figure 4.9

'Swoosh, Glide and Rule Number 5' Picture Book



4.8.2 Non-Material Actants

4.8.2.1 Play-Based Learning

Within the participating service and according to the EYLF V2.0 (AGDE, 2022), play-based learning was the primary pedagogical approach used at the centre. During each cycle of the codesign process, educators and I reflected on the role of play-based learning and intentional teaching in ECEC. The Pedagogical Play Framework was introduced and used by educators as an intentional approach to play-based learning throughout each of the three Implementations (Edwards & Cutter-Mackenzie, 2013). Detailed in Chapter Two, Section 2.5.2, this included three play-types: 1) Open-ended play; 2) Modelled play; and 3) Purposefully framed play. Open-ended play involved the direct provision of materials to children where they engaged in exploratory play with the provided materials with minimum engagement by educators. In modelled play, prior to the children interacting with materials, educators showed the children how to use the materials through demonstrations and explanations relating to a learning concept [e.g., using the support learning materials] and then stepped back to encourage playful exploration of materials. In purposefully framed play, the children were first provided with the materials in a provisioned open-ended play context. The educator then modelled how the materials could be used relative to a given concept [e.g., input and output] and engaged in interactions with the children using a range of strategies such as discussions, explanations, open-ended questions, and further use of support materials [i.e., YouTube™ videos, visual aids, and books]. During the design and redesign phases of each co-design cycle, the educators and I reflected upon and considered which combinations of pedagogical play-types were most appropriate and of value to supporting subsequent Implementations.

4.8.2.2 Assessment and documentation

Assessment for learning is a key regulatory requirement (ACECQA, 2020) in Australia, and is generally conducted through observations of children. At the participating service, the QKLG (QCAA, 2018) as well as the EYLF V2.0 (AGDE, 2022) were used by educators as reference points for assessment in the form of nominated Learning Outcomes and associated Key Indicators in each of these documents to ascertain children's progress. The QKLG (QCAA, 2018) describes a set of five learning and development areas which align directly to the five broad Learning Outcomes identified in the EYLF V2.0 (AGDE, 2022). At this service, children's learning was documented using software designed specifically for the centre. Similar to other mainstream digital documentation platforms used in ECEC settings, this system enabled educators to upload digital photographs and videos of children engaging in a range of play activities alongside narratives of the children learning.

During the first group planning session, and subsequent semi-structured interviews and focus group interviews, I encouraged the educators to share any digital documentation used to assess children's Learning Outcomes relating to the Implementations. Educators initially agreed to sharing digital documentation of children's learning, however only one educator shared a screen shot of a daily reflection regarding the first Implementation. I followed up on this request for digital documentation by the educators during their individual interviews, and in response educators articulated that they were verbally informing parents about the children's tinkering at pick up but had not yet had time to digitally document children's learning. I was assured by educators that they would share copies of the documentation once they were completed, but this did not eventuate.

4.9 Data Generation

There were four methods of data generation employed for this research: 1) Video observations; 2) Digital images; 3) Semi-structured interviews; and 4) Focus group interviews. Methods were selected to complement participatory co-design. In this study, educators were active participants in the co-design process and viewed as expert professional contributors. Accordingly, methods of data collection were employed to facilitate ongoing participant involvement which drew deeply on the views, insights, and experiences of each educator.

4.9.1 Video Observations

Video observations are a method of generating visual and audio data using technology which is typically digitally enabled (LeBaron et al., 2018; Pink, 2007). Video observations have a long history in social research (Erickson, 2011) and have become "a tool of choice for many researchers within a variety of disciplines" (LeBaron et al., 2018, p. 240). Frequently employed in education research, video observations offer powerful ways of "collecting, sharing, studying, and presenting detailed cases of practice and interaction for both research and instructional purposes" (Derry et al., 2010; Goldman et al., 2007) in formal and informal learning environments. Video observations in research can be employed for data generation in a variety of ways. Penn-Edwards (2004) discusses six approaches to using video for data generation, two of which include *observational recordings* and *subject response*. Observational recordings produce video for analysis "where the camera is focused on a specific action and records material that may be used as a database for coding and interpretation, for evaluation, or for profiling purposes" (Penn-Edwards, 2004, p. 268). In addition, Penn-Edwards (2004) describes the use of video as a tool for elicitation where "the video recording stimulates reflection and discussion of the viewed material" (p. 269). Griffin (2019) similarly offers a typology of video use which includes content that is produced internally to the research process. Internal content is described as footage that records participants engaging in events or interactions specific to the research project, which can also include footage of those same events as stimulus for discussions during subsequent interviews. Video observations employed in this project were used to digitally capture interactions between children and materials during each Implementation, to record discussion between educators during the initial planning session, semi-structured interviews and focus group interview, and to act as stimulus for dialogue during all interviews with educators leading to consequent Implementations.

4.9.1.1 Video to Capture Interactions Between Children and Materials

Video observations in research are valuable for exploring unfolding social interactions over time where there is a focus on the verbal and the non-verbal, as well as bodily movement and gesture in interactions between people and materials (Jewitt, 2012; Knoblauch, 2012; Pink, 2007). Accordingly, in education settings video observations are considered a powerful way of making ‘things’ visible in everyday relations (Rose, 2014), acting as microscopes to illuminate interactional detail (Derry, 2007). This method of data generation has potential to open-up “a multitude of possibilities in terms of attending to the layers of complexity that are inherent in the acts of teaching and learning” (Fitzgerald et al., 2013, p. 3). The use of video for observation facilitates repeated play back viewing (DuFon, 2002) which can be slowed, zoomed, replayed, and juxtaposed (LeBaron et al., 2018) to see naturally occurring events in new ways (Jewitt, 2012) and to look at the world differently (LeBaron et al., 2018). Play back opportunities contribute to intensive interpretation of interactions which may not be evident in real time (Erickson, 1982, 2006, 2011). Video observations provide opportunities for researchers to look more closely at what is otherwise unnoticed (LeBaron et al., 2018) and thereby generate accounts of unseen phenomena which may be buried in day-to-day education settings (Jewitt, 2012).

Providing “dense close-to-reality information” (Hall, 2007, p. 4), video observations can be used to examine embodied interactions within complex material and technical environments (Heath et al., 2010; Luff et al., 2013) where the social and the material are captured as mutually embedded (LeBaron et al., 2018). The use of video as an observation tool allows for documentation of the materiality of research settings and can serve as a means of explicitly recording people and materials, and the ways they become entangled with each other in complex environments (MacLeod et al., 2019). Video observations provide opportunities to capture the nature of a setting to achieve depth of understanding of an everbecoming world (Heath & Hindmarsh, 2002), enabling the researcher to “just follow the flow…. follow the actors themselves” (Latour, 2005, p. 237). Consequently, video observations were chosen as a method of data generation because they could capture the evolving relations between children and material and non-material actants.

Each Implementation was documented using video observations. In total there were 320 minutes of recorded footage of tinkering Implementations. Two digital tablets [iPads] were used to video record each Implementation. iPads were selected over handheld video recorders because the children were familiar with the use of iPads in their classrooms. During each Implementation, the children were initially aware of the iPads, and would at times look directly at an iPad to smile or pose. This unintended response by participants is referred to as the Hawthorne effect and presents as a change in participant behaviour as a consequence of their awareness to being studied (McCambridge et al., 2014). However, children’s awareness of the iPad quickly subsided as they participated in the tinkering. Heath and colleagues (2010b) suggest that within a short time the recording “camera is made at home” (p. 49), whilst Rosenstein (2002) describes the camera as fading into the background once participants lose their initial self-consciousness response to the camera.

Prior to commencement of data generation, both iPads were erased back to factory settings mode to eliminate any risk of data sharing. After each Implementation, data was immediately transferred from the iPads to a secure cloud data storage platform. Decisions about where to position each iPad for recording were made in consultation with each educator during the initial planning session. The location varied according to the layout and design of each educator’s classroom. Adhering to the National Statement’s principle of respect for human participants (NHMRC, 2007-updated 2018) when setting up the iPads, ethical parameters were taken into consideration with consenting children only captured by the digital lens. It was decided to position consenting children at the same table or group of tables while non-consenting children were situated at tables away from the view of the iPad. iPad One was positioned on a tripod and focused solely on tables seated with consenting children. iPad One began recording at the start of each Implementation, upon assent of each consenting child. I regularly changed the angle of iPad One to capture alternative views of actants, both human and material, but always took great care to ensure that tables with non-consent children were not in view. iPad Two was held manually by myself and was used to zoom in on tinkering interactions which particularly caught my attention. I sought engagements involving clusters of heterogenous actants, for example screwdriver-child -playdough-educator -computer mouse-open-ended play. I then aimed to capture interesting interactions between actants including verbal interactions between children and educators.

Upon consultation with educators and to maintain the National Statement's principle of respect for human participants (NHMRC, 2007-updated 2018) whereby participants are treated fairly and with respect, it was decided to terminate video observations in the event of a child displaying any type of anxiety or aversion to video recording. However, this did not eventuate. During Implementations, a moderate approach to participation was selected with myself-as-researcher adopting a peripheral membership role in observations (Adler & Adler, 1987). Spradley (1980) described a continuum of researcher participation levels ranging from non-participation or passive observation, involving no interaction with participants, to complete participation by the researcher where they become fully engaged in the activities. In between these levels, lies a moderate approach to participation where the researcher occasionally interacts with the participants. In this role, I was recognised and accepted by the children as an insider but only participated in activities when called on by the children for assistance or when invited by a child to look at or comment on their work.

4.9.1.2 Video to Record Discussions

Video observations were also used to record discussions with educators during the initial group planning session, each of the semi-structured interviews and the focus group interviews leading into the Implementations. Using video observations to record interviews can 'free up' a researcher's focus on documenting communication cues and details, enabling the researcher to be more present in the conversation (Griffin, 2019). Consequently, video recording of interviews can help to avoid missing important visual data as well as verbal and non-verbal cues (Pink, 2007, 2011). This can lead to a more complete recounting of an experience or event, where the researcher becomes more of an active listener in the conversation rather that a recorder of information. In addition, the use of video as an observation tool can facilitate the researcher more time for detailed, accurate transcription of interactions which can then be permanently stored for comprehensive analysis and reanalysis (Derry, 2007). This allows for the constitution of permanent records that researchers can examine repeatedly "to boost the accuracy and validity of research findings" (LeBaron et al., 2018, p. 240).

iPad One was used to record observations during the planning session, and during each of the semi-structured interviews and focus group interviews. The iPad was placed on a tripod stand and positioned behind me so as not to create a potential barrier to communication with participants or distract from topics of discussion (Knowles & Cole, 2012). The impact of the iPad on educators was taken into consideration. Participants were certainly aware of the camera and demonstrated this through occasional glances at the iPad at the start of interviews. The convergence of a camera lens upon a participant being videorecorded may be received by that individual with misgivings and discomfort (Penn-Edwards, 2004), however the educators appeared to become immersed in the discussions and were comfortable in the presence of the recording device (Heath et al.,2010).

At the start of the planning session and each semi-structured and focus group interview, the researcher verbally obtained educator permission to video record the discussions. It was clearly communicated to educators that the video observations would be used as a record of the ongoing conversation (Merriam & Tisdell, 2015) and would only be viewed by myself and the supervisors of the work reported in thesis.

4.9.1.3 Video as Stimulus

According to DuFon (2002), video observations are useful to 'play back' to participants as stimulus for recall, prompting insights into thoughts, feelings and reactions experienced during activities (DuFon, 2002). Consequently, elicited responses from participants become part of the data to be analysed (Griffin, 2019; Pink, 2007). Video stimulated interviews are used widely in the field of education (Nicholas et al., 2018) and can act as a catalyst to stimulate memory and reflection, prompting participants to discuss topics and phenomena of interest more extensively (Li & Ho, 2019).

In this project, semi-structured and focus group interviews were conducted according to educator availability, and so were flexibly scheduled. Most interviews occurred at least seven days after each Implementation. Accordingly, educators and I felt it beneficial to review segments of video observations capturing the Implementations at the start of interviews to refresh memory of events. Stimulus content was selected by myself-as-researcher. It was presented to the educators using PowerPoint on a laptop computer and featured examples of the children participating in the tinkering Implementations.

4.9.2 Digital Photographs

Photographs provide a way of capturing complex aspects of everyday life that cannot be revealed through oral language (Walker, 1993). Photographs in research can give voice to groups that have previously been silenced (Pink, 2007), providing non-human things with opportunities to be noticed and heard. Photographs can provide evidence of a real tangible world, where the material and the social are made visible as they are seen or experienced (Kind, 2013), thereby enabling insights into what is happening at a particular time. Photographs can reveal how people and things relate to each other and serve as a mechanism for tracing the complexity of interactions (Cleland et al., 2021). Photographs can carry action and meaning as immutable mobiles (Latour, 2005) and can illuminate the materiality of interactions.

I aimed to take photographs that captured both children and materials in interactions. These photographs were then used as stimulus for discussion within semi-structured interviews with educators, thereby generating both data and providing contextual detail to discussions. In addition, photographs were used to document evidence of the post-digital as embedded in children’s everyday lives. Here, I aimed to capture completed artefacts constructed by the children following their participation in the tinkering Implementations. Photographs were taken with iPad Two which I held manually. On many occasions, children asked me to take a photograph of their completed tinkering so that they could view their creations on the screen. I accommodated all of these requests.

In addition, I also generated digital photographs in the form of screenshots from selected video footage of tinkering Implementations. Screenshots were taken post-Implementation and enabled frame-by-frame capture of interactions occurring between heterogenous actants, including the children, and material artefacts. Such screenshots were also used as stimulus material during semi-structured interviews with educators. In total, there were approximately 130 digital photographs and screenshots recorded.

4.9.3 Semi-Structured Interviews

Semi-structured interviews generally comprise standardised questions asked of several participants (Diefenbach, 2009; Galletta, 2013). This approach is described as a type of organized conversation, guided by new information obtained from participants as the interactive discussion unfolds (Ahlin, 2019). Semi-structured interviews generally begin with a set of open-ended, yet pre-determined questions from which the researcher can improvise follow-up questions based on a participant's responses (Kallio et al., 2016). This approach facilitates "digging deep" into topic areas generated by participants (Ahlin, 2019, Abstract section), thereby enabling participants to contribute new meanings to the topic of discussion (Galletta, 2013). Semi-structured interviews are generally sufficiently developed to address the specific dimensions of a study, but also offer flexibility as participant narratives unfold during conversations. Semi-structured interviews are particularly valued for understanding viewpoints from a range of perspectives and have potential to add detailed and rich information to a phenomenon under exploration (Ahlin, 2019). Semi-structured interviews, as used in this study, therefore allowed for two-way discussions between myself-as-researcher and each of the educators, where the educators could contribute their unique insight into tinkering with unplugged technologies as a form of play-based learning in response to young children's lived experiences in the post-digital.

In this project, I conducted three semi-structured interviews with each educator [e.g., one per co-design cycle], altogether forming a total of nine individual interviews. Interviews were conducted face-to-face for approximately 30-minutes with each educator and were video recorded. Interviews were scheduled by the service's Centre Director and were dependent on availability of educators. Scheduling of interviews was flexible and generally occurred one week after tinkering Implementations. Interviews were conducted in either a meeting room or in quiet corridor if the meeting room was not available. Prior to interviews, I emailed each educator a copy of the semi-structure interview questions. This was requested by Julia who expressed interest in receiving questions in advance of the face-to-face meeting to feel more prepared for the meeting and was then adopted for Emily and Stacey. This also accommodated occasions when due to staffing shortages, educators had shorter release time from their rooms to participate in interviews. This occurred during co-design cycle two when interviews necessitated a more constricted time frame and were shortened from 30 minutes to 20 minutes duration.

At the start of every interview, I thanked the educators for their ongoing participation in the project and assured them that their insights and expert knowledge were valued and appreciated. Similarly, throughout the interviews, I continued to validate and encourage the educators to share their points of view. The semi-structured interview commenced with digital stimulus material, providing an overview of the previous tinkering Implementation [Figure 4.10].

Figure 4.10

Examples of PowerPoint Slides with Digital Stimulus Material

Educators were invited to comment on what they saw happening in the stimulus material and on what they thought about the tinkering Implementation. Following on from this, questions were grouped into three general areas for discussion: 1) Learning Outcomes; 2) Play-based learning; 3) Engagement with materials [Appendix R]. Questions were designed to examine educators' unique perspectives on children's Learning Outcomes arising from tinkering, as well as to provide insight into the network of material and conceptual non-human actants. At the end of each interview and prior to the subsequent group focus interviews, educators were asked to consider and reflect on one key moment which they considered significant to the children's Learning Outcomes. Educators were then invited to share this reflection with their colleagues at the subsequent focus group interviews.

4.9.4 Focus Group Interviews

Focus groups are a method of generating data through group discussion on a topic (Morgan, 1996). Focus groups can facilitate interpretations of experiences relative to a research phenomenon in the context of group interactions which have potential to generate multiple points of view (Barbour & Morgan, 2017; Skop, 2006). Focus group interviews are commonly used in participatory co-design (Thompson et al., 2017) and are beneficial for forming a synergy between participants and researchers through the creation of a communicative space (Bergold & Stefan, 2012). Focus group interviews can ensure that priority is given to sharing participant expert knowledge and perspectives to "unmask ideas and opinions through dialogue and debate with others" (Bagnoli & Clark, 2010, p. 104).

In this project, there were three focus group interviews, each conducted following an Implementation. Focus group interviews occurred approximately one week after individual interviews and were held in a meeting room located at the ECEC service. They lasted for approximately 45-minutes each. All three focus group interviews were video recorded. The focus group interviews served two purposes: 1) for educators to share selected highlights of children's learning to stimulate further group conversation; and 2) for educators to refine their planning and share ideas for subsequent tinkering Implementations. At the start of each focus group interview, each educator was invited to share with their colleagues some aspect of a child's or group of children's learning, particularly in the form of Learning Outcomes, arising from the previous tinkering Implementation. Sharing of a key Learning Outcome often acted as a catalyst to group discussion where an educator built onto another educator's insights with similar examples of their own. Likewise, shared examples of Learning

Outcomes reminded other educators of observed Learning Outcomes they may have forgotten which they could contribute to the interview.

Focus group interviews also enabled group discussions around planning for each cycle of redesign. Based on their children's identified Learning Outcomes in the previous Implementation, educators discussed approaches to play-based learning, drawing on the pedagogical play-types to support the next tinkering Implementation. These discussions included possibilities for combining play-types, and/or the type of strategies which could be used to support purposefully framed play. Focus group interviews also involved educators in discussions on how best to assess and document the children's play-based learning through tinkering with unplugged technologies in relation to the QKLG (QCAA, 2018) and the EYLF V2.0 (AGDE, 2022).

4.9.5 Data Management

Effective management of data is critical in research particularly when multiple methods of data generation are employed (Creswell, 2012). Data management involves the compilation and storage of data (Yin, 2016, p. 184). Data generated through video recordings in this project was immediately removed from the two iPads directly after each observation. Data were transferred to Cloudstor, a secure cloud-based file storage service. Once data was securely uploaded to Cloudstor, I reviewed footage of the Implementations to remove any material that contained nonconsenting children, a process referred to as cleaning the data (Wahyuni, 2012). There was one incidence of this where a non-consenting child approached the iPad and posed for the camera. This section of the video was subsequently cut and deleted. It should be noted that Cloudstor is due for decommission in December 2023, and in light of this, all data have been transferred to the ACU internal system, OneDrive.

Semi-structured and focus group interviews were transcribed by myself-as-researcher, and aided by Version 12 of NVivo's transcribe features. NVivo (Lumivero, 2020) is a qualitative data analysis program. The transcribe function in this program helped me to transcribe recorded dialogue and create new transcript rows. When necessary, a speed slider was used to adjust the speed of the audio to adequately hear and transcribe conversations. Transcripts consequently became key data sources that were used for coding and interpreting the findings (Erickson, 2006).

4.10 Ethical Considerations

4.10.1 Research Merit and Integrity, Justice, Beneficence and Respect for Human Beings

All steps in research necessitate engagement in ethical practices which permeate "from the origins of a research study to its final completion and distribution" (Creswell & Guetterman, 2021, p. 47). Consequently, ethical practices should be positioned at the forefront of a researcher's agenda (Creswell & Guetterman, 2021; Guillemin & Gillam, 2004; Mertens, 2018). In Australia, the National Statement (NHMRC, 2007-updated 2018) acts as a key resource when considering the rights and welfare of human participants. Jointly developed by the National Health and Medical Research Council [NHMRC], the Australian Research Council [ARC] and Universities Australia [UA], the National Statement informs and heightens ethical awareness around the design, review and conduct of human research. Included in the National Statement are descriptions and examples of four key principles which ethically shape the relationship between researchers and human participants to ideally "one of trust, mutual responsibility and ethical equality" (NHMRC, 2007-updated 2018, p. 9). These principles are: Research merit and integrity; Justice; Beneficence; and Respect for human beings, which provide flexible and substantial frameworks to guide the design, review and conduct of human research (NHMRC, 2007-updated 2018). Accordingly, during each progressive stage of this research project's design and implementation, I adhered closely to these principles and referred (in the preceding sections of this chapter) to the specific principle as per National Statement (NHMRC, 2007-updated 2018) which I felt guided that method’s ethical choices. For example, as stated by the National Statement in ‘Research merit and integrity’, unless a research project has merit and the researcher holds integrity, the involvement of human participants in the research cannot be ethically justified (NHMRC, 2007-updated 2018). In the case of this research, I initially conducted an extensive literature review of current and previous studies which positioned the central focus of this research [i.e., identifying the particular actants associated with educator integration of technologies in ECEC, via tinkering with unplugged technologies, as a form of play-based learning in response to young children’s lived experiences in the post-digital] as well justified and an important contribution of knowledge to the ECEC sector.

The ethical principle of Justice (NHMRC, 2007-updated 2018) refers to the obligation to treat human participants equitably and lawfully, and not place unfair burdens on participants or expose participants to research protocols which could disadvantage them. This principle served to guide me throughout the project, and I was particularly informed by it during the recruitment process of the pilot-study service. Detailed in Section 4.7.1, the pilot-study service expressed strong interest in participating in the research project and in sharing with me their extensive knowledge around tinkering. However, due to staffing limitations and time constraints, the Centre Director could not commit to participating in the full project. Accordingly, I suggested that the service might consider participating in a much shorter pilot-study which would alleviate the burden of time. The Centre Director embraced this suggestion stating that a 3-week commitment was manageable and accommodating to the service’s needs, and consequently once ethics approval was modified to include the pilot-study, they returned signed consent forms. In another example of incorporating the ethical principle of ‘Justice’, the participating educators and I developed a video observation protocol whereby we decided to terminate video observations of children during tinkering implementations in the event of any child displaying anxiety or aversion to video recording, thereby treating child participants with sensitivity and fairness.

‘Beneficence’ another key principle detailed in the National Statement, requires that human participants are protected from harm and that all efforts are made to ensure the well-being of each person. As detailed in Section 4.7, the development and adoption of clear protocols around safety, set-up and the feasibility of materials ensured that the risks of harm and discomfort to the welfare of all participants throughout the pilot and full-scale studies were minimised. This principle was continuously adhered to and critically reflected on throughout all cycles of the research project.

‘Respect for human beings’ recognises participants’ intrinsic values including their beliefs, perceptions, customs and cultural heritage (NHMRC, 2007-updated 2018). Detailed in Section 4.10.2 and in line with values of participatory co-design, I clearly positioned the educators in this research as the more knowledgeable others [and more practiced in Early Childhood Education] than myself. Consequently, this helped to encourage participating educators to share their expert points of view, beliefs and perspectives about children’s learning throughout the three cycles of co-design where their insights were heralded by myself as invaluable. ‘Respect’ as an ethical principle also includes adhering to participant privacy and confidentiality as well as to the capacities of individual participants to make their own informed decisions (NHMRC, 2007-updated 2018). Accordingly, at the beginning of all initial information meetings with educators, I highlighted participants’ rights to confidentiality and anonymity, and their right to withdraw at any time. This right to confidentiality and anonymity was also extended to child participants. According to the National Statement (NHMRC, 2007-updated 2018), it is imperative that researchers respect the developing capacity of children to be involved in decisions about participation in research. Adhering to this, I clearly articulated to each participating child that they could choose to withdraw at any time from the research project without negative consequences. Moreover, participating children's autonomous decision making was further respected through the use of a daily assent form where each child could independently decide to participate in the tinkering implementation or not, depending on how they were feeling on each day. All participants [educators and children] self-selected pseudonyms for their participation in the project to protect their privacy and confidentiality. Self-selected pseudonyms were subsequently used throughout all stages of analysis. In addition, detailed in Section 4.9.1, children who did not return signed consent forms were not excluded from the tinkering activities, instead they were situated at tables away from the view of the recording iPads to protect their privacy, and no data was collected.

4.10.2 Researcher Reflexivity and Ethics

Ethical responsibility in participatory research requires careful consideration and researcher reflexivity to staying at all times within the ethical and theoretical parameters of a research project (Canosa et al., 2018). This involves continuous reflection on the effects the research may have on participants [including the researcher] as well as on changing interpretations and contexts (Canosa et al., 2018; Guillemin & Gillam, 2004; Wint, 2011). In keeping with a post-qualitative worldview and a methodological commitment to principles of participatory co-design, I considered myself located within the research process. This necessitated careful consideration of the role of my role throughout the research process and awareness of the "dynamic interplay" (Yin, 2016, p. 339) between participants and myself where participants may be influenced by my presence and actions, and conversely where the presence and actions of the participants may influence me as the researcher (Yin, 2016). As Law (2004) suggests, it is not possible to conduct research without affecting, or being affected by other actants. This awareness is referred to as reflexivity where a researcher considers "their own biases, values, and assumptions and actively write them into their research" (Creswell, 2012, p.18). By adopting a reflexive stance, a researcher can view the world through the lens of participants, not just through their own eyes, thereby remaining open to other, new, and developing interpretations (Mao, 2018). Reflexivity then involves an ongoing awareness which makes visible the practice and construction of knowledge to produce more accurate analyses of research (Pillow, 2003). It requires the researcher to be aware of themselves as the instrument of research (Borg et al., 2012).

Personal reflexivity involves the researcher reflecting upon how their beliefs, values, experiences, interests, and social identities shape the research (Borg, et al., 2012). Bergold and Stefan (2012) discuss the need in participatory research for the disclosure of personal attributes and dispositions amongst participants. In this project, I shared with participating educators my own past professional experiences which includes extensive primary and secondary teaching experience [over 25 years], as well as research qualifications and field work experience focusing on loose parts play (Mackley et al., 2022). I was clear to position the educators as the more knowledgeable others and more practiced in Early Childhood Education than myself in this project, and consequently encouraged the educators to share their expert points of view throughout the three cycles of co-design. This helped me to develop reciprocity with the educators where I strived to hear, listen, and learn within the research relationship and in doing so, deconstruct the authority of the researcher in the process (Pillow, 2003). According to Spinuzzi (2005), in participatory design, participants knowledge is valorised, rather than depreciated and "their perspectives therefore become invaluable when researching their activity and designing new ways to enact that activity" (Spinuzzi, 2005, p. 165). As mentioned in the previous section, this is consistent with the key value of 'Respect' in the National Statement which advocates that each human participant brings value and autonomy to a research project. Consequently, in this project I was aware of, and willing to relinquish control and share ownership, enabling educators to assume leadership in their areas of expertise (Ey & Spears, 2020) thereby closing “the distance to be bridged between the researcher and the researched ‘other’ the source of information” (Day, 2012, p. 63).

Over time, by engaging with the educators as co-participants in the project, I acquired a membership status in relationship with them which was active in nature (Adler & Adler, 1987), because as Latour (2005) says “there is nothing less natural than to go into fieldwork and remain a fly on the wall” (p. 136). Given my role as an active participant in the co-design process, I was considered not as an invisible entity, but as active within the research process. I connected and created associations with the educators and children, as well as with material and non-material actants [e.g., as indicated by what I decided to record with iPad Two] and thereby generated effects with and in relation to those other actants. These associations were particularly captured in the video and interview data, where I brought my own interests in the actants to what was presented to the educators as stimulus material. In this way, I was part of doing research ‘with’ the participants instead of ‘on’ participants (Pillow, 2003).

4.11 Data Analysis

Data were analysed using deductive and inductive coding approaches. Coding refers to the process of labelling and segmenting text to form descriptions and broad themes in the data (Creswell, 2021; Derry et al., 2010; Stuckey, 2015). This process involves allocating a word or short phrase to a segment of text that “symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language based or visual data” (Saldana, 2009, p. 14). Deductive coding involves provisional lists of codes established prior to conducting an in-depth analysis of data which are employed to directly address research questions (Saldana, 2009). Deductive codes are generally informed by pre-existing theories and concepts derived from literature related to the project (Blair, 2015) and drive the coding process (Saldana, 2009). Inductive coding involves developing codes directly from the data which often evolve according to emergent key words and descriptions articulated by participants (Linneberg & Korsgaard, 2019).

Four stages of analysis were conducted. Stages one and two addressed Research Question One: What Learning Outcomes do educators identify in children's tinkering with unplugged technologies as a form of play-based learning? Stages two and three addressed Research Question Two: How do young children's experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies?

4.11.1 Stages One and Two

Deductive coding was used in stage one. Deductive codes establish the coding framework before analysis commences. Because the unit of analysis in this project was educator identified Learning Outcomes, following children's participation in tinkering with unplugged technologies as form of play-based learning, the primary deductive codes used in stage one were Learning Outcomes. Deductive coding was therefore established based on Learning Outcomes described by the EYLF V2.0 (AGDE, 2022) and directly aligned to the QKLG (QCAA, 2018). Broadly these Learning Outcomes related to:

1. 'Children have a strong sense of identity' (AGDE, 2022), aligned to 'Identity' (QCAA, 2018)
2. 'Children are connected with and contribute to their world' (AGDE, 2022), aligned to 'Connectedness' (QCAA, 2018)
3. 'Children have a strong sense of wellbeing' (AGDE, 2022), aligned to 'Wellbeing' (QCAA, 2018)
4. 'Children are confident and involved learners' (AGDE, 2022), aligned to 'Active learning' (QCAA, 2018)

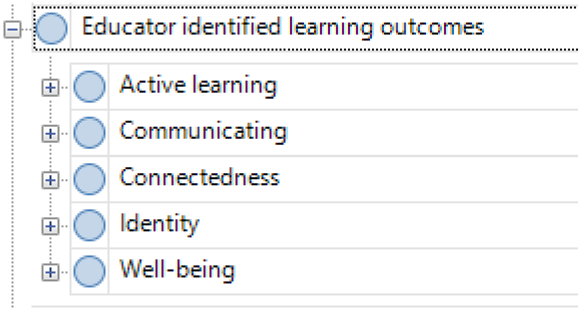
5. ‘Children are effective communicators’ (AGDE, 2022), aligned to ‘Communicating’ (QCAA, 2018)

The deliberate decision to follow educator identified Learning Outcomes follows research suggesting that where educators see learning values in experiences for children, they are more likely to use, adapt or integrate digital technologies into their pedagogy (Wood et al., 2019). This decision is also significant in terms of ANT and post-qualitative thinking as the guiding framework for the study. ANT conceptualises any entity that makes a difference to or influences something else as an actant (Loke & Kocaballi, 2016), while post-qualitative research orientates analysis towards fluid assemblages of heterogenous actants (MacLeod et al., 2019). Consequently, an analytical focus on assemblages means the number of potential actants are potentially infinite. Despite the flat ontology associated with ANT and post-qualitative research, a decision needs to be made regarding “what to include (or exclude) in the network, as for practical reasons analysis and data collection cannot continue forever” (Cresswell et al., 2010, p. 8). Limiting the scope of analysis in ANT informed research and focusing on specific actants can help a researcher “to adhere to clear parameters aimed to balance analytical richness and practical manageability” (MacLeod et al., 2019, p. 184). A focussed scope of analysis consequently helps to address the research question and provides an entry point into the network of actants to be examined (Cresswell et al., 2010). In this project, educator identified Learning Outcomes, derived from the QKLG (QCAA, 2018) and aligned to the EYLF V2.0 (AGDE, 2022) therefore provided the selected entry point, and were deductively coded for across all semi-structured interviews and focus group interview transcripts.

Learning Outcomes were established as deductive codes in NVivo (Lumivero, 2020). Within NVivo software, codes [known as ‘nodes’] can be organised into a hierarchical structure comprised of several levels: parent, child, grandchild, and great grand-child. For this project, educator identified Learning Outcomes formed the top-level code [e.g., parent node], with the five Learning Outcomes derived from the QKLG (QCAA, 2018) and aligned to the EYLF V2.0 (AGDE, 2022) comprising the child nodes [Figure 4.11].

Figure 4.11

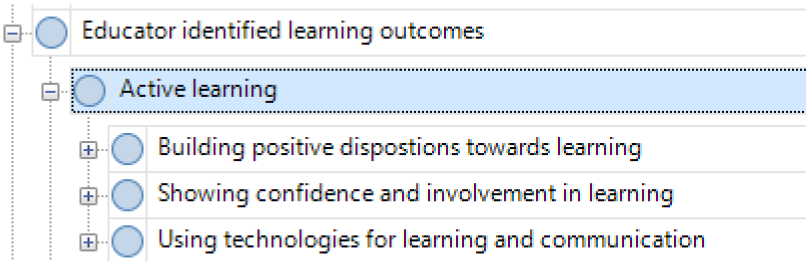
Educator Identified Learning Outcomes as Parent and Child Nodes



Grand-child nodes were further established under each Learning Outcome to identify key focus Learning Outcomes, as derived from the QKLG (QCAA, 2018) and aligned to the EYLF V2.0 (AGDE, 2022) [Figure 4.12].

Figure 4.12

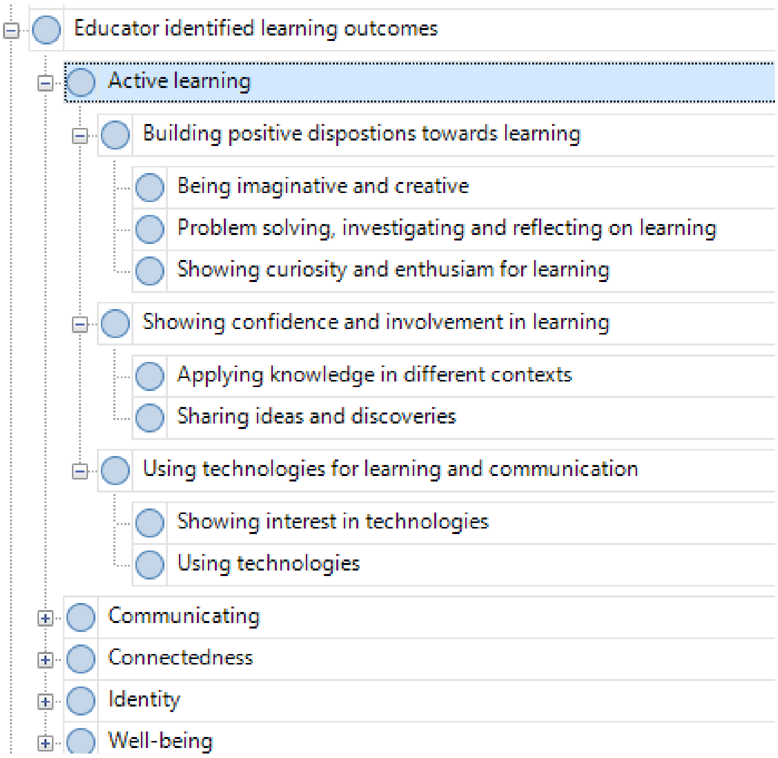
Key Focus Learning Outcomes as Grand-Child Nodes



Key Learning Outcomes were then further deductively coded as per the QKLG (QCAA, 2018) and aligned to the EYLF V2.0 (AGDE, 2022) to their final point as great grand-child nodes [Figure 4.13]. The coding structure with illustrative examples from the data is provided in Appendix S.

Figure 4.13

Educator Identified Learning Outcomes as Great Grand-child Nodes



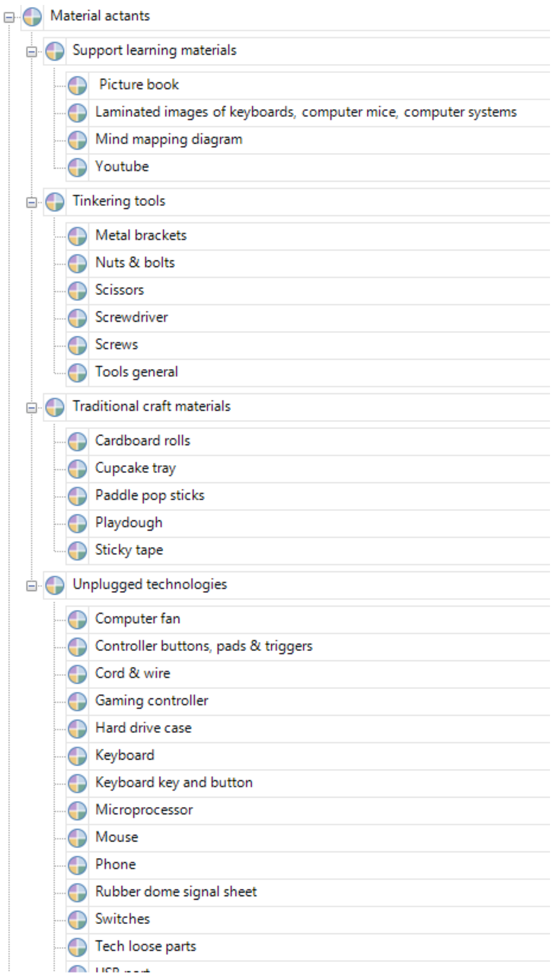
Deductive coding was also used in stage two. In stage two, deductive codes derived from ANT were applied to the educator identified Learning Outcomes from stage one. The stage two deductive codes were:

1. Material actants
2. Non-material actants
3. Participant actants

Material actants were categorised as entities that were physical and tangible in nature. Material actants comprised the parent node, with child and grand-child nodes used to categories the variety of available materials [Figure 4.14].

Figure 4.14

Material Actants as Parent, Child and Grand-child nodes

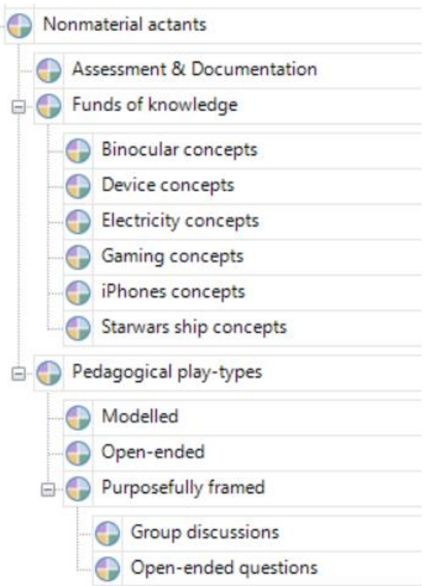


For the purpose of coding to the child node, support learning materials were described as visual images including a laminated computer system diagram, along with images of a keyboard and a mouse, texts in the form of a picture book, a mind map drawn on the whiteboard by one educator, and a YouTube™ clip showing an animated Netflix Junior™ series. Tinkering tools were defined as material implements which were handheld and utilised to carry out functions relating to tinkering. Traditional craft materials were everyday commonly used craft resources in ECEC settings such as playdough and cardboard/paper materials. Unplugged technologies were coded as discarded, disconnected technological artefacts including computer keyboards, computer mice, computer game controllers, as well as hard drive cases containing various computer components such as wires, cords, plastic computer fans.

Non-material actants were categorised as abstract or conceptual actants which did not have physical form. They were also deductively coded into child and grand-child nodes using core concepts from the literature related to this project, including assessment and documentation, funds of knowledge, pedagogical play-types associated with play-based learning [Figure 4.15].

Figure 4.15

Non-material Actants as per Parent, Child and Grand-Child Nodes

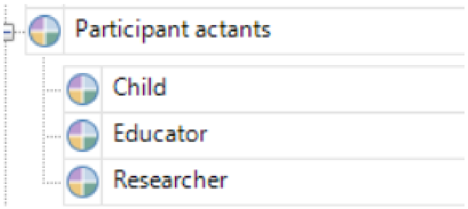


For the purpose of coding to the child node, assessment and document was defined as information gathered by educators about children's learning relevant to tinkering with unplugged technologies as a form of play-based learning. Funds of knowledge were defined as ideas articulated by participating children relating to their direct experiences of digital technologies and popular culture either within or outside of ECEC settings as observed by educators during tinkering implementations. Pedagogical play-types were defined as open-ended exploratory play with minimum engagement by educators, modelled play with educators showing children how to use tinkering tools, and purposefully framed play through a range of pedagogical strategies including group discussions, open-ended questions and explanations.

Participant actants were categorised as human participants, including educators, children and myself-as-researcher. Participant actants comprised only one child node each [Figure 4.16].

Figure 4.16

Participant Actants as Parent and Child Node



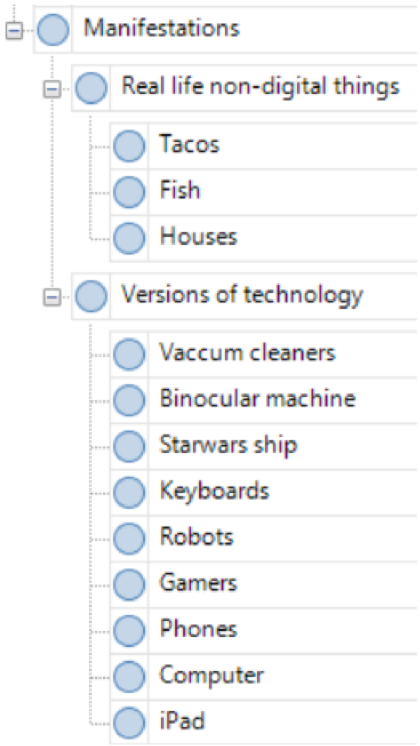
Coding of participant actants brought Stages One and Two of analysis to completion. By the end of these two stages, educator identified Learning Outcomes had been established, and all material, non-material and participant actants associated with each Learning Outcome were confirmed.

4.11.2 Stages Three and Four

Inductive coding was used in stage three. Inductive coding was applied to the previously identified educator Learning Outcomes and associated material, non-material and participant actants [e.g., as evident in the semi-structured interviews and focus group interviews]. The intention in stage three was to capture children's experiences in the post-digital as manifest in educator identified Learning Outcomes. The parent node for these experiences relative to educator identified Learning Outcomes was labelled 'manifestations' and comprised a series of inductively coded grandchild nodes [Figure 4.17]. The coding structure for manifestations, with illustrative examples from the data, is provided in Appendix T.

Figure 4.17

Manifestations as Child and Grand-Child Nodes



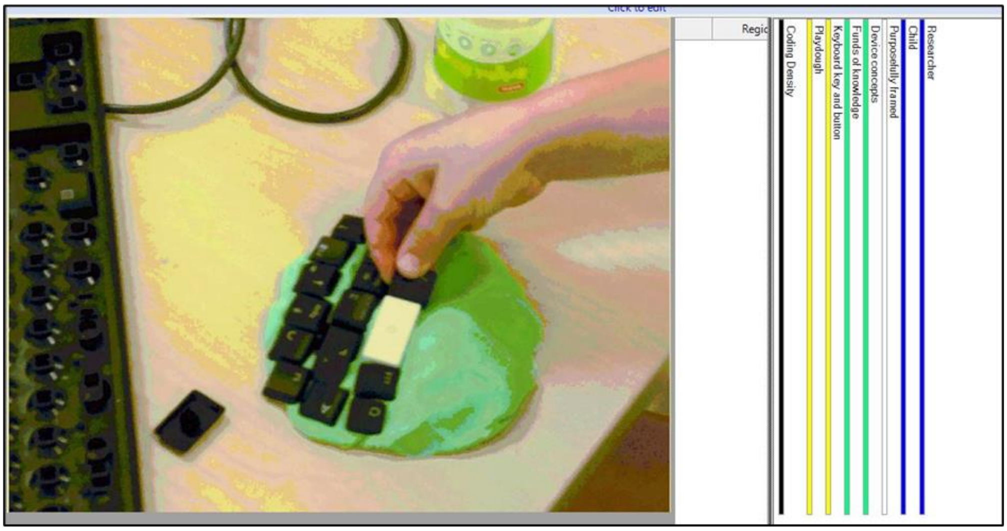
For the purpose of coding to the child node, 'Versions of technology' were defined as technologically themed physical constructions by children relative to educator identified Learning Outcomes. 'Real life non-digital things' were defined as non-technologically themed physical constructions by children' relative to educator identified Learning Outcomes. Manifestations for the purpose of this project were consequently defined as the relationship between collective actants directly related to educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies as a form of play-based learning related to young children's lived experiences in the post-digital.

Stage four involved tracing coded manifestations from the semi-structured interview and focus group interviews according to educator identified Learning Outcomes in the photographic and digital data. All visual data was consequently searched for evidence of 'Versions of technology' or 'Real life digital things'. Any manifestation which did not show unplugged technologies as an actant were excluded to ensure consistency with the project aim [i.e., to understand how the integration of technologies in ECEC may be achieved via educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies as a form of play-based learning related to young children's lived experiences in the post-digital].

As manifestations were identified, each was recoded for material, non-material and participant actants [remembering that these were derived from educator identified Learning Outcomes in stage one]. This recoding confirmed the status of any given manifestation, therefore addressing Research Question Two: 'How do young children's experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies?'. Figure 4.18 provides an example of an identified manifestation in video data, comprising coded evidence of material [e.g., keyboard key, playdough], non-material [e.g., purposefully framed play, funds of knowledge], and participant actants [e.g., child, researcher].

Figure 4.18

Identified Manifestation 'Version of Technology' Comprising Material, Non-Material and Participant Actants



4.12 Data Reduction

Completion of stages one and two, and stages three and four resulted in large number of codes, both for educator identified Learning Outcomes and Manifestations. As reporting on this number of codes would not be feasible within the scope of the thesis, it was decided to reduce the reportable data to a more manageable level. Data reduction refers "to the process of selecting, focusing, simplifying, abstracting, and transforming the data" (Miles & Huberman, 1994, p. 10) for increased manageability in reporting and discussing the findings. Data reduction was completed from the analysis related to Research Question One: What Learning Outcomes do educators identify in children's tinkering with unplugged technologies as a form of play-based learning? [i.e., stages one and two]; and for Research Question Two: How do young children's experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies? [i.e., stages three and four].

For Research Question One, a frequency count was conducted for each of the five identified Learning Outcomes. The mean number of Learning Outcomes was then calculated by adding up the scores for each and dividing the total by five. Mean is a measurement of central tendency, referring to the average value of a group of numbers (Chakrabarty, 2021). Learning Outcomes scoring above the mean were then abstracted from the data set as evidence of educator identified Learning Outcomes for the purpose of the study. The process of calculating mean was iterative and conducted in the same manner through each hierarchical node [e.g., child, grandchild] associated with one of the five Learning Outcomes. Through this process 'Active Learning' (QCAA, 2018) was identified as the only Learning Outcome above the mean for all five Learning Outcomes [Table 4. 1]. This established 'Active Learning' as the primary Learning Outcome identified by educators.

Table 4.1

'Active Learning' as the Primary Learning Outcome Identified by Educators

Learning Outcomes (QCAA, 2018)	
'Active Learning'	444
'Identity'	28
'Communicating'	19
'Wellbeing'	17
'Connectedness'	12
Mean	**104**

Following the same process, all grand-child nodes coded to 'Active Learning' were analysed to identify those grand-child nodes also above the mean. This process identified two relevant grand-child nodes ‘Building positive dispositions towards learning’ and ‘Using technologies for learning and communication [Table 4.2].

Table 4.2

‘Building Positive Dispositions Towards Learning’ and ‘Using Technologies for Learning and Communication’ as the Primary Grand-Child Nodes to Learning Outcome: ‘Active Learning’

Learning Outcome: ‘Active Learning’ (QCAA, 2018)	
‘Building positive dispositions towards learning’	103
‘Showing confidence and involvement in learning’	43
‘Using technologies for learning and communication’	156
Mean	**101**

Great grand-child nodes of ‘Building positive dispositions towards learning’ and ‘Using technologies for learning and communication’ were also analysed via frequency count and establishment of a mean. This resulted in the identification of the final two Learning Outcomes ‘Being imaginative and creative’ [Table 4.3] and ‘Showing interest in technologies’ [Table 4.4].

Table 4.3

'Being Imaginative and Creative' as Great Grand-Child Node of 'Building Positive Dispositions towards Learning'

Learning Outcome: 'Building positive dispositions towards learning' (QCAA, 2018)	
'Being imaginative and creative'	79
'Problem solving, investigating, and reflecting on learning'	73
'Showing curiosity and enthusiasm for learning'	73
Mean	**75**

Table 4.4

'Showing Interest in Technologies' as Great Grand-Child Node of 'Using Technologies for Learning and Communication'

Learning Outcome: 'Using technologies for learning and communication' (QCAA, 2018)	
'Showing interest in technologies'	54
'Using technologies'	45
Mean	**49**

For Research Question Two, there were a total of 62 identified manifestations coded to the two Learning Outcomes of interest 'Being imaginative and creative' (QCAA, 2018) and 'Showing interest in technologies' (QCAA, 2018). This number of manifestations was not feasible to report on in the thesis. The same process of calculating the mean for the manifestations at the level of child and grandchild nodes was therefore repeated. This process established 'Versions of technologies' as a child level manifestation of young children's experiences in the post-digital [Table 4.5]. Following 'Versions of technologies', three primary manifestations of children's experiences in the post-digital were confirmed, including 'iPads', 'computer' and 'gamer' [Table 4.6].

Table 4.5

'Versions of Technology' as Child Node of Manifestations

Manifestations	
'Real life non-digital things'	8
'Versions of technology'	54
Mean	**31**

Table 4.6

'iPad', 'Computer' and 'Gamer' as Grand-Child Nodes of 'Versions of Technology'

'Versions of technology'	
Vacuum cleaner	3
Star Wars ship	3
Keyboard	4
Binocular machine	2
iPad	10
Computer	11
Phone	2
Robot	5
Gamer	14
Mean	**6**

The process of data reduction, drawing on the completed deductive and inductive analysis of the semi-structured interviews, focus group interview, digital and video footage confirmed the response to both Research Questions One and Two. For Research Question One, the identified Learning Outcomes were ‘Showing interest in technologies’ (QCAA, 2018) and ‘Being imaginative and creative’ (QCAA, 2018). For Research Question Two, young children’s experiences of the post-digital manifest in educator identified Learning Outcomes as ‘iPad’, ‘computer’ and ‘gamer’.

4.13 Conclusion

This chapter has considered various approaches to research in education, examining the role of epistemology and ontology in forming the worldview that shapes how research is conducted. In this research, post-qualitative inquiry has been used [noting that this implies a blurring of boundaries between epistemology and ontology] so that the focus of attention is on tracing and understanding how networks of action and activity occur between objects and people, especially as these are defined by ANT in terms of actants.

Participatory co-design has been described as the method informing this research, including the rejection of technological determinism by participatory co-design in the search for understanding the relationship between people and technologies. Details of participants, recruitment and ethics have been presented, including the participation of Julia, Emily and Stacey as the primary participants, and the focus of attention on the Learning Outcomes they identified as occurring for children, following children’s participation in tinkering as a form of play-based learning. Centring on Learning Outcomes, the pathway to analysis confirmed two Learning Outcomes identified by educators: ‘Showing interest in technologies’ (QCAA, 2018) and ‘Being imaginative and creative’ (QCAA, 2018), and three subsequent manifestations of children’s experiences in the post-digital: iPad; computer; and gamer. In the next Chapter of the thesis, these findings are presented and explained in detail, including examples from the educator semi-structured interviews, focus group interviews, and digital photographs and video images of the various actants [e.g., material, non-material, participant] evident in the manifestations.

CHAPTER 5 : FINDINGS

5.1 Introduction

The research informing this thesis is based on a long-standing problem in ECEC where educators have found it challenging to integrate technologies in their pedagogy. Research shows this is due to the historical value placed on play-based learning in ECEC and the perception of technologies as too abstract to support children's learning (Clements, 1987; Cordes & Miller, 2000b; Yelland, 1998). This problem has been complicated in the last decade by the emergence of the post-digital as a time in human history where digital technologies are now considered imbricated with social practices (Hood & Tesar, 2019; Marsh et al., 2019; Pettersen, Silseth, et al., 2022), including those of very young children. This project sought to examine the capacity of tinkering with unplugged technologies as form of play-based learning to support children's lived experiences in the post-digital. In this project, specific attention was paid to educator identified Learning Outcomes associated with children's tinkering, as enabling children's learning as motivating aspects of educators' use of technologies in children's learning (Nuttall et al., 2015). The aim of the research was therefore to understand how the integration of technologies in ECEC may be achieved via educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies as a form of play-based learning related to young children's lived experiences in the post-digital. To achieve this aim, two research questions were addressed:

1) What Learning Outcomes do educators identify in children's tinkering with unplugged technologies as a form of play-based learning?

2) How do young children’s experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies?

For Research Question One, the identified Learning Outcomes were ‘Showing interest in technologies’ and ‘Being imaginative and creative’ (QCAA, 2018). For Research Question Two, young children’s experiences of the post-digital manifested in educator identified Learning Outcomes as ‘iPad’, ‘computer’ and ‘gamer’. Each of these findings are now presented and explained in turn.

5.2 Educator Identified Learning Outcomes

Research Question One was concerned with the Learning Outcomes participating educators in the study identified in children’s tinkering with unplugged technologies as a form of play-based learning. Two main Learning Outcomes were identified in response to this question, ‘Showing interest in technologies’ and ‘Being imaginative and creative’ (QCAA, 2018). Both Learning Outcomes are derived from ‘Active Learning’ as a key learning area in the QKLG (QCAA, 2018). According to the QKLG (QCAA, 2018), children as Active Learners develop an understanding of themselves and the world, creating their ideas through imaginative and dramatic play (QCAA, 2018). Active Learning aligns with Outcome 4 in the updated EYLF V2.0 (AGDE, 2022) ‘Children are confident and involved learners’.

5.2.1 ‘Showing Interest in Technologies’

‘Showing interest in technologies’ (QCAA, 2018) is demonstrated when a child displays interest in technologies and represents technologies (either real or pretend) in play situations (QCAA, 2018). Findings suggested that educators observed children to be actively engaged with unplugged technologies, reflecting what educators interpreted as children showing interest in technologies. For example, Stacey remarked that the children's interest and *"engagement was more on the technology-based resources"* [Stacey, semi-structured interview three]. Julia also reported that the children were *"very interested"* in the different unplugged technologies, noting that these resources, "*engaged a large majority of them* [children] *and engaged them for a long time which you know not everything does"* [Julia, focus group interview two]. Julia went on to explain how the children had participated in tinkering with unplugged technologies for approximately 60 minutes which she stated was "*a very long time for that group to be engaged"* [Julia, focus group interview two]. Julia further elaborated to explain that the children showed "*a deep engagement, not just a quick look and move off – it was a deep interest and concentration"* [Julia, focus group interview two]. Julia attributed this deep engagement to the fact that the unplugged technologies were something different for the children to explore than they were typically offered within the ECEC setting, and consequently children were interested and curious about them.

All three educators reported that children showed particular interest in computer keyboards and computer mice, gaming controllers and hard drive cases. Julia detailed how children in her room expressed interest in deconstructing computer keyboards and mice during the second tinkering implementation. She described how the children asked questions about the artefacts and how they explored the unplugged technologies in a hands-on manner [Figure 5.1].

Figure 5.1

Children Explored Unplugged Technologies in a Hands-On Manner

Julia said the children were "*intrigued by how they approached them and the time they spent examining them"* [Julia, semi-structured interview two]. Julia noticed that children spent time exploring the keyboards to understand how to *"unwrap"* the universal serial bus [USB] cord [positioned around each keyboard] before starting the deconstruction process, "*They had the new keyboards and mice, and they were asking, "oh what is this?" "what's this wrapped around it?" when they saw the attached USB cord"* [Julia, semi-structured interview two]. Connecting with open-ended play as an exploratory opportunity, Julia described how the children spent time looking at the artefacts and then carefully began to use their hands to investigate the keyboards and mouse, *"They were actually doing a lot of observing; and then they were gently touching the technologies. So, it took them time to work out how to unwrap it ...and then they were like "oh so what do we do now?"* [Julia, semi-structured interview two].

Drawing on modelled play, Julia detailed how she explained some concepts to the children, further supporting their interest in technologies [Figure 5.2],

> *"Then I had to show them a few things to get them to started, so I had to prompt them a bit more to start with but once they realised what they could do then they could keep going on their own, "oh look there is a screw! ", "there's another*

screw!" and "how do we open it?", and so I showed them how to open the side and then they worked that out" [Julia, focus group interview two].

Figure 5.2

Children Supported to use Screws

Julia also observed some children expressed keen interest in locating the microprocessor in the keyboard. Rectangle green microprocessors [sometimes described as 'a chip' or 'a microchip' or 'a brain' by educators and children] were in most of the keyboards. Children were intensely interested in finding the *'chips'* [Figure 5.3],

> *"Then they found the chips and they were all so engaged in finding them...some said oh mine doesn't have a chip, so I said let's find a keyboard that does have a microchip. It was just wonderful to see them thinking and figuring out the keyboards"*. [Julia, focus group interview two].

Figure 5.3

Children Intensely Interested in Finding Microchips

Emily also reflected on the interest shown by children in technologies. Keyboards were identified by Emily as artefacts of particular interest to her children. Emily described the children as more engaged and intent on deconstructing the keyboards, than on the computer mice,

> *"I think the keyboard was definitely number one just because there were so many parts to it, because with the mouse, once they got that apart there wasn't much they could do with it until we got the playdough and things out, but the keyboards once they were opened, they pulled apart the little signal sheets inside and then all of a sudden the keys were coming out!"* [Emily, focus group interview two].

Emily also noted the children's strong interest in microprocessors. She described group discussions held with the children about microchips, *"I talked a little about microchips, we reflected on that towards the end of that conversation I had with them"* [Emily, focus group interview two]. Emily subsequently described how one of the keyboards did not have a microprocessor, much to a child's disappointment, which necessitated a search for a keyboard which did contain one [some microprocessors were removed by the researcher prior to tinkering because they contained sharp components]. For example, the child in Figure 5.4 was very focused on locating the *"brain,*

> *"one of the keyboards didn't have a brain, and the child was saying I want one with a brain in it! So, I had to find a keyboard that had a chip or brain in it...because he saw another child working on trying to get the chip out, and this other child really wanted to try that, so I did find one!* [Emily, focus group interview two].

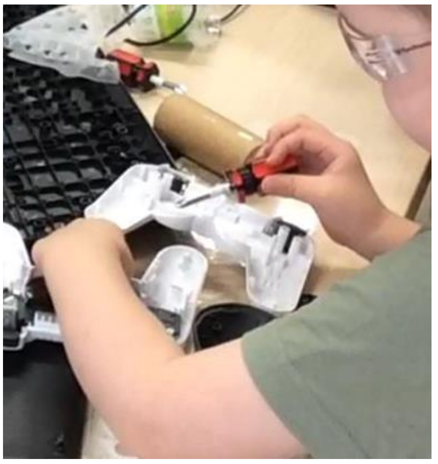
Figure 5.4

Finding a Microprocessor 'Brain'

Children also showed strong interest in gaming controllers. These were introduced to children during the third tinkering implementations. Julia described her children's interest in the unplugged controllers and their excitement upon noticing the controllers, evident though exclamations such as "*Oh it's a controller!".* Julia noted the children showed enthusiasm for *"exploring it and pulling it all apart!"* [Julia, semi-structured interview three] [Figure 5.5].

Figure 5.5

Children Showed Interest in Technologies by Deconstructing Gaming Controllers



Unplugged technologies used in this research also included hard drive cases containing various computer components. Prior to tinkering sessions, I removed all potentially harmful components [power supplies, motherboards, hard drives, memory, and sharp components]. However, computer cases were filled with technology related materials such as coloured wires and computer fans. Educators observed that children were *"drawn to the hard drive and the loose parts"* [Julia, focus group interview three] and were *"really intrigued with the big hard drive"* [Emily, focus group interview three] [Figure 5.6]. Julia commented that: "*We had the hard drive with all the bits in it, and they spent a long time just going through all of that and talking about each thing"* [Julia, focus group interview three].

Figure 5.6

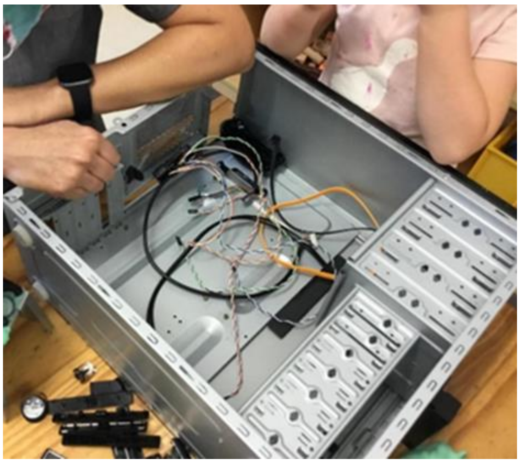
Children Drawn to and Intrigued by the Hard Drive Case

In Stacey's classroom, one hard drive was placed on a table which was easily accessible by children. She described how children showed interest in the unplugged, inquiring *"what the big thing was?"* [Stacey, semi-structured interview three]. She explained to children that it was the *'brain'* of the computer but that any sharp and dangerous parts had been removed to make it safe for the children to play with. Connecting with purposefully framed play, Stacey and children subsequently discussed the contents of the hard drive [Figure 5.7],

> *"I did notice that they asked what is the 'big thing'? So, I had to explain that's the computer brain, and then you know we opened it up and they were pulling all the parts out and looking at all the different things inside and they were like oooh and they actually even said to me as well "do you think these parts are sharp inside too?"* [Stacey, semi-structured interview three].

Figure 5.7

Stacey and the Children Explored and Discussed the Hard Drive Case



Children in Emily’s room also expressed interest in hard drive cases. Emily commented how one child showed particular interest in exploring and deconstructing the front section of the case [Figure 5.8], “*One of my children was really interested in deconstrucing the front panel* [of the hard drive case] *and feeling, getting the sensory vibe of the different components of it, particularly the mesh part”* [Emily, semi-structured interview three].

Figure 5.8

Deconstructing the Front Section of the Case

As an identified Learning Outcome, children's interest in technologies surfaced as evidence of their funds of knowledge about technologies, especially in terms of their lived experiences in the post-digital. All three educators observed that during group discussions, children could recognise and identify commonly used digital artefacts, establishing connections to familiar technologies. Stacey explained: "*some children started connecting that to home – "my dad has a computer at home", "my mum has got one", "I've got an ipad at home" so they were making those connections with digital things"* [Stacey, semi-structured interview two]. Emily described how her children recognised and identified examples of commonly used technologies which children recognised from their home settings, *"We talked about spoons and forks and chairs, and then I asked them further about technology - what they use at home that could be classified as digital, so they said things like phones and iPads, so it was really cool"* [Emily, semi-structured interview two].

As the educators became aware of children's funds of knowledge pertaining to technologies, they connected with children's existing knowledge via purposefully framed play, incorporating laminated images of computer keyboards and computer mice into their discussions. Educators used these images to provide visual stimulus for children's understandings about these artefacts and their uses. Emily noted that children displayed prior knowledge of these technologies, with many children recognising and identifying the images: "*We looked at some of the visual pictures, and I asked them "what this is?". They said it was a keyboard, they knew what a keyboard is, and they knew that it was a mouse"*. [Emily, semi-structured interview two]. Stacey also observed that children in her classroom demonstrated prior knowledge of these technologies, attributing this knowledge to children's familiarity with technologies in their home settings and from mainly outside of the service. Stacey ascribed this prior knowledge to the fact that most children are generally, *"surrounded by so many technologies in this world now, I think that is a big part of it. I guess we don't have so much at our centre that we can offer then, definitely not as much as they have access to at home like computers, iPads and phones. In the room they see us use the iPad to take photos, but they really don't see very much more of that"* [Stacey, focus group interview two].

Stacey subsequently described how children in her room recognised the computer keyboards, computer mice and the room's desktop computer,

"Some of the children were able to identify the images of a mouse and the keyboard on the visual posters. I prompted a discussion with the children and asked them if they had seen one of these input devices before. The children could relate to this question, and they mentioned that the classroom has a computer, and their parents have one at home" [Stacey, focus group interview two].

This suggests that children in this study were familiar with keyboards and computers in both domestic and education settings which corresponds to literature which investigates children's familiarity and use of digital technologies (Chaudron et al., 2018).

In addition to unplugged computer keyboards and mice, educators also noted that the children were excited by the unplugged gaming controllers which were incorporated into the third tinkering implementation. Educators observed that children identified the gaming controllers as devices used for entertainment systems or to control a character or object in a game, "*They were able to relate to them* [controllers] *because we have had a lot of discussions about Nintendo™ and PlayStation™ in our rooms and many children have these at home.* [Emily, semi-structured interview three]. Nintendo™ is the brand name of a highly popular Japanese multinational video game company which develops video games and video game consoles. PlayStation™ is also a popular home video game console developed by an American multinational company. All three educators remarked that many children recognised and actively engaged with the unplugged controllers. For example, Stacey described how Nintendo™ was frequently a topic of conversation amongst children and herself,

> *"Throughout the year, I've had alot of conversations with my children about Nintendo™ in particular, and last week they were just talking about Nintendo™ Switch and everything .....and when they saw it [controller] on the table they were so excited!"*[Stacey, semi-structured interview three].

Julia made a similar observation, noting that the children in her room also related strongly to the gaming controllers: "*It was good to see them being introduced to the controllers because a lot of our children made connections with them, and I guess that is very popular at this stage"* [Julia, semi-structured interview three]. Children in Emily's room were also excited to "*recognise the gaming controllers"* with some children exclaiming *'I have these at home',* and *'This is the thing we use for the games'* [Emily, semi-structured interview three]. Emily talked about her children's familiarity with PlayStation™ controllers and how recognition of these unplugged technologies in the tinkering sparked curiosity amongst the children about the internal composition of the artefacts, *"The PlayStation™ controller was a favourite ... they have seen it at home, and now they are inquiring 'I wonder actually what could be inside?' so, they were definitely interested in the controllers"* [Emily, semi-structured interview three]. Emily also observed that once children had deconstructed the controllers, they started to redesign and rebuild the unplugged controllers to recreate their own versions of '*gamers'* [Figure 5.9]. It would appear that Nintendo™ and PlayStation™ formed part of children's lived experiences of entertainment at home. Research shows that children use digital technologies including tablets, smartphones, and handheld video game consoles for entertainment in domestic contexts (Chaudron et al., 2018).

Figure 5.9

Children Create Their own Versions of Gamers

‘Showing interest in technologies’ (QCAA, 2018) as an identified Learning Outcome by educators of children’s participation in tinkering was supported by high and sustained levels of engagement by children with the unplugged technologies. Educators were clear that children showed genuine interest and curiosity about the unplugged technologies, and furthermore, that they brought to bear their own funds of knowledge about technologies to the tinkering implementations.

5.2.2 ‘Being Imaginative and Creative’

‘Being imaginative and creative’ involves children exploring, creating, and innovating with new and different materials to represent their interests (QCAA, 2018). Findings from this study suggested that educators observed participating children to extend their interests and ideas through imaginative and creative exploration of the tinkering resources. The capacity for children to be imaginative and creative was indicated by the educators in terms of the approach taken to play-based learning, and the nature of the children’s outputs during their participation in tinkering. Educators commented on the affordances of different play-types, including open-ended, modelled and purposefully framed play relative to tinkering. For example, Stacey believed that unplugged technologies and craft materials used via open-ended play facilitated “*freedom for their* [children’s] *imagination”* [Stacey, focus group interview three]; and yet through purposefully framed play, "*they* [children] *were all extending their own interests, their own ideas and creativity through using all those resources* [Stacey, focus group interview three]. Emily described how her implementation of purposefully framed play encouraged children's imaginative and creative activities throughout the tinkering sessions,

> "*I then left the deconstruction and play to be more open-ended and encouraged the children to explore. So, they had all those materials like the unplugged keyboards and the mice, and the tools and I was just really happy to see what they could make and create with those"* [Emily, focus group interview two].

Stacey also remarked that open-ended play, related to purposefully framed play as a form of intentional teaching, provided children with opportunities to be imaginative and creative, as well as encouraging children to engage in peer observation and collaborative learning. She observed that this approach encouraged children to,

> *"Branch out and create on their own and have a think about what they were going to create and what their friends were creating, and for me just watching them and seeing how some developed their learning and imagination"* [Stacey, focus group interview three].

Julia also believed that during tinkering the children had freedom to express imaginative ideas, either independently or working with others to co-construct and develop creative ideas, especially through open-ended play,

> *"It's all open-ended play-based learning so it is up to the children to create their own creations and it was so nice to see them building things on their own and working together to construct things...they made such amazing creations!"* [Julia, focus group interview three].

Educators described how using various play-types enabled children as active participants and decision makers in their learning. For example, Julia encouraged children to engage in tinkering without set expectations for outcomes, ensuring children were free to choose and explore their own creative possibilities. Julia commented that children,

> *"were able to make connections to learning on their own because they were provided with their resources which is very much active learning, and then they created the plan with what they wanted to do with them and then they used them to explore their learning, so they were investigating and creating"* [Julia, focus group interview three].

Educators generally believed that open-ended play was an important play-type within children's tinkering opportunities, especially for developing children's independent decision making, and a sense of agency in their thinking. Emily observed that open-ended play is imperative for kindergarten-aged children,

> *"Play has such an important role in our daily experiences, and I think in order to support the children's learning it's important to let them just be creative and giving them choice at this age, they just love having a sense of agency to build and create the things that they want!"* [Emily, semi-structured interview two].

Julia concurred with this observation, explaining that open-ended play fostered creativity and innovation amongst children, *"Giving them that freedom to just look at the resources and just go for it, I think was really important because it got their creative minds thinking!"* [Julia, semi-structured interview two].

Modelled and purposefully framed play were also used with educators when sharing an episode of 'Ask the StoryBots'™ from Netflix Junior™. This episode showed the main characters climbing inside a computer to learn about inputs, processing, and outputs. Emily chose to play the full-length episode to children, whilst Stacey and Julia decided on a shorter version available on YouTube™. Emily described how this visual material helped to consolidate children's understanding of the internal workings of the unplugged technologies,

> *"I think that it got the children thinking more about the computer world and how it actually works and from there they were talking more about the input and the output and things like that...which was really good, and it got them to relate to other things that they had seen and things that they see here at Kindergarten"* [Emily, semi-structured interview three].

Emily further commented that children were then able to make connections from the keyboards and mice they were deconstructing to the computer systems they observed in the episode and in the laminated posters,

> *"We made the links between the computers and the keyboards from the video by pausing it and talking about it a bit further and then using the visuals too, they were very interested in that for sure, I think they looked at the different technologies that they were deconstructing and then noticed a few similarities to the video as well, like this is the input and that is the output."* [Emily, semi-structured interview three].

Julia also found that use of the episode supported purposefully framed play. She described how the children were very engaged with following one of the main animated characters [a 'purple bot'] as it navigated the internal signal board of a keyboard. Julia noted that the children used what they had learned within their open-ended play with the unplugged technologies and were able to relate some of their learning to what was happening in the episode,

> "S*o they watched that and I asked at the end "Can you tell me what you saw?", and they were very animated about what the keys were doing when they were pushed down because the purple bot got stuck under one and they linked her feeling of "oh*

my goodness she is getting squashed!" to themselves and they were concerned she got stuck under the keys!" [Julia, semi-structured interview three].

Julia subsequently guided the discussion to inquire about what happened when the keyboard component was pressed. Using the animation to highlight what occurred when a key was pushed down, Julia and children talked about how the key sends a signal or message to the computer [Central Processing Unit-CPU] telling it what letter or number it wants to be shown on the computer screen [output device]. The children described how they saw the signals moving along electrical signal lines ["*light moving fast"*], which Julia explained contained the messages or instructions for the computer brain,

> *"I then asked them what was the man doing at the keyboard and they said he was presssing down the buttons ...and I said "remember that is the input"and "where was it going when they pushed the buttons?" and they said "the light travelled really fast along the signal line!"...they remembered the light and seeing the light moving fast ..and I said 'what was that?", and they were a little bit confused about that, so I said well, that was the message- that was the message going into the computer brain so I just revisited all those concepts through that."* [Julia, semi-structured interview three].

As the children developed more knowledge about the specifics of the unplugged technologies, their capacity for 'Being imaginative and creative' (QCAA, 2018) advanced. For example, Emily described how tinkering provided opportunities for children to explain their emerging concepts of inputs, processing, and outputs by combining the range of tinkering materials,

> *"I think in the tinkering that was what they were trying to do as they put the different materials together! It was really fascinating just showing them an image for example*

and then having a quick discussion about it, not in-depth but then they were able to, you know, explain that through their play!" [Emily, semi-structured interview two].

A child from Stacey's classroom showed her some playdough with inserted keyboard keys, along with a small USB port which the child called an '*input'*. The child then explained, "*I put the input in, and it makes it* [the playdough] *alive!"* [Stacey, semi-structured interview three] [Figure 5.10].

Figure 5.10

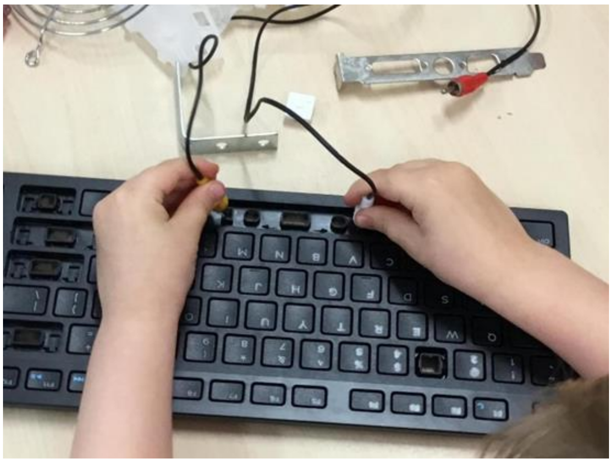
Child Combines Materials and Concepts About Devices

Stacey remarked that children in her classroom also transferred concepts about technologies to their tinkering [Figure 5.11]. She described how the children's language showed their developing understandings of concepts of the digital,

"I had a lot of children explain to me that they loved playing with the unplugged technologies - one of the girls said she loved playing with the computer brain, and she used that language too so that was nice to hear that, and a lot of children said that they love connecting the wires to the computer keyboard to make it work!" [Stacey, semi-structured interview three].

Figure 5.11

Concepts About Technologies in Tinkering – Trying to Make a Device 'Work'



'Being imaginative and creative' (QCAA, 2018) as an identified Learning Outcome by educators from children's tinkering evidenced combinations of play-types enacted between children and educators, including open-ended, modelled and purposefully framed play. Educators valued children's open-ended exploration of materials, but were clear that purposefully framed play, especially drawing on the episode from 'Ask the StoryBots™', advanced children's conceptual knowledge about technologies which was integrated with their ongoing tinkering and evident in their creations, discussions, and language.

5.3 Manifestations

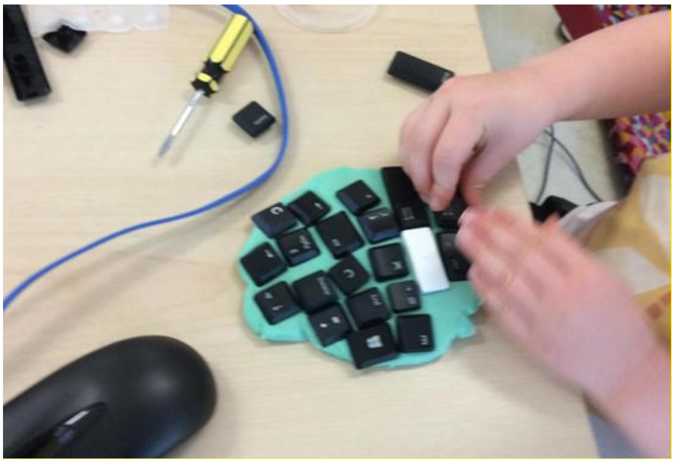
Research Question Two was concerned with how young children's experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies. This question was addressed according to two main types of manifestations, including children's creations of 'real-life non-digital things' and 'versions of technologies'. As reported in the Methodology chapter, 'versions of technologies' were more frequently evident than 'real-life non-digital things' and so followed for further analysis. Within the category of 'versions of technologies', three manifestations were most evident, these being: iPad, computer and gamer. Manifestations were represented by children's created 'versions of technologies', containing material, non-material and participant actants. Material actants were defined as entities that were physical and tangible in nature [e.g., unplugged technologies, playdough]. Non-material actants were defined as abstract or conceptual actants which did not have physical form [e.g., play-based learning, Learning Outcomes]. Participant actants were defined as human participants, including educators, children and myself-as-researcher. According to the process of data analysis, a manifestation could only be identified if it contained evidence of all three actants [Chapter 4, Section 4.11.2].

5.3.1 iPad as Manifestation

The first manifestation was iPads. Julia commented that some children in her room created and innovated using deconstructed unplugged technologies to represent iPads [Figure 5.12)], "*It's interesting to see how they made an iPad, and they knew obviously devices like that, and they were able to put those little keys down and go "well this is what my mum and dad has or I have one of these at home"* [Julia, semi-structured interview three].

Figure 5.12

Child Constructs an iPad



Children in Stacey's room were also observed to create iPads using computer keys and playdough, *"We had children that used the keys that were popped out from the keyboard, and* *they made their own iPads so that was great!"* [Stacey, focus group interview three]. All three educators reported that playdough was commonly flattened and used as a base for insertion of computer keys [Figures 5.13 and 5.14]. For example, as observed by Emily, "*Mine were pushing the playdough down and then they were putting buttons* [keys] *in"* [Emily, focus group interview three].

Figure 5.13

Playdough Used as Base for iPad

Figure 5.14

Keys Inserted into Flattened Playdough

Data located in video footage further evidenced iPad as manifestations. For example, in Stacey's room, a child [pseudonym] 'Stella' combined individual computer keys with playdough. When asked what she was making, Stella replied "*It's an iPad".* The educator further asked what Stella was doing with the individual computer keys and she replied, "*They are to press down, so they know what's on the* iPad*, so they know what's on the screen*" [Stacey's room, tinkering implementation three]. Stella then demonstrated the concept of the iPad keys as input devices which when pressed, send messages to a screen as part of a computer system [Figure 5.15].

Figure 5.15

Child Pushes Keys on iPad to Send Messages

5.3.2 Computer as Manifestation

The second manifestation was computer. Stacey described how children combined playdough with computer keys and wires to represent computers, "*they were pushing up the playdough to make the screen and then they were putting buttons in, and pressing them, and had a little wire out the back"* [Stacey, focus group interview three]. Computer construction by children showed differentiation between the screen [output] from the keyboard [input] with power represented through the small wire positioned at the back of the device [Figure 5.16].

Figure 5.16

Child Constructs a Computer

Educators reported that children connected basic learning concepts, supported by laminated images, discussions, and other support learning materials, with computers at home. For example, Stacey described how children "*mentioned that the classroom has a computer, and their parents have one at home"* [Stacey, semi-structured interview two] stating that children in her room made comments to include, "*my dad has a computer at home, my mum has got one"* [Stacey, semi-structured interview two]. Emily also reported that some children in her room made connections between input devices and hardware to create a computer. She described how children demonstrated understandings of computer systems because they talked to her about "*when you put things together like hardware and those input devices together it makes something like a computer"* [Emily, semi-structured interview three]. Emily further described how the tinkering implementation afforded children the opportunities to develop those concepts by combining materials using playdough to represent computers commenting that "*I think in the tinkering that was what they were trying to do as they put the different materials together"* [Emily, semi-structured interview three].

In the case of computer as manifestation, playdough was used to physically support and enable the combination of deconstructed loose parts including keys and keyboard cases.

For example, Figure 5.17 shows a child integrating two sides of a deconstructed keyboard, keys, and playdough to demonstrate their version of a computer system. The child recreates their own keyboard [input device] using playdough and keys, linking it to the other half of the keyboard which is positioned upright to represent a screen [output device]. When asked by the educator what they were making, the child replied, "*a computer*" [Stacey's room, tinkering implementation three].

Figure 5.17

Child Represents Computer

Figure 5.18 also shows a version of technology representing a computer. In this image, Emily shows the researcher a child's construction where they created a playdough keyboard connected by a wire to a *'computer screen'* represented by a deconstructed keyboard, thereby evidencing developing knowledge of device concepts associated with children's learning about inputs and outputs.

Figure 5.18

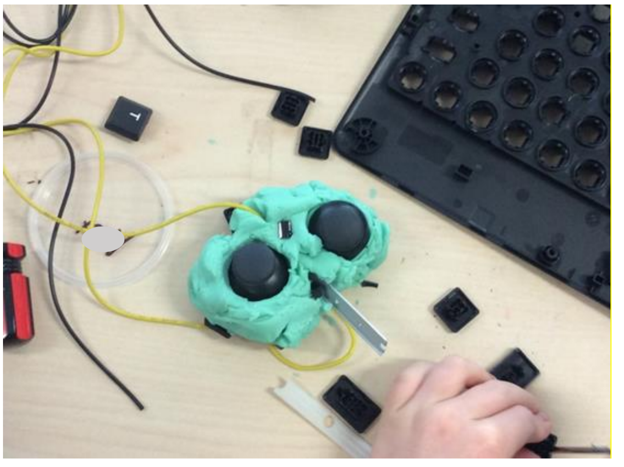
Computer with Keyboard, Wire, and Screen

5.3.3 Gamer as Manifestation

The third manifestation was gamer. Children were particularly focused on gamers [video game controllers] as an expression of their experience in the post-digital via tinkering. Educators commonly observed children recreating gamers or gaming controllers. Julia observed that the children were "*very creative and came up with all sorts of ideas relating to Nintendo™, PlayStation™, and Pacman™*" [Julia, semi-structured interview three]. Stacey also described that many of the children in her room *"were making 'gamers'-controllers*" [Stacey, semi-structured interview three]. For example, she observed a child combining a variety of deconstructed parts, including playdough, control buttons, wires, and metal brackets to create "*a controller to control people"* as described by the child [Figure 5.19].

Figure 5.19

Child Constructs a Gamer



Some versions of gaming controllers [Figure 5.20 and 5.21] involved combining deconstructed controller cases with playdough to affix and reattach the controller back together.

Figure 5.20

Playdough Inserted into Controller

Figure 5.21

Playdough Affixed Controller Cases Together

Other versions of gaming technologies involved combinations of a range of different material actants to make ‘*new*’, innovative, and non-traditional types of controllers. For example, a child [pseudonym ‘Fred’] in Stacey’s room showed how he combined playdough, controller case, a metal bracket, controller buttons and a microchip [Figure 5.22]. When asked by the educator what he created, Fred responded, “*It’s a new controller what I did. It’s a new um Nintendo™ which I did created”* [Stacey’s room, tinkering implementation three].

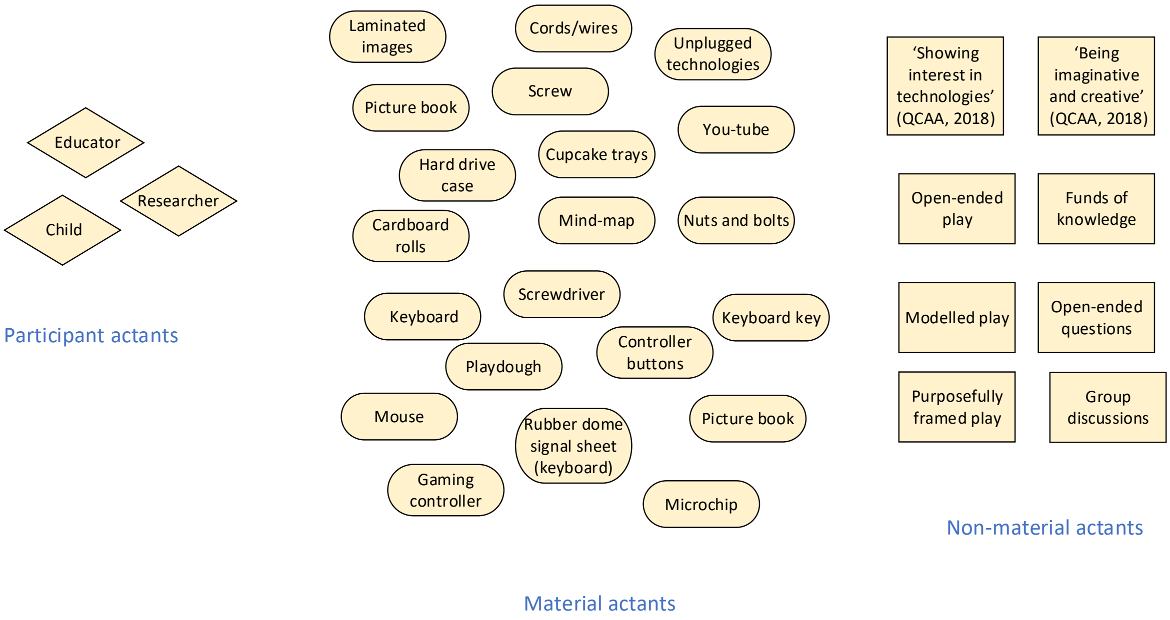
Figure 5.22

It’s a New Nintendo™

The three manifestations all evidence combinations of the required actants necessary to bring them forth as lived examples of children's experiences in the post-digital, according to educator identified Learning Outcomes for children (e.g., 'Showing interest in technologies' (QCAA, 2018) and 'Being imaginative and creative' (QCAA, 2018) following children's participation in tinkering with unplugged technologies. Illustrated in 5.23, these include material [rounded-rectangular shapes], non-material [rectangular shapes] and participant actants [triangular shapes]. Using these actants it is possible to map the pathway of activity comprising each manifestation, noting these begin with educator identified Learning Outcomes as the central unit of analysis. In this manner, the problem of educators integrating technologies into their pedagogy, and the need to connect more strongly with children's experiences in the post-digital can be viewed relationally in terms of what educators can do pedagogically with children using play-based learning [e.g., non-material actants], what materials teachers can use with children to support digital integration via unplugged technologies [e.g., material actants] and how teachers can engage with children [e.g., participant actants to support learning].

Figure 5.23

Material, Non-Material and Participant Actants in the Manifestation of Children's Lived Experiences of the Post-Digital in Educator Identified Learning Outcomes



5.4 Conclusion

Educator integration of technologies in ECEC is a long-standing problem and one complicated in recent times by young children's immersion in the digital as mode of social practice – or what is known as the post-digital. The aim of this research is to examine the capacity of tinkering with unplugged technologies as a form of play-based learning to support children's lived experiences in the post-digital. This aim recognises that play-based learning is a significant pedagogy in ECEC and that tinkering affords opportunities for such play. Unplugged technologies offer opportunities for children to engage with technologies that educators may view as more appropriate for learning because they can be hands-on rather than relying only on working technologies for learning.

In this chapter, the two research questions addressing this aim have been presented in terms of the findings. For Research Question One [What Learning Outcomes do educators identify in children's tinkering with unplugged technologies as a form of play-based learning?], the findings were ‘Showing interest in technologies’ and ‘Being imaginative and creative’ (QCAA, 2018). For Research Question Two [How do young children’s experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies?], the findings were young children’s experiences of the post-digital manifest in educator identified Learning Outcomes as ‘iPad’, ‘computer’ and ‘gamer’.

In the next Chapter of this thesis, I present the three manifestations in terms of their composite actants, and then bring the three manifestations together to illustrate how a variety of actants operate within a network of activity to shape a response to the problem of integration of digital learning opportunities into ECEC, especially noting the role of play-based learning, and acknowledging young children’s own funds of knowledge, or lived experiences in the post-digital.

CHAPTER 6 : DISCUSSION

6.1 Introduction

This chapter discusses the findings to address the main aim of this project: To understand how the integration of technologies in ECEC may be achieved via educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies as a form of play-based learning related to young children's lived experiences in the post-digital. The chapter begins by detailing the three identified manifestations from the findings: these being iPad, computer, and gamer. It is important to note that the manifestations are derived from and contain the educator identified Learning Outcomes 'Showing interest in technologies' (QCAA, 2018) and 'Being imaginative and creative' (QCAA, 2018). The manifestations are detailed as mapped actor-networks showing the various material, non-material and participant actants involved in the creation of each.

After this, the role of play-based learning in ECEC, as evident in curriculum frameworks including the EYLF V2.0 (AGDE, 2022) and QKLG (QCAA, 2018) is revisited and identified as an Obligatory Passage Point through which educator identification of Learning Outcomes are made possible as an actant. The role of the material, non-material, and participant actants, starting with educator identified Learning Outcomes [e.g., Showing interest in technologies (QCAA, 2018)] in mapped networks are then explained in terms of being either mediators or intermediaries in their operation. This leads to the identification of children's funds of knowledge as an important mediator in the manifestations which, derived from children's lived experiences in the post-digital, also acts as an Obligatory Passage Point. The discussion then suggests that the problem of technology integration in ECEC may be addressed by helping educators to pay attention to the various actants in a network involving children tinkering with unplugged technologies as form of play-based learning, especially by paying attention to children's funds of knowledge.

6.2 Manifestations

In line with the principles of ANT, manifestations in this study were conceptualised as children's created versions of technologies, containing material, non-material and participant actants. Actants are co-constituted as relational effects generated through their associations with other actants. This means that each material, non-material, and participant actant in the identified manifestations influenced, formed or shaped each other giving the manifestations themselves their unique form.

The literature suggests that the development of actor-networks is not a linear one-way process (Callon, 1990; Latour, 2005). However, for the purpose of this research, I made the decision to follow the actants sequentially because I felt it necessary to freeze-frame the various moments of associations between material, non-material and participant actants. Although, the growth of actor-networks is not one-way (Callon, 1990; Latour, 2005), chronological mapping of actants and their associations makes visible distinguishable pathways of action. According to Latour (2005), the course of any actor-network "will rarely consist of human-to-human connections or of object-object connections" (p. 75). Moreover, actor-networks are in processes of constant change representing dynamic relationships continuously in translation and under construction (Latour, 2005). This chapter therefore provides a captured moment in time of the three manifestations as relational effects of material, non-material and participant actants involving children, educators, myself-as-researcher, identified Learning Outcomes, tinkering with unplugged technologies and play-based learning.

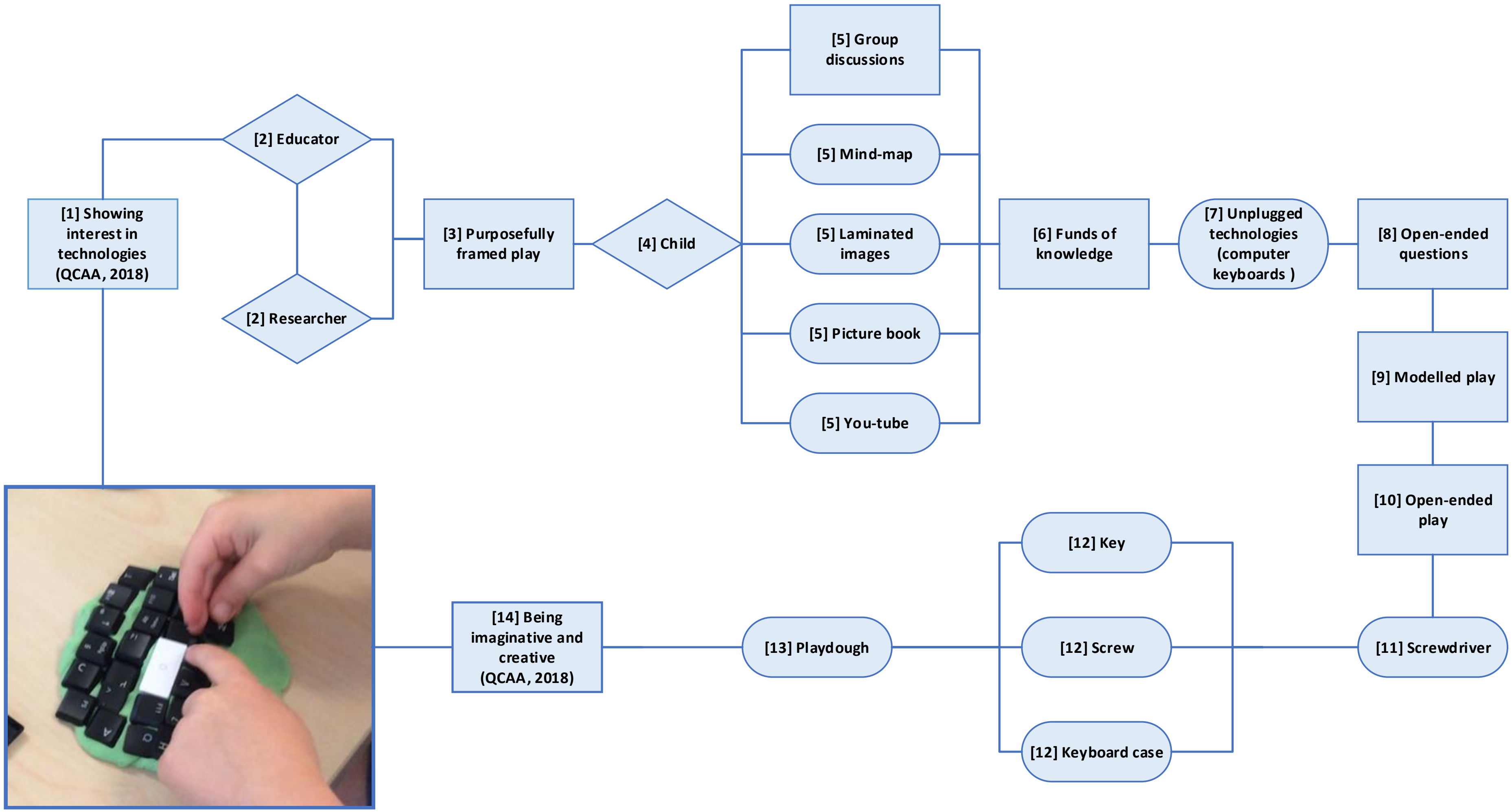
My decision to follow the actants sequentially is also important for understanding the problem of technology integration in ECEC. There is already research in ECEC that suggests children's play and social activities in the post-digital form messy relations (Apperley et al., 2016; Jandrić et al., 2019; Pettersen, Arnseth, et al., 2022). Such work claims that it can be difficult to see where and how any point of action and/or interaction involving humans and the digital begin and end. However, a messy description is not likely to help educators in practice make decisions about how and why they might use tinkering with unplugged technologies as form of play-based learning, especially in relation to the pedagogical provision of digital learning opportunities for children. In the three manifestations I next present [iPad, computer, and gamer], the actants are therefore illustrated as a networked map. In each manifestation, Learning Outcomes are the starting point for the networked maps, thus reflecting Learning Outcomes as the central unit of analysis in the project [due to children's learning being a motivating object of activity for educators]. Tracing the actants involved following the educator interview data where Learning Outcomes were identified to the subsequent representation of the next actant in the data set [e.g., videos and photographs].

6.2.1 iPad

iPad was the first manifestation identified in this study. It comprised fourteen material, non-material and participant actants in total [Figure 6.1]. Material actants were illustrated as rounded-rectangular shapes, non-material actants as rectangular shapes and participant actants as triangular shapes.

Figure 6.1

iPad as Manifestation Comprising Fourteen Material, Non-Material, and Participant Actants



To create the iPad map, ‘Showing interest in technologies’ (QCAA, 2018) [1] was first followed to its association with educator [2] as participant actant because educators identified this particular Learning Outcome. Educators as participant actants were associated directly with myself [2] as participant actant because as the researcher I interacted directly with educators during all stages of the co-design process. Both the educators and I collaborated to plan for play-based learning and traced this to purposefully framed play [3] as actant.

Purposefully framed play was then followed to child [4] as participant actant because children were direct participants in the play. Purposefully framed play included the provision of support learning materials to children. As a result, child as actant was followed to a range of support learning materials which included, group discussions [5] as non-material actant, a visual mind-map [5] as material actant, the use of laminated images [5] of input devices and computer systems as material actants, the use of a picture book [5] as material actant, as well as the episode ‘Ask the StoryBots™’ [5] also as material actant. These actants were linked to funds of knowledge [6] as non-material actant where children drew from their lived experiences with technologies to demonstrate prior knowledge of iPads.

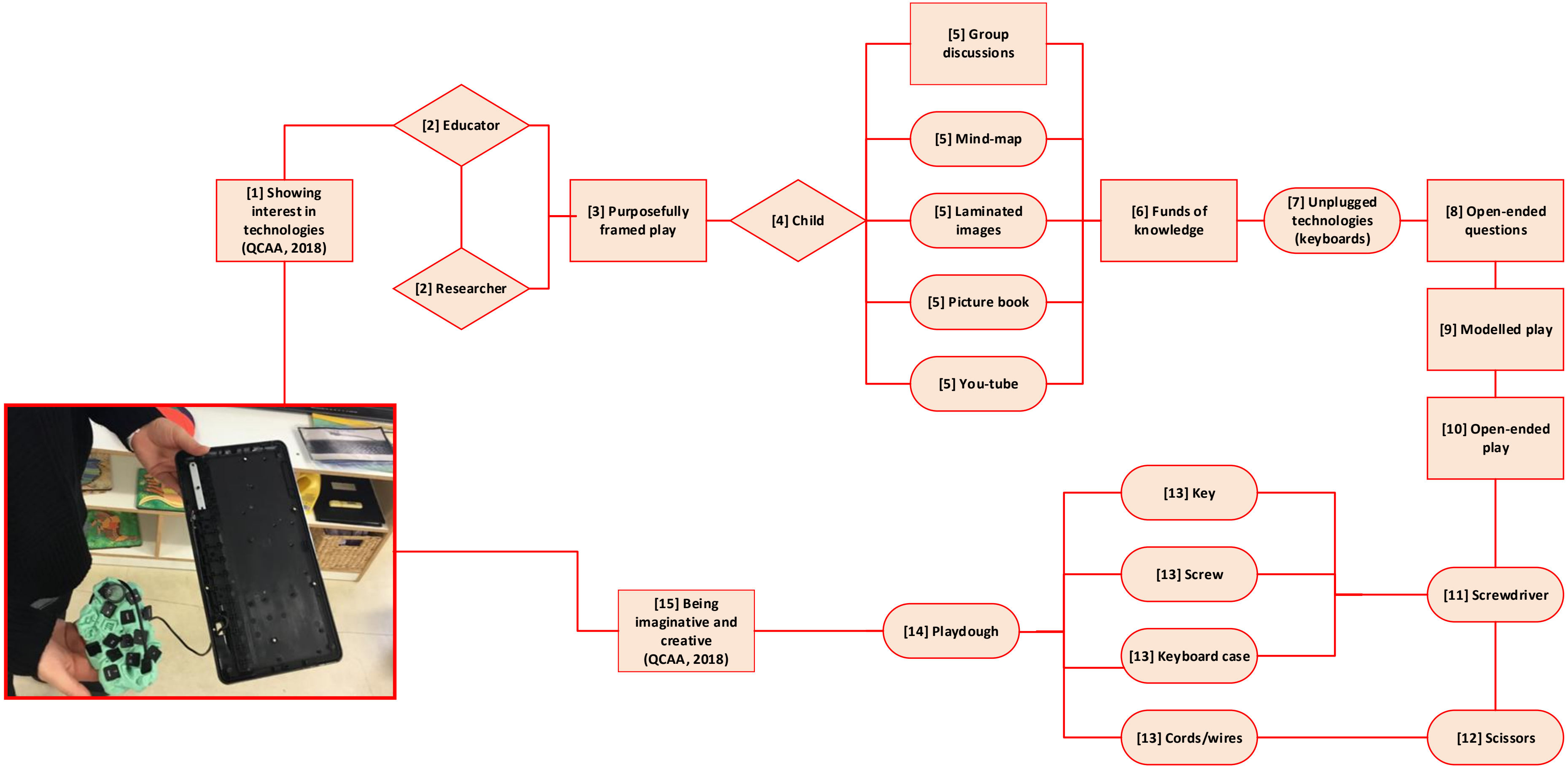
Funds of knowledge [6] as actant was then traced to the introduction of unplugged technologies [7] as non-material actants, including computer keyboards and to a series of open-ended questions [8] asked of children by educators, including *“what is this?”* and *“what does it do?”* as non-material actants. Open-ended questions as non-material actants were traced to modelled play [9] as non-material actants and open-ended play [10] as non-material actants as children engaged in deconstruction. Modelled and open-ended play as non-material actants connected to screwdrivers [11] as material actant which resulted in a number of deconstructed loose parts materials [12] including keyboard case, screws and individual keyboard keys. Once unplugged technologies as actants were deconstructed into smaller loose parts, these materials were directly connected to playdough [13] where children combined and experimented with materials according to their own individual interests. Material loose parts [13] were then connected to 'Being imaginative and creative' (QCAA, 2018) [14] as a non-material actant. This was because children continued to engage in exploration of the material actants, which resulted in the creation of their own versions of technologies [e.g., iPads], which the educators consequently identified as the Learning Outcome 'Being imaginative and creative' (QCAA, 2018), thus bringing the network map for iPad as manifestation to close.

6.2.2 Computer

Computer was the second manifestation identified in this study. It comprised fifteen material, non-material and participant actants in total [Figure 6.2]. Material actants were illustrated as rounded-rectangular shapes, non-material actants as rectangular shapes and participant actants as triangular shapes.

Figure 6.2

Computer as Manifestation Comprising Fifteen Material, Non-Material and Participant Actants



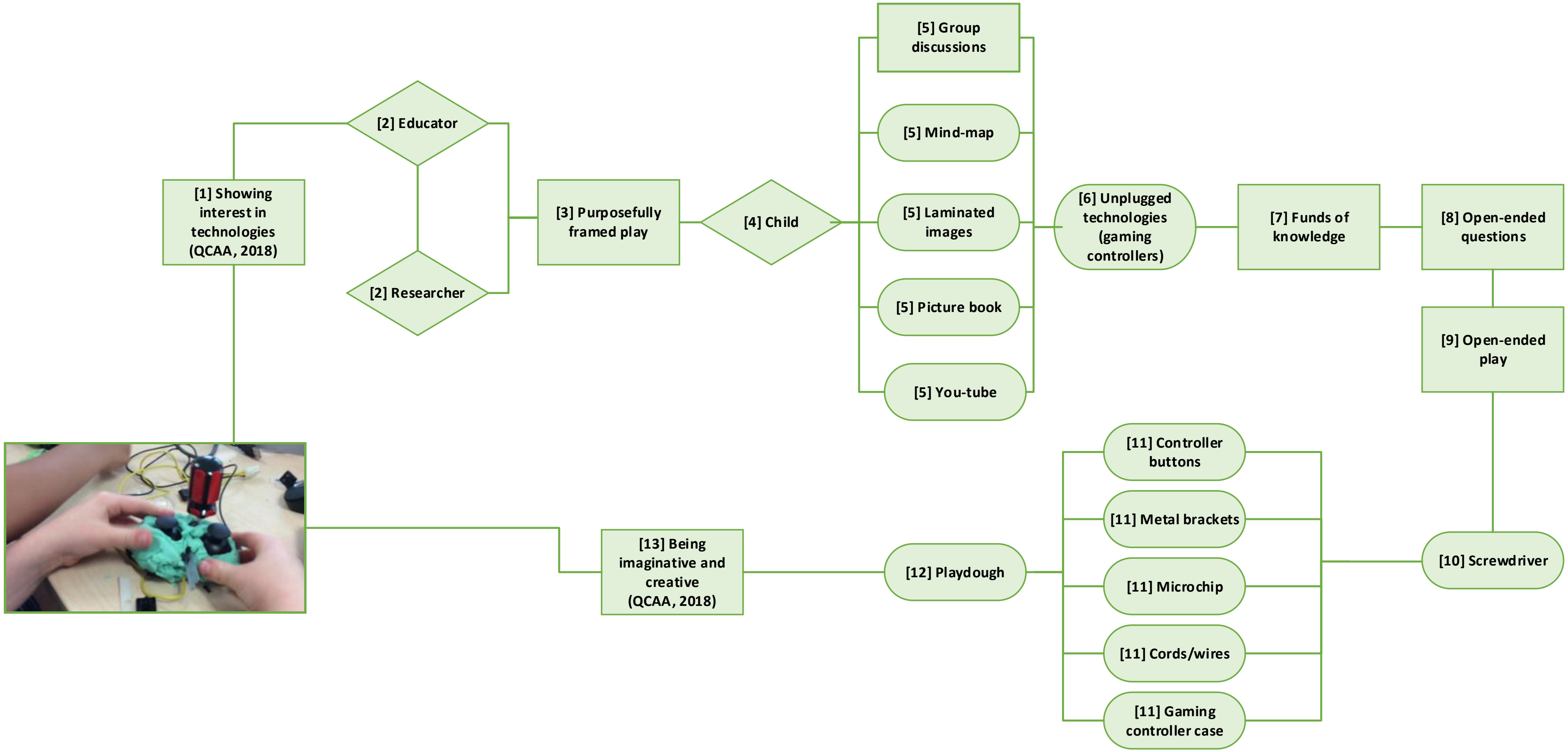
To create the computer map, the starting point was again Learning Outcome 'Showing interest in technologies' (QCAA, 2018) [1]. The pathway in the computer map was the same as for iPad, in terms of actants from [1] through to [6]. Funds of knowledge [6] as actant was followed to unplugged technologies [7]. Unplugged technologies [7] as non-material actant was traced to open-ended questions [8] as non-material actant, involving children and educators in discussions about the function, purpose, and internal composition of unplugged technologies. Open-ended questions as actant [8] were in turn mapped to modelled play [9] as non-material actant to ensure safe use of tools and materials and to aid children whenever they required assistance. Open-ended questions [8] were linked to open-ended play [10] as non-material actant when children explored and made choices about the tinkering tools, they were using to deconstruct the unplugged technologies. Children choose screwdrivers [11] as material actant to aid in deconstruction, with some children additionally selecting scissors [12] as material actant '*to snip'* or shorten cords/wires. Screwdriver [11] and scissors [12] were followed to a range of deconstructed loose parts of unplugged technologies, including keyboard case [13], screw [13], individual key [13] and cords/wires [13]. Deconstructed loose parts [13] were subsequently mapped to playdough [14] as a material actant because children experimented with combining loose parts with playdough to create their own versions of technologies, resulting in educator identified Learning Outcome 'Being imaginative and creative' (QCAA, 2018) as a non-material actant [14].

6.2.3 Gamer

Gamer were the third manifestation identified in this study. It comprised thirteen material, non-material and participant actants in total [Figure 6.3]. Material actants were illustrated as rounded-rectangular shapes, non-material actants as rectangular shapes and participant actants as triangular shapes.

Figure 6.3

Gamer as Manifestation Comprising Thirteen Material, Non-Material and Participant Actants



To begin the gamer map, the educator identified Learning Outcome ‘Showing interest in technologies’ (QCAA, 2018) [1] was once again the starting point. Actants [1] through to [8] were the same as for the mapped network in iPad and computer. Open-ended questions [8] as non-material actant were subsequently mapped to open-ended play [9] as non-material actant. Modelled play was not reported in this assemblage because by time of this third tinkering implementation in which the gaming controllers were introduced, the children were very familiar with the deconstruction process and used tools confidently and safely. Open-ended play [9] with the controllers involved children making their own choices of tools used to extend their interests in the interior make up of controllers. Screwdriver [10] as material actant was then identified in the deconstruction of the gaming controllers into loose parts materials [11]. Once gaming controllers were deconstructed into loose parts [11], the children began to explore and experiment with these materials, combining them with playdough as actant [12]. Children’s combined materials lead to the educator identified Learning Outcome ‘Being imaginative and creative’ (QCAA, 2018) as actant [13].

6.3 Orientating to the Manifestations Through Curriculum Frameworks

According to Latour (2005) what occurs between actants at points of connection can induce two or more actants into “co-existing” (p. 108). Co-existing is a process referred to as translation (Callon,1990). Translation occurs at nodes of association when one actant works on another “to translate it or change it to become part of a network of coordinated things and actions” (Fenwick & Edwards, 2010, p. 9). ANT in this network involves continuous dynamic translations, deploying strings of actants which create associations with other actants which did not exist before. In other words, there is “no society, no social realm, and no social links, but there exist translations between mediators that may generate traceable associations” (Latour, 2005, p.108) which grow and expand actor-networks. Actor-networks are fluid and dynamic taking on different shapes, aims and capacities according to the success or failure of translations between actants. Actor-networks themselves are simultaneously linked and are "capable of nesting within other diverse networks" (Muniesa, 2015, p. 1). Taken from this perspective, it is necessary to orientate the manifestations of iPad, computer and gamer to the wider actor-network from which they necessarily derive in terms of curriculum frameworks. In this study, those curriculum frameworks were the EYLF V2.0 (AGDE, 2022) and the QKLG (QCAA, 2018), especially given that the Learning Outcomes were derived from the QKLG (QCAA, 2018).

Under National Law and Regulations, all ECEC services in Australia are mandated to provide educational programs for children based on an approved learning framework (ACECQA, 2020). The EYLF V2.0 (AGDE, 2022) acts as a nationally recognised learning framework which is used as an overarching document in conjunction with state approved learning frameworks such as the QKLG (QCAA 2018), as used in this project. The EYLF V2.0 (AGDE, 2022) represents the collaboration of early childhood experts, practitioners, relevant institutions, and bodies, as well as Federal, State and Territory Governments in response to the need to ensure quality and consistency in the delivery of ECEC programs to young children (ACECQA, 2020). As a curriculum framework for educators, the EYLF V2.0 (AGDE, 2022) positions play as a context for learning through which young children organise and make sense of their social worlds, as they engage actively with people, objects, and organisations. Consequently, play-based learning is foundational to the EYLF V2.0 (AGDE, 2022) involving educators in play-based and intentional approaches to pedagogy that support children's learning in terms of identifiable Learning Outcomes. Five such Learning Outcomes are indicated in the EYLF V2.0 (AGDE, 2022) including:

1. Children have a strong sense of identity
2. Children are connected with and contribute to their world

3. Children have a strong sense of wellbeing
4. Children are confident and involved learners
5. Children are effective communicators

Learning Outcomes include skills, knowledge, or dispositions that educators can actively promote in ECEC settings (AGDE, 2022).

From an ANT perspective, the EYLF V2.0 (AGDE, 2022) can be viewed as an actor-network of actants aligned to achieve Learning Outcomes for children via play-based learning. Consequently, the EYLF V2.0 (AGDE, 2022) represents a stable assemblage which has become translated into a nationally accepted set of standards, practices, and principles to which pre-existing state-based learning frameworks [in the case of this study the QKLG (QCAA, 2018)] are enrolled. Within this curriculum-framework-network, many actants [e.g., government bodies, policy makers, child advocacy groups, play-based learning, intentional teaching, policy makers, curriculum documentation, Learning Outcomes, observation and assessment processes, educators, children, parents] are mobilised into accepting their roles and performing in expected ways. Within this curriculum-framework-network, play-based learning in particular performs as a dominant actant indispensable to the achievement of children's Learning Outcomes within the EYLF V2.0 (AGDE, 2022) and QKLG (QCAA, 2028). This dominance is evident in contemporary literature about play-based learning in Australia and in the relationship between play-based learning and intentional teaching (Fesseha & Pyle, 2016; Grieshaber et al., 2021; Leggett, 2017).

From an ANT perspective, play-based learning therefore works as an Obligatory Passage Point. Obligatory Passage Points operate as gatekeepers between other actants in the formation of a network. They position themselves as indispensable to the network and modify other actants to align with its needs (Booth et al., 2016). Play-based learning as Obligatory Passage Point means that all actants associated with the EYLF V2.0 (AGDE, 2022) and the

QKLG (QCAA, 2018), including educators, children and technologies, must align with play in some manner to remain part of the coordinated actions comprising the network itself. The three manifestations identified in this project are therefore no different, because their relationship to the QKLG (QCAA, 2018) via the educator identified Learning Outcomes means they must be shaped by play-based learning in some manner. This is because play is positioned with the curriculum-framework-network as the mode of learning via which Learning Outcomes are achieved.

6.4 From Play-Based Learning as Obligatory Passage Point to Manifestations as Networks

Play-based learning as an Obligatory Passage Point shapes the formation of the manifestations confirmed in this project as networks, commencing with educator identified Learning Outcomes as an actant. The actions and interactions of curriculum-framework-networks are therefore present in the networks illustrating the manifestations [e.g., iPad, computer, and gamer]. Actants can be material, non-material or participant and in these forms can operate as either intermediaries or mediators within the network. Intermediaries transport meaning between actants without transforming that meaning (Caldwell & Dyer, 2020; Cresswell et al., 2010). In contrast, mediators act to “transform, translate, distort, and modify the meaning or the elements they are supposed to carry” (Latour, 2005, p. 39), and may change a setting in unexpected ways. Unlike an intermediary, the input of a mediator is not a reliable predictor of output because a mediator can lead in multiple directions. According to Latour (2005), the distinction between intermediaries and mediators is relational because each enacts the other into existence. Generally, ANT assumes that any given network will be constituted mostly by mediators and a few intermediaries.

In the next section of this chapter, I explain and define how the actants evident in iPad, computer and gamer as manifestations variously operate as either intermediaries or mediators. I present the actants as they are broadly indicated in the network maps [e.g., Figure 6.1; Figure 6.2; Figure 6.3] beginning with Learning Outcome: 'Showing interest in technologies' (QCAA, 2018)[1], educators and myself-as-researcher [2], purposefully-framed play [3], children [4], learning materials and group discussions [5], funds of knowledge [6], unplugged technologies [7], open-ended play and questions [8], modelled play [9], screwdriver and scissors [10], loose parts [11], playdough [12] and Learning outcome: 'Being imaginative and creative' (QCAA, 2018) [13].

6.4.1 Learning Outcome: 'Showing Interest in Technologies' as Intermediary

The educator identified Learning Outcome 'Showing interest in technologies' (QCAA, 2018) operates within the mapped networks of the manifestations as an intermediary. This is because from an ANT perspective, texts, such as curriculum frameworks work as an intermediary of inscription. Inscription transports programs of action from one network to another related network, i.e., Learning Outcomes from the QKLG (QCAA, 2018) as a network to the mapped network of iPad, computer and gamer. Learning Outcomes as an intermediary within all three manifestations codifies meaning essential for the stabilisation, growth, and extension of the EYLF V2.0 (AGDE, 2022) initially and consequentially the QKLF (QCAA, 2018) as an actor-network (Fenwick, 2010). Learning Outcomes are therefore intermediary actants which "transport meaning or force without transformations" (Latour, 2005, p. 39), i.e., they are actants which carry meaning without changing that meaning. Moreover, Learning Outcomes as intermediaries move across two identifiable networks in this study, curriculum-framework-networks and the networks of the mapped manifestations. In doing so, the specific Learning Outcome 'Showing interest in technologies' (QCAA, 2018) maintains play-based learning as an Obligatory Passage Point because it is only through this point that Learning Outcomes can be used to permit or reject any emergent networks. This confirms the decision in this thesis to use educator identified

Learning Outcomes as unit of analysis because research shows educators are motivated by evidence of children's learning from play-based activities, especially in relation to digital technologies (Nuttall et al., 2015).

6.4.2 Educators and Researcher as Mediator

Educators and myself-as-researcher serve as mediators within the mapped networks of iPad, computer, and gamer. This is because the Learning Outcome was the first actant was identified by educators, who themselves operated as translated actants within the QKLG (QCAA, 2018) as a preparatory network to those of the manifestations. Here, recognising that play-based learning relative to technology integration in ECEC is difficult due to the perception of play as hand-on and the digital as abstract and possibly inappropriate for young children (Nikolopoulou & Gialamas, 2015b; Palaiologou, 2016b), the educators and I accepted our roles within the co-design process. These roles being to share our expert knowledge, and to engage with various other actants [e.g., play-based learning, tinkering tools and unplugged technologies]. In this research, translations between educators and the myself led to a string of actions which expanded the respective networks of each manifestation into tinkering related activities from which iPads, computers, and gamers were created by children as versions of technologies, which educators went on to re-identify as the second Learning Outcome: 'Being imaginative and creative' (QCAA, 2018). Mediators are actants which actively work to change meaning in the process of transferring to the next actant, and in doing so, often "make others do unexpected things" (Latour, 2005, p. 106). This occurred as the educators and I drew upon purposefully framed play as the next actant to invite the children into tinkering with unplugged technologies.

6.4.3 Purposefully Framed Play as Mediator

Purposefully framed play worked as mediator in the mapped networks of iPad, computer, and gamer. During the first stage of this project, educators and myself-as-researcher participated in a group planning session that enrolled purposefully framed play into our shared activity. Purposefully framed play is an approach to play-based pedagogy incorporating various levels of educator involvement to support children's learning through for example, provisioned learning environments and teaching strategies to scaffold children's conceptual learning (Edwards & Cutter-Mackenzie, 2013). Purposefully framed play represents an intentional approach to play-based learning involving educators being deliberate and purposeful in their planning and actions (AGDE, 2022). In this project, educators and myself-as-researcher engaged in discussions to intentionally design an approach to play-based learning via tinkering with unplugged technologies. Here purposefully framed play mediated what and how the children would encounter the tinkering because mediators "transform, translate, distort, and modify the meaning or the elements they are supposed to carry" (Latour, 2005, p. 39). Consequently, purposefully framed play carried the meaning of play-based learning conducted in an intentional manner. Purposefully framed play as mediator therefore added to and modified the ongoing chains of action between actants (Sayes, 2014) within each mapped network, directly impacting the translation of other actants [e.g., children] into the network itself.

6.4.4 Children as Mediator

Purposefully framed play as a mediator served to enrol children as participant actants into the mapped networks of iPad, computer and gamer. Children were reported by educators to show high levels of focus in and engagement in tinkering with unplugged technologies. High levels of involvement can suggest a state of intense, wholehearted mental activity, characterised by sustained concentration and intrinsic motivation (AGDE, 2022). For example, Stacey remarked on the levels of '*deep concentration'* [Stacey, focus interview two] shown by children, and Emily believed that "*engagement was probably one of the big things ...having them sit there for 45 minutes to an hour"* [Emily, focus group interview two]. Such high levels of engagement indicates that children were active participants in the tinkering. Children as mediators altered the flow of the mapped networks, with their intense concentration and engagement shaping consequent chains of action for iPad, computer and gamer as manifestations (Sayes, 2014).

6.4.5 Learning Materials and Group Discussion as Mediator

Learning materials and group discussions with children were enrolled into the mapped networks as mediators by educators and myself-as-researcher following purposefully framed play. Learning materials included a visual mind-map, laminated visual images of input devices and computer systems, a picture book, and episode from 'Ask the StoryBots'™. Group discussion involved educators and children sharing ideas, information, and existing knowledge. As mediators serve to change networks, learning materials and group discussion created associations with children as actants serving to promote learning and making connections to funds of knowledge as the following actant. Learning materials and group discussions were noted by educators to influence children's subsequent open-ended play. This aligns with Latour's (2005) premise that actants are agential when in relationships with other actants [e.g., purposefully framed play in relationship with children in relationship with funds of knowledge], and therefore agency can be understood as distributed (Fenwick et al., 2015). Learning materials and group discussions therefore operated as mediators, stemming from purposefully framed play and developing children's thinking relative to their funds of knowledge, and later engagement in the networks via open-ended play.

6.4.6 Funds of Knowledge as Mediator

Funds of knowledge operated in the networks of iPad, computer, and gamer as a mediator. Research suggests that young children's interests, evident through their choices and levels of engagement in activities, can correspond to their funds of knowledge (Chesworth, 2016). Funds of knowledge are socially acquired skills and bodies of knowledge necessary for well-being and general household functioning (Moll et al., 1992). Hedges and colleagues (2011) suggest that young children generate their own funds of knowledge through family routines and activities and participation in community practices. According to the EYLF V2.0 (AGDE, 2022), funds of knowledge are "the historically accumulated experiences and understandings that an individual has and includes abilities, skills, bodies of knowledge, life experiences and cultural ways of interacting" (p. 66). Funds of knowledge are quite literally described in the EYLF V2.0 (AGDE, 2022) as a 'virtual backpack' (p.66) of all the life experiences and knowledge that a child brings into the ECEC setting.

Funds of knowledge as a mediator therefore represents the prior experiences, understandings and interests relating to young children's lived experiences in the post-digital in their homes and community settings within the emerging networks of the three manifestations of iPad, computer, and gamer. For example, Stacey commented on children's funds of knowledge relative to learning materials,

> "*They* (children) *responded really well to them* (learning materials), *and some children started connecting that to home – "my dad has a computer at home", "my mum has got one", "I've got an ipad at home" so they were making those connections with digital things"* [Stacey, semi-structured interview two].

Stacey's observation is consistent with Marsh and colleagues (2019) findings which suggest that young children's funds of knowledge are derived from everyday interactions with digital technologies.

Funds of knowledge represent the development of children's prior knowledge about digital technologies where educators, through purposefully framed play, provided opportunities for children to expand their existing understanding of technologies. For example, Emily noted,

> “*I think that having that group discussion prior to the tinkering session the children could talk about the types of devices that they had at home and how they work, so when you put things together like hardware and those input devices together, it makes something like a computer……I think in the tinkering that was what they were trying to do as they put the different materials together”* [Emily, semi-structured interview three].

Funds of knowledge therefore worked as mediator shaping children’s consequent interactions with the unplugged technologies. However, funds of knowledge themselves derive from a broader network representing young children’s lived experiences in the post-digital [i.e., all the ways in which they interact with, use, and see others interacting with and using digital technologies in their daily lives through for example using mobile devices, popular media, internet of toys, voice-conferencing applications, voice activation devices amongst many others (Nansen, 2020; Purington et al., 2017; Watson et al., 2021)]. As a mediator, funds of knowledge in the mapped networks of iPad, computer and gamer reached across the boundaries occurring between children’s experiences at home and in the ECEC settings, serving to influence the flow of action within the ongoing networks of activity. In this manner, funds of knowledge also acted as an important Obligatory Passage Point within each of the three manifestations – indispensable to the network and modifying other actants to align with its needs (Booth et al., 2016).

6.4.7 Unplugged Technologies as Intermediary

Unplugged technologies worked in the networks as intermediaries. Intermediaries transport meaning between actants without transforming that meaning (Caldwell & Dyer, 2020; Cresswell et al., 2010). In this study, unplugged technologies included non-working computers, computer mice and gaming controllers. As intermediaries transport meaning between actants, [e.g., children’s funds of knowledge to unplugged technologies to open-ended play], they hold meaning rather than transform other actants around them. A special type of intermediary is an immutable mobile. Immutable mobiles are objects, and in many cases technologies, that facilitate the standardization and reproduction of actions in different places (Law, 2002). Immutable mobiles work as objects that can be moved physically, while at the same time maintaining their relational or functional shape to stabilise a network of associations. In this project, unplugged technologies held their relational shape for children as representative of the digital although in non-working form.

From an ANT perspective, in the context of this unfolding assemblage, unplugged technologies functioned as delegates of the wider actor-network of digitality accessed through funds of knowledge, discussed in the previous section. From this viewpoint, computer keyboards, computer mice and gaming controllers performed as immutable mobiles to transport behaviours, knowledge, and meaning necessary for expansion of networks of digitality. Described by Law and Singleton (2005), according to Latour (1987) immutable mobiles are objects that can be transported physically or geographically, while at the same time maintaining their relational or functional shape to stabilise a network of associations. These objects enact long-distance control and maintenance of stability which enable networks to hold themselves together. In the case of the iPad, computer, and gamer networks this is evident in the manifestations of the children's lived experiences in the post-digital, especially through their funds of knowledge in relation to the unplugged technologies themselves. According to Michael (2018), immutable mobiles mandate particular rules of use to get them to 'work', whereby specific capacities and skills need to be incorporated because "human comportment needs to adapt to the demands of the technology" (p.17). In this study, unplugged technologies as intermediaries did not necessarily change actants around them, but continued to work in their immutable form, for example children would use buttons or keys as buttons or keys in their own versions of technologies.

6.4.8 Open-Ended Play and Questions as Mediator

Open-ended play and questions operated in the network as mediators acting to shape other actants in the network. This occurred as children and educators engaged with unplugged technologies and provided opportunities for building onto children's funds of knowledge. Open-ended play with unplugged technologies saw children exploring, deconstructing and re-using the loose parts materials generated through tinkering. This play, alongside open-ended questions by educators fostered a mindset amongst the children driven by inquiry to investigate the internal composition of keyboards, mice, and controllers. For example, educators asking the children *"what is this?"* and *"what does it do*?" [Tinkering implementations 1-3]. Likewise, children were seen to be highly exploratory, with Emily noting "*they pulled apart the little signal sheets inside and then all of a sudden, the keys were coming out!"* [Emily, focus group interview two]. Latour (2005) suggests that when in relation with other actants mediators can be agential, and in the case of open-ended play and questions this fostered children's curiosity and exploration of the unplugged technologies.

6.4.9 Modelled Play as Intermediary

Modelled play operated as an intermediary in the mapped networks of iPad, computer and gamer. Intermediaries transport meaning between actants without necessarily transforming meaning. In this study, modelled play involved educators in experiences where the educator illustrated, explained and/or demonstrated the use of materials (Edwards & Cutter-Mackenzie, 2013). Modelled play was especially used by educators to help children get started on the deconstruction process and to demonstrate safe use of tools. For example, Julia explained:

> *"I had to show them a few things to get them to started, so I had to prompt them a bit more to start with but once they realised what they could do then they could*

> *keep going on their own, "oh look there is a screw!", "there's another screw!"* [Julia, focus group interview two].

It is important to note that modelled play was not evidenced in the gamers network, because by the time of this tinkering implementation children were largely confident and competent in using the tools on the unplugged technologies.

Modelled play as an intermediary, helped the network to translate other actants, including child, educator and unplugged technologies to perform particular roles. For example, working on children as actant to transport meaning and behaviour [e.g., about how to open unplugged technologies in a safe manner] without necessarily changing that meaning [e.g., of the open action demonstrated by educators]. Modelled play as intermediary "simply transported intactly" (Latour, 2005, p. 105) ways that the children could deconstruct unplugged technologies [e.g., '*turn the screw left to loosen and open']* as demonstrated by educators.

6.4.10 Screwdrivers and Scissors as Intermediaries

Screwdrivers and scissors were also intermediaries in the mapped networks of iPad, computer and gamer, holding their form and function as tools achieving specific goals for the children within the act of tinkering. Julia captured this notion of screwdrivers and scissors as relativity unchanging, saying they were "*closed ended in that they just screw and are used to put a screw in or take a screw out"* [Julia, semi-structured interview two] and consequently required children to act or use them in certain ways. When performing as intermediaries, actants for all their potential complexities always lead in one direction (Goodchild & Ferrari, 2021), in this case towards children's engagement with loose parts derived from their tinkering with the unplugged technologies. Consequently, those loose parts were only possible to achieve due to the functional status of screwdrivers and scissors.

6.4.11 Loose Parts as Mediators

Loose parts derived from the children's deconstruction of the unplugged technologies worked as mediators in the networks of iPad, computer and gamer. Mediators have capacity to evolve the network through their influence on other actants. In this study, loose parts derived from the unplugged technologies included computer keys, controller buttons, screws, keyboard, controller cases, cords and wires. Stacey described how loose parts informed children's versions of technologies in the form of iPads, essentially describing the mediating activity of these parts: "*We had children that used the keys that were popped out from the keyboard, and they made their own iPads"* [Stacey, focus group interview three]. Emily also reflected on the role of loose parts as mediators in children created versions of technologies,

> *"Mine were really interested in the keyboards mainly and popping out the keys and then after they finished tinkering with that they got the playdough back out and they were making their own keyboards and their own computers and some just very random things but then another one had used the wire from the keyboard into the playdough and was making that as their computer, and things like that ...so making their own version of technology"* [Emily, focus group interview three].

This description highlights how loose parts tended to support children's innovation and creativity, acting to modify or mediate meaning according to children's funds of knowledge "where passions, opinions, and attitudes bifurcate at every turn" (Latour, 2005, p. 39).

6.4.12 Playdough as Mediator

Playdough operated as mediator in all three mapped networks of iPad, computer and gamer. Mediators work to "transform, translate, distort, and modify the meaning or the elements they are supposed to carry" (Latour, 2005, p. 39). This was very much the case with playdough having a malleable material form. Julia described how this supported the children to explore and combine *"the loose parts, connecting them together mainly"* in order *"to* *extend their own ideas”* [Julia, focus group interview three]. As mediator, playdough was consistently used by children as a base material, especially for reconstructing deconstructed unplugged technologies into children’s own versions of technology. Stacey noted the children “*were pushing up the playdough to make the screen and then they were putting buttons in, and pressing them, and had a little wire out the back”* [Stacey, focus group interview three]. Playdough as mediator allowed children to transform not only the material actants in the form of loose parts, but also their funds of knowledge as non-material actants, resulting in their many versions of technologies. Here children’s lived experiences in the post-digital were facilitated through the mediatory capacity of the playdough to express children’s knowledge and understanding of technologies in material form.

6.4.13 Learning Outcome: ‘Being Imaginative and Creative’ as Intermediary

Educators identified the Learning Outcome ‘Being imaginative and creative’ (QCAA, 2018) thereby completing the networked map for iPad, computer, and gamers as an intermediary. According to ANT, texts such as curriculum frameworks work as an intermediary of inscription whereby action from one network is transferred to another (Fenwick et al., 2011). Here, the identified Learning Outcomes derived from the QKLG (QCAA, 2018) was inscribed by educators in their recognition of the children’s versions of technologies as evidence of ‘‘Being imaginative and creative’’ (QCAA, 2018). Julia explained this Learning Outcome as the children’s “*curiosity and imagination to create and explore….to develop their own ideas through the resources and to extend their own interests through the resources”* [Julia, focus group three].

Learning Outcomes as inscription maintain the stability of curriculum-framework-networks [e.g., the EYLF (AGDE, 2022) and the QKLG, (QCAA, 2018)] by ensuring that all actants relating to the curriculum adhere to principles associated with play-based learning as the formative pedagogy for achieving children’s Learning Outcomes. Thus, the Learning

Outcome ‘Being imaginative and creative’ (QCAA, 2018) was enrolled in the mapped network for iPad, computer and gamer in relation to the string of previous mediators [e.g., educators, children, funds of knowledge, open-ended play] and intermediaries [e.g., unplugged technologies, modelled play, screwdrivers and scissors], completing the network in terms of educator identified Learning Outcome ‘Being interested in technologies’ (QCAA, 2018).

6.5 Digital Technology Integration and Mapped Networks

The aim of this thesis is to understand how the integration of technologies in ECEC may be achieved via educator identified Learning Outcomes following children’s participation in tinkering with unplugged technologies as a form of play-based learning related to young children’s lived experiences in the post-digital. To address this aim, two questions were asked:

1. What Learning Outcomes do educators identify in children’s tinkering with unplugged technologies as a form of play-based learning?
2. How do young children’s experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies?

In answer to the first question, two Learning Outcomes were clearly identified, these being ‘Showing interest in technologies’ (QCAA, 2018) and ‘Being imaginative and creative’ (QCAA, 2018). Following these Learning Outcomes as starting points for a network of activity containing multiple mediatory and intermediary actants, the second question confirms children’s self-created versions of technologies in the form of iPad, computer, and gamer as manifestations of their experiences in the post-digital [following their joint participation with educators in tinkering with unplugged technologies]. These manifestations are possible and identifiable according to the string of relationships between various material, non-material and participant actants operating as either mediators or intermediaries within the opportunity provided to children via tinkering – especially as form of play-based learning [Table 6.1].

Table 6.1

Actants Making Possible Children's Versions of Technologies as Manifestations of Their lived Experiences in the Post-Digital [in Terms of Form and Operation as Per Mapped Networks for iPad, Computer and Gamer]

Actant	Form	Operation	
		Mediator	Intermediary
Learning Outcome ‘‘Showing interest in technologies’’ (QCAA, 2018)	Non-material		✓
Educators, children, researcher	Participant	✓	
Purposefully framed play	Non-material	✓	
Learning materials and Group discussion	Non-material	✓	
Funds of knowledge	Non-material	✓	
Unplugged technologies	Material		✓
Open-ended play and questions	Non-material	✓	
Modelled play	Non-material		✓
Screwdriver and scissors	Material		✓
Loose parts	Material	✓	
Playdough	Material	✓	
Learning Outcome ‘‘Being imaginative and creative’’ (QCAA, 2018)	Non-material		✓

iPad, computer, and gamer as manifestations of children's lived experiences in the post-digital were the result of continuous processes of translation performed through interactions between actants. By adopting an ANT perspective, each individual actant was examined according to how it influenced the flow of the network and exerted force on other actants as either a mediator or intermediary. This shows that of the thirteen identified actants, eight were mediators and five were intermediaries. This finding is consistent with Latour's claim that "there exist endless number of mediators" (Latour, 2005, p. 40) and that typically in any given network there will be more mediators than intermediaries. In this research adhering to the principles of generalised symmetry, material, non-material, and participant actants were afforded equal potential for generating agency with no single actant positioned as inherently stronger or weaker than another. As surmised by Harman (2007), "metaphysically speaking, all entities are on the same footing" (p.33) but capable of accruing strength through assembling numerous other allies. Consequently, all actants had capacity to become powerful depending on the balance of their interactions resulting in iPad, computer, and gamer as manifestations of children's lived experiences in the post-digital in relation to educator identified Learning Outcomes in children's tinkering with unplugged technologies.

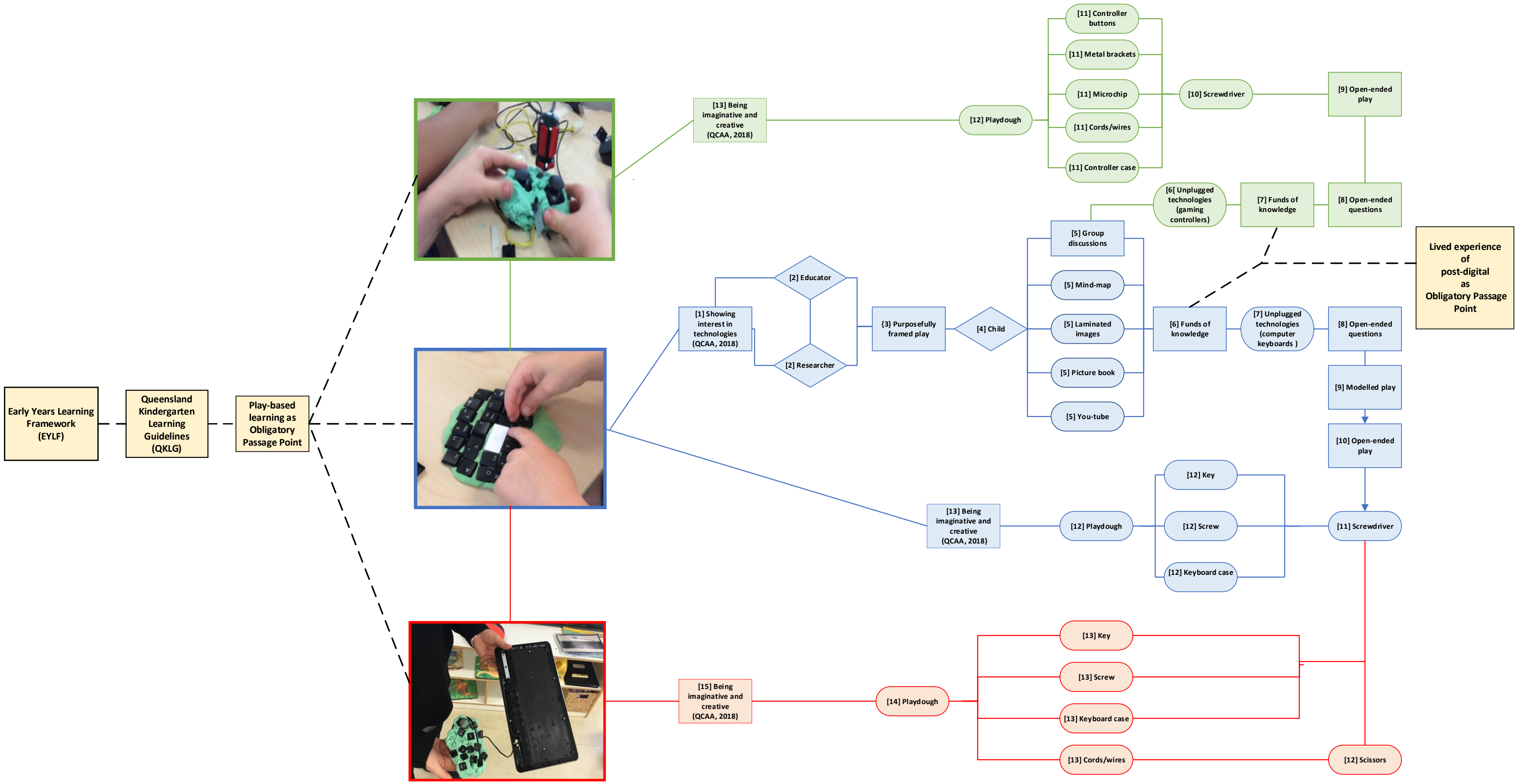
Despite actants being on the same footing metaphysically, they are capable of differing levels of agency according to their operation in the network, especially as a mediator or intermediary. This shows in the three identified manifestations of iPad, computer, and gamers, especially in their connection to external networks. Here, two external networks had clear importance for the manifestations including curriculum-framework-networks via play-based learning, and children's lived experiences in the post-digital via funds of knowledge. Consequently, Latour's (2005) claim that "what is acting at the same moment in any place is coming from many other places, many distant materials, and many faraway actors" (p. 200) becomes evident. Play-based learning as pedagogically valued in ECEC through Learning Outcomes was inherent in operating as an Obligatory Passage Point via which young children's learning could be identified and achieved. By way of a reminder, Obligatory Passage Points operate as gatekeepers between other actants in the formation of any new network to position themselves as indispensable to that network and modify other actants to align with its needs (Booth et al., 2016). This is important to the problem of educator integration of digital technologies in ECEC because the historical value placed on play as a mode of hands-on learning has at times implied technologies as too abstract to support young children learning.

Funds of knowledge also emerged as an important actant, derived from another external network [young children's lived experiences in the post-digital] because it acted upon play to give digitality a presence within each of the mapped networks [in alignment with other actants including unplugged technologies]. In other words, through funds of knowledge, children's experiences in the post-digital flowed through the tinkering network transforming the available material actants, including unplugged technologies, deconstructed loose parts and playdough. It was this mobilisation of the material by the children's funds of knowledge, as non-material, which resulted in the interweaving of the children's experiences in the post-digital with their tinkering. In this manner, funds of knowledge, like play-based learning, appears as an Obligatory Passage Point through which all other actants in the network were aligned with children's interests and needs in terms of their lived experiences in the post-digital. For example, funds of knowledge modified unplugged technologies as intermediaries to act as delegates of children's experiences in the post-digital. In doing so, unplugged technologies performed as immutable objects to transport information and knowledge about what and how technologies are used in daily life, thereby mandating specific behaviours in relation to other actants [i.e., pressing a key to input information to the computer ‘brain’]. Children’s funds of knowledge, derived from their lived experiences in the post-digital, shaped how deconstructed loose parts were re-designed and represented through associations with playdough. Playdough in turn was mobilised as mediator through which children could express their own versions of technologies as manifestations of their lived experiences in the post-digital.

With play-based learning and funds of knowledge operating as Obligatory Passage Points in each of the three networks comprising the manifestations [e.g., iPad, computer, gamer], the problem of educator integration of technologies may be addressed by directing educator attention to the networks themselves, and specifically how to actants within the networks mediate children’s lived experiences in the post-digital. Instead of being concerned that technologies do not align appropriately with play-based learning or are too abstract for children, educators can orientate towards any given actant within the network as a starting point for technology integration – albeit with non-working technologies. Funds of knowledge would seem particularly important in this orientation given the role of this actant on children’s created versions of technologies. Figure 6.4 presents each of the mapped networks of iPad, computer, and gamer as a summary of the actants in operation, including their connection to two important external networks [the EYLF (AGDE, 2022) and the QKLG (QCAA, 2018)] and young children’s lived experiences in the post-digital [via funds of knowledge], whereby play-based learning and children’s lived experiences in the post-digital operate as Obligatory Passage Points respectively.

Figure 6.4

Teachers can Direct Attention to Actants within a Network of Activity Involving Children in Tinkering with Unplugged Technologies as a Form of Play-Based Learning to Support Technology Integration in ECEC



6.6 Conclusion

This chapter has presented the mapped networks for each of the three identified manifestations of young children's experiences in the post-digital, including iPad, computer and gamer. How the various material, non-material, and participant actants in the networks operate as either mediators or intermediaries has been detailed. The significance of curriculum-framework-networks via play-based learning as an Obligatory Passage Point for educator identified Learning Outcomes has been highlighted. Moreover, children's lived experiences in the post-digital as an Obligatory Passage Point informing funds of knowledge was positioned as an important mediating actant in the creation of children's own versions of technologies. In the next and final chapter of this thesis I consider how ANT has shed light on how the range of actants and their operations involved in children's tinkering with unplugged technologies, as a form of play-based learning, might help address the ongoing problem of digital technology integration in ECEC.

CHAPTER 7 : CONCLUSION

7.1 Introduction

This chapter lays out the conclusion to this thesis. Firstly, the chapter revisits the problem addressed by this research and then restates the aim and research questions. Next, this chapter provides a brief review of the core theoretical ideas underpinning this research, followed by a summary of key findings. After that, the findings are considered in relation to how they address the research problem, and the new knowledge pertaining to ECEC to which the research contributes. Limitations are then discussed, along with areas for future research.

7.2 The Problem Addressed by this Research

Literature chronicles the pedagogical importance of integrating digital technologies into ECEC settings, however inclusion of technologies in play-based learning and intentional teaching still remains a long-standing and significant challenge for the sector (Hatzigianni & Kalaitzidis, 2018; Schriever et al., 2020; Vidal-Hall et al., 2020). Extant research has examined barriers to integration reporting that educator beliefs and attitudes towards digital technologies in pedagogy, as well as lack of knowledge, skills and confidence strongly influence technology uptake by practitioners in ECEC (Fenty & Anderson, 2014; Palaiologou, 2016b; Plowman & McPake, 2013). The problem of integration can be seen across three generations of research about young children and digital technologies (Edwards, 2022). Early first generation thinking engaged in debates around whether ‘to use or not to use’ due to concerns about technologies as too abstract to support young children’s learning. Second generation thinking, made possible through rapid technological advancements from 2000s onwards [especially in touchscreen and mobile technologies], recognised and positioned technologies as pedagogically viable in ECEC settings in the form of digital play through the application of conventional theories of play including developmentalism, constructivism and socio-cultural theory (Edwards, 2013; Marsh, 2010; Verenikina & Kervin, 2011). Third generation thinking is currently evolving to acknowledge a 'post-digital' moment in time whereby researchers and practitioners recognise that digital technologies are now so interlaced with the lived experiences of young children and families that it is almost impossible to avoid them in ECEC settings. This has led to descriptions of post-digital play which suggest digital and non-digital materiality have become messy and entangled in contemporary early childhood play practices. Conceptualised through theoretical frameworks, such as socio-materialism (Orlikowski, 2007; Pettersen, Silseth et al.,2022) and posthumanism (Latour, 2005), literature reports that educators are now beginning to recognise that play and learning can be co-constructed by children when in relationship with the digital and non-digital to create meaningful learning experiences. However, whilst educators are now more accepting of embedding technologies in play-based learning and intentional teaching, they are not necessarily sure how to achieve this pedagogically (Havu-Nuutinen et al., 2017; Kewalramani & Havu-Nuutinen, 2019; Nuttall et al., 2015).

The pedagogical problem is also related to the historical and ongoing importance of play-based learning in ECEC as a mode of learning for children in Western-European traditions (Stephen, 2010). Play-based learning and intentional teaching [or more recently discussed in the updated EYLF V2.0 as 'intentionality'] in curriculum is now aligned to academic Learning Outcomes stipulated by ECEC policy documentation (AGDE, 2022) with increased educational accountability and focus on improved academic standards (OECD, 2015; Weisberg et al., 2013). Moreover, literature shows that educators are directly motivated by evidence of children's learning from play-based activities, especially in relation to digital technologies (Nuttall et al., 2015). Tinkering and making have been shown to engage young children in meaningful learning experiences in relation to makerspaces, STEM and STEAM (Bers et al., 2014; Peppler et al., 2019; Wohlend et al., 2018). Tinkering as a physical, hands-on exploratory activity (Parisi et al., 2017) is recognisable as a form of play-based learning to educators because it encompasses open-ended as well as guided discovery and creative experimentation within provisioned learning environments, which can align with intentional teaching (Bevan et al., 2014; Martinez & Stager, 2019).

Moreover, literature reports that making and tinkering can facilitate young children to draw upon rich funds of knowledge derived from their lived experience in the post-digital to move fluidly between digital and physical worlds in post-digital play (Marsh et al., 2019). Funds of knowledge relate to children's interests which can reflect their choice of activities and subsequent engagement levels in activities in ECEC settings (Chesworth, 2016). One key source of funds of knowledge acquired by young children in their home and community settings is derived from their experiences with digital technologies (Marsh et al., 2019). Tinkering and making provide opportunities for educators to connect with intentionality in play-based learning using tinkering and children's rich at-home experiences with technologies (Gonzalez et al., 2005). Whilst recent literature explores making and tinkering in ECEC (Marsh, 2019a; Peppler et al., 2019; Wohlend et al., 2018), tinkering with unplugged technologies is under-investigated as a possibility for addressing the problem of digital technology integration in ECEC.

7.3 Aim and Research Questions

Given this set of related issues especially concerning play-based learning, digital technology integration, children's Learning Outcomes and young children's lived experiences of the digital, the aim of this research project was to understand how the incorporation of technologies in ECEC may be achieved via educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies as a form of play-based learning related to young children's lived experiences in the post-digital. The research questions supporting this aim were:

1. What Learning Outcomes do educators identify in children's tinkering with unplugged technologies as a form of play-based learning?

2. How do young children's experiences in the post-digital manifest in educator identified Learning Outcomes following their joint participation in tinkering with unplugged technologies?

7.4 Core Theoretical Ideas

This project used Actor-Network Theory [ANT] (Latour, 2005) as an available theoretical framework within Science and Technology Studies [STS]. STS offers models of social constructivism which view relations between people and technologies as socially constructed, arising from deeply social processes of technological development (Wyatt, 2008). Social constructivism critiques and challenges the limitations of technological determinism, a theory of technology which argues that technologies impact directly on society to shape and determine events (Sismondo, 2007) by considering the mutual influence of people and technology in social processes and knowledge production. Through problematising the assumption that technologies are primarily determinant of what happens to children, social constructivism was selected as a viable ontology for this research project in light of children's lived experiences in the post-digital. This is because, as mentioned previously, notions of the post-digital argue that children's social practices are so interwoven with technologies that it is no longer appropriate to situate the digital as distinct to the everyday and separate to human and social life. ANT as a representative form of social constructivism is reflective of this post-digital claim because it acknowledges the non-binary perspective inherent in descriptions of the post-digital as constituting networks of social practices and non-human materials and artefacts.

In this study, core concepts derived from ANT were used to address the project aim. These were actants, generalised symmetry, translation [including mediators and intermediaries] and translation in action [Obligatory Passage Points]. In ANT terminology, an actant is considered as any ‘thing’ [human or non-human] which acts, interacts with or influences something else. Non-human actants can be understood as material and tangible [e.g., unplugged technologies] as well as non-material or abstract [e.g., Learning Outcomes and funds of knowledge]. From an ANT perspective, actants connect to each other and act on each other forming dynamic shifting webs of associations called actor-networks, with all actants [human, material and non-material] afforded equal potential for agency as per ANT principles of generalised symmetry.

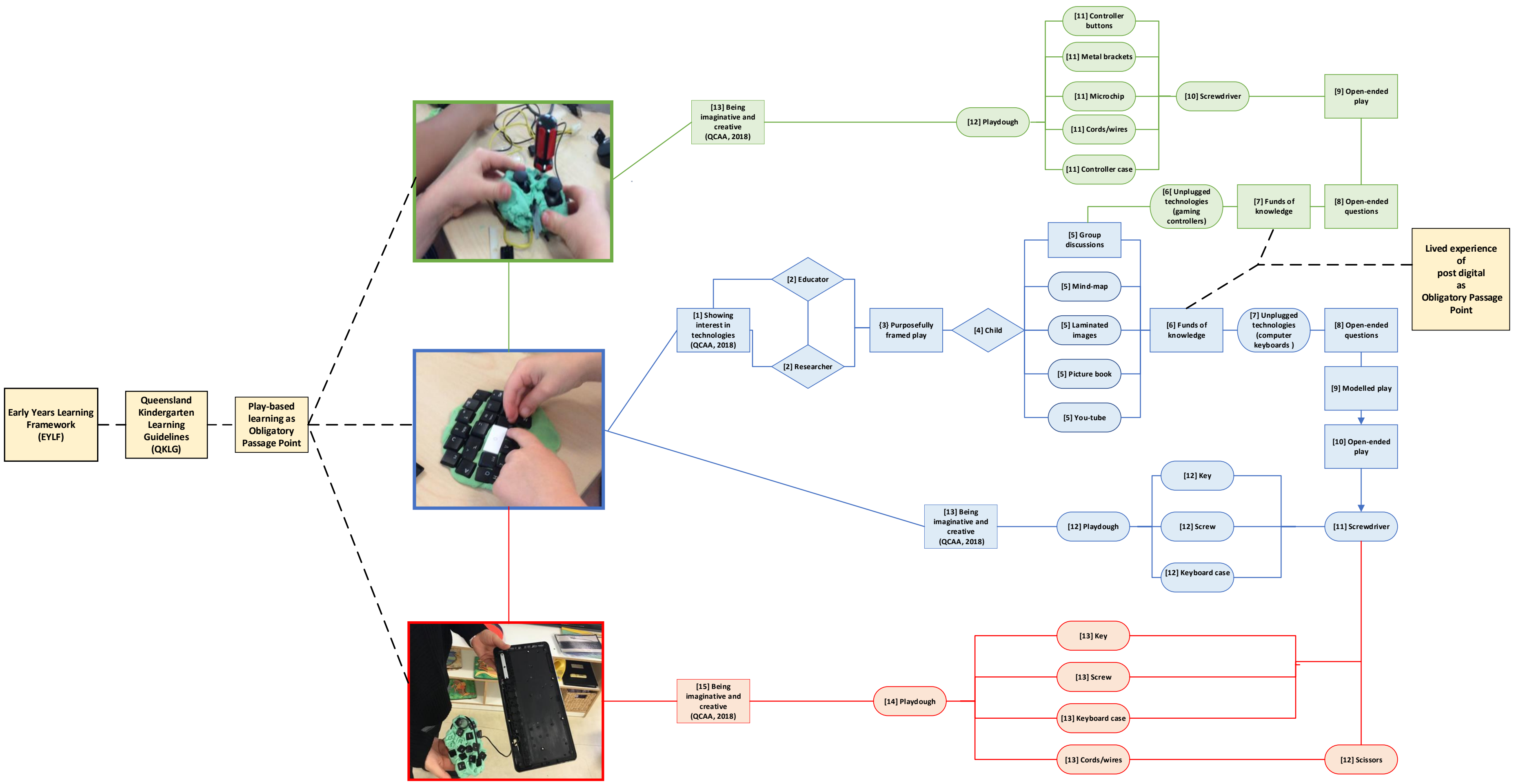
Translation describes what happens when actants come together and generate new associations to consequently grow or expand actor-networks. Translation is enabled by different forms of actants which are described in terms of their capacities to perform specific roles. Two such roles include acting as mediators or intermediaries. Mediators are actants which dynamically work on other actants to bring about change to modify meaning and relationships [e.g., children’s funds of knowledge modifying how educators perceive or understand the role of technologies in ECEC]. Intermediaries are also a type of actant but with a different function within an actor-network. They perform to neutrally transport meaning or effects to other actants without changing or transforming that meaning [e.g., Learning Outcomes inscribed by the EYLF V2.0 (AGDE, 2022) and the QKLG (QCAA, 2018) distribute meaning essential for the stabilisation, growth, and extension of the QKLG as a curriculum-framework-network] (Caldwell & Dyer, 2020; Cresswell et al., 2010). Consequently, intermediaries are responsible for transferring specific behaviours and thinking which are necessary to maintain consistent practices within an actor-network (Fenwick & Edwards, 2010).

7.5 Findings

In response to Research Question One, this project found that the educator identified Learning Outcomes were ‘Showing interest in technologies’ and ‘Being imaginative and creative’ (QCAA, 2018). Both Learning Outcomes are derived from ‘Active Learning’ as a key learning area in the QKLG (QCAA, 2018) where children as active learners develop understandings of themselves and the world, creating their ideas through imaginative and dramatic play (QCAA, 2018). Active Learning aligns with Outcome 4 in the updated EYLF V2.0 ‘Children are confident and involved learners (AGDE, 2022). In response to Research Question Two, children’s lived experiences in the post-digital were found to manifest as iPad, computer and gamer in educator identified Learning Outcomes, following participation in tinkering with unplugged technologies. Each of the three manifestations were illustrated as networked maps [Figure 7.1] with Learning Outcomes forming the starting actants [the central unit of analysis in the project due to children’s learning being a motivating object of activity for educators]. Manifestations were evident as children created versions of technologies which were mapped to a range material, non-material and participant actants operating as mediators and intermediaries.

Figure 7.1

Three Manifestations of the Post-Digital Illustrated as Networked Maps



7.6 Addressing the Problem

The findings address the problem of educator integration of technologies in the context of young children's lived experiences in the post-digital by providing insight into the range of actants related to young children's tinkering with unplugged technologies as a form of play-based learning relative to educator identified Learning Outcomes. Actants are shown to have various operations as mediators or intermediaries [Table 7.1] with consequent flow-on effects for what and how children are likely to play with unplugged technologies, and for what educators will consequently identify as Learning Outcomes for children.

Table 7.1

Actants Making Possible Children's Versions of Technologies as Manifestations of Their lived Experiences in the Post-Digital [in Terms of Form and Operation as Per Mapped Networks for iPad, Computer and Gamer]

Actant	Form	Operation	
		Mediator	Intermediary
Learning Outcome ''Showing interest in technologies'' (QCAA, 2018)	Non-material		✓
Educators and children	Participant	✓	
Purposefully framed play	Non-material	✓	
Children	Participant	✓	
Learning materials and Group discussion	Non-material	✓	
Funds of knowledge	Non-material	✓	
Unplugged technologies	Material		✓
Open-ended play and questions	Non-material	✓	
Modelled play	Non-material		✓
Screwdriver and scissors	Material		✓
Loose parts	Material	✓	
Playdough	Material	✓	
Learning Outcome ''Being imaginative and creative'' (QCAA, 2018)	Non-material		✓

Translation (Callon, 1984) shows how this brings multiple actants [e.g., children, unplugged technologies, learning materials, educators] into relationships that create networks of mapped activity to manifest children experiences in the post-digital. Translation in action is significant to the three manifestations of iPad, computer and gamer, and this is especially evident through Obligatory Passage Points which force their meaning onto actants within the networks. Obligatory Passage Points act as gatekeepers to control and modify other actants to align with their own needs, so they become indispensable to particular actor-networks (Booth et al., 2016; Fenwick & Edwards, 2010). In this study, two important Obligatory Passage Points were identified. These were curriculum-framework-networks via play-based learning, and children's lived experiences in the post-digital via funds of knowledge. Callon (1984) explains that translation in action happens over three stages in which Obligatory Passage Points are influential. Stage one is 'problematisation' which refers to the initial formation of a network where actants with common interests are brought together [e.g., educators, play-based learning, unplugged technologies and myself-as-researcher], and where some actants may emerge as more dominant than others to act as Obligatory Passage Points [e.g., play-based learning and funds of knowledge]. 'Interessement', stage two, involves persuading other actants into accepting the roles defined for them by the Obligatory Passage Points. In this study, play-based learning [via curriculum-framework-networks] and children's funds of knowledge [derived from children's lived experiences in the post-digital] induced actants to perform as mediators [e.g., educators, children, purposefully framed play] or intermediaries [e.g., Learning Outcomes, unplugged technologies]. Once actants accepted the role stipulated by the Obligatory Passage Points, translation then progressed to the third stage, 'enrolment'. Enrolment occurs when actants align themselves with the roles defined for them and become engaged in new behaviours in the actor-network (Booth et al., 2016; Carroll et al., 2012). This was illustrated in the mapped networks where actants took on roles specific to manifestations of the children's experience in the post-digital, relative to educator identified Learning Outcomes. For example, modelled play as intermediary employed by educators to show children how to use tools to participate in tinkering; unplugged technologies as intermediary holding their form and function as reflective of children's experiences in the post-digital; and playdough as mediator which worked to transform children's knowledge and understandings of technologies into material expression.

An important fourth phase in translation, 'mobilisation', can sometimes be reached by an actor-network. Mobilisation is when the actants in the actor-network recognise and reaffirm that their roles and interests align with the other actants in the actor-network (Booth et al., 2016). This can lead to the network becoming stable and durable enough to extend its translations to other locations and domains (Fenwick & Edwards, 2010). Mobilisation is core to addressing the problem of digital technology integration in ECEC, especially through tinkering with unplugged technologies as form of play-based learning. This is because as educators become more aware of the various actants available to them, they can deliberately employ these actants [e.g., unplugged technologies, purposefully framed play] to ensure that actor-networks derived from tinkering accept play-based learning and children's funds of knowledge as Obligatory Passage Points to become stable within ECEC pedagogy. Consequently, instead of being concerned about whether digital technologies are appropriate or too abstract, a mobilised network of tinkering can support children and educators as participant actants to work with, rather than oppose children's funds of knowledge derived from lived experiences in the post-digital.

Over time, as an unplugged tinkering network becomes stable and actants continue to align their interests, there will be capacity for educators to introduce working technologies into the network so that the unplugged tinkering network can extend its translations into the domain of working technologies as well. This could involve ‘plugging in’ some material actants [e.g., unplugged technologies, loose parts, playdough] and non-material actants [purposively framed play] using for example electronic invention kits to further develop basic concepts around digital learning. In doing so, the stability of the unplugged tinkering network would carry play-based learning and children’s funds of knowledge relative to their lived experiences in the post-digital into the extended ‘plugged’ network via the presence of Obligatory Passage Points informing Learning Outcomes and funds of knowledge. This in turn would result in ongoing capacity to address the problem of educator integration of technologies through networks of activity, rather than focusing on barriers to inclusion or attempting to use various forms of digital play as technological learning opportunities.

7.7 New Knowledge Pertaining to ECEC Advanced by this Thesis

The ongoing problem of educator integration of technologies has historically been informed by the value of play-based learning in ECEC as hands-on and tangible, and the idea of digital technologies as too abstract to support young children’s learning. This research presents an alternative theoretical perspective which argues for conceptualisations of material, non-material and human actants as ontologically entangled in ECEC settings in response to calls for changes in theoretical orientation in ECEC research (Hood & Tesar, 2019; Marsh, 2019a; Nuttall et al., 2015; Pettersen, Silseth, et al., 2022; Tesar & Hood, 2019). In doing so, this research contributes two new insights to the problem: 1) educator integration of technologies as theoretically possible via ANT concepts of mobilisation within translation; and 2) advancements in understanding the post-digital in ECEC as part of children's lived experiences.

7.7.1 Educator Integration of Technologies is Theoretically Possible via Mobilisation

Educator integration of technologies as the first new contribution to knowledge is theoretically possible in this study through concepts of mobilisation as the final stage of translation (Callon, 1984). Employing a post-qualitative worldview (St Pierre, 2013) and ANT (Latour, 2005) as a relational ontology offers understandings of play-based learning and technologies as interconnected actants co-constituting actor-networks [rather than separate entities in terms of pedagogy or abstract materials] which have become translated into manifestations of children's lived experiences in the post-digital [in relation to educator identified Learning Outcomes in children's tinkering with unplugged technologies]. Viewed from this theoretical perspective, educator integration of technologies can successfully occur in the event the mapped networks representing the manifestations reported in this study become sufficiently stable to allow extension to working technologies by educators over time. Mobilisation from unplugged tinkering to working technologies over time challenges technological determinism with the notion that educators could be less focused on the impact of technologies on children. Instead, the sector can draw from more recent literature and theory to recognise a more fluid ontology indicated by the post-digital thus acknowledging the post-digital as a condition of the world (Jandrić et al., 2018) which young children inhabit with the familiarity of those who have known nothing else (Tesar & Hood, 2019).

7.7.2 Advancing Understandings of the Post-Digital in ECEC as Part of Children's Lived Experiences

The post-digital signals the second knowledge contribution of this thesis. By recognising children's lived experiences in the post-digital via their funds of knowledge within the mapped networks, the notion of the post-digital as convoluted and complicated (Jandric, 2022) can be tested. Current literature about post-digital play sometimes describes it is as messy (Apperley et al., 2016; Jandrić et al., 2019; Pettersen, Arnseth, et al., 2022) claiming that borders between the digital and non-digital have become so blurred that it is difficult to distinguish between where children's digital and non-digital activities begin and end. However, as Edwards (2022) argues, messy descriptions are not useful for educators in practice because they fail to guide educators to know where and how they should engage with children to support learning. Mobilisation of mapped tinkering networks means research can offer educators more than a messy description of post-digital play and instead direct educator attention to the various ways in which they might work with material, non-material and participants actants within a given network. For example, an educator might choose to start with open-ended play because this is a pedagogy with which they are comfortable, and then move to unplugged technologies and then onto funds of knowledge. Another educator may be interested in children's funds of knowledge, and so orientate themselves with the tinkering from this starting point and then move to unplugged technologies and onto modelled play. Rather than being told that the post-digital is messy and involves children in fluid movement between the digital and non-digital, educators can work from their own pedagogical strengths, interests or areas of comfort into the post-digital in practice. Moreover, working in terms of mapped tinkering network includes educators and children as part of the network itself, collectively advancing the post-digital as lived experience rather than a described type of play.

7.8 Limitations

Participatory co-design as a methodological approach requires considerable investments of time and effort by participants. The educators in this research were employed full-time at the ECEC service. Co-ordinated by the centre director, educators were provided with time during their teaching day to attend semi-structured and focus group interviews as we progressed through the co-design cycles. This meant that additional staffing arrangements were necessary to release educators when they participated in interviews. At times this was challenging especially considering that data generation was conducted in the middle of the COVID pandemic. As a result, during codesign cycle two, semi-structured interviews with each educator necessitated shortening from 30 minutes to 20 minutes duration due to limited staff members available to cover their classes. This challenge was mitigated by sending educators the questions a couple of days in advance of our interviews, a practice which was already in place as requested by Julia after the first round of interviews in co-design cycle one.

Co-design as methodology requires close relationships with participants where the researcher relinquishes control and shares ownership maintaining a level power balance. This was particularly important at the beginning of the project where educators appeared to regard me as an expert in Early Childhood Education. To mitigate this, I was clear to articulate and position the educators as more knowledgeable and more practiced in Early Childhood Education than myself. Throughout the co-design process, I maintained this practice of constantly deconstructing my authority by continually reinforcing the value and importance of each educator's expert insights and perspectives on the children's learning via tinkering with unplugged technologies.

In this research, Learning Outcomes identified by educators relative to the QKLG (QCAA, 2018) and the EYLF V2.0 (AGDE, 2022) formed the primary unit of analysis so consequently educators were positioned as the main human participants in the co-design process. Given the research focus, interviews with child participants were deemed as unwarranted and beyond the scope of this existing research project. However, focusing on the children's perspectives of tinkering through child-centred methods could have offered a more in-depth exploration of their lived-experiences in the post-digital, and may be of value in future studies.

Given that this research reports on the perspectives of just three educators at one ECEC service, the intention of project was not to produce generalised accounts which could be universally applied across the sector. Instead, the aim of this research was to understand how the integration of technologies in ECEC may be achieved via educator identified Learning Outcomes following children's participation in tinkering with unplugged technologies as a form of play-based learning related to young children's lived experiences in the post-digital at this single service.

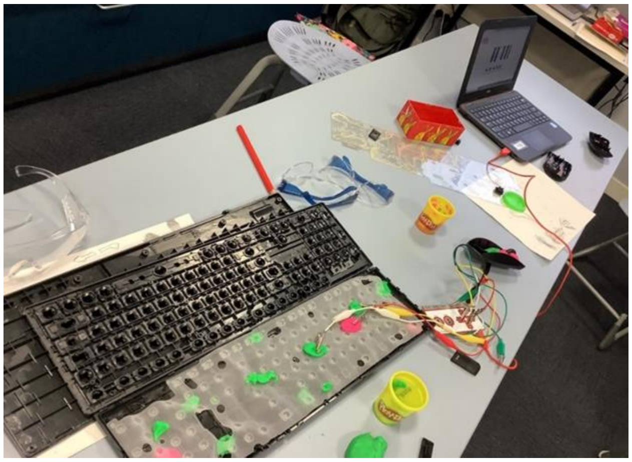
7.9 Future Research

This research project contributes new knowledge to the problem of educator integration of digital technologies in ECEC and to advancing understandings of the post-digital in ECEC as shaped by children's lived experiences with technologies. In this project, the educators were considered as active participants in the co-design process with their perspectives and insights deeply informing the data. Future research, using child-centred research methodologies, could involve children more directly as active participants to shed light on the specific types of knowledge and lived experiences in the post-digital that children bring into their learning settings. It would be of empirical value to examine the extent to which children understand the social uses of technologies [e.g., who, why and how people use technologies], as well as investigating how children technically understand the use of technologies [e.g., hardware, software, the internet] and how this then could inform educators decisions around intentionality for digital learning. As Julia aptly surmised *"we don't know what they know unless we provide them with the opportunities to share it"* [Julia, focus group interview three].

Once the unplugged tinkering actor-network becomes stabilised it would also be of value to expand the co-design process with educators to mobilise the unplugged tinkering network into practice and then extend this to translate working 'plugged' digital technologies into the network. For example, in my role as a practicing primary teacher, I currently collaborate with colleagues to offer tinkering with unplugged technologies to children in the junior school. As part of a STEM enrichment program for Year One children (aged 6-7 years) and based on the same design and format as the tinkering described in this thesis, children are provided with opportunities to tinker with unplugged technologies through a sequence of iterative tinkering implementations. Upon completion of the third implementation, 'make and create', children are then invited to 'plug in' their creations to iPads using 'Plug & Play Makey Makey™' apps. Makey Makey™ is a digital invention kit using circuit boards and alligator clips to connect material objects [e.g., playdough and loose parts] to digital devices and systems [Figure 7.2].

Figure 7.2

'Plugging In' Loose Parts Materials to a Digital Invention Kit



My anecdotal observations suggest that introducing working technologies as an additional tinkering implementation can consolidate and extend children's knowledge of computer systems relating to input and output devices.

7.10 Conclusion

This thesis has grappled with the ongoing problem of technology integration in ECEC. Considering that this problem has a long history related to the role of play-based learning in ECEC and that young children today are living in a post-digital moment in human history, an alternative way of thinking about children and technologies beyond technological determinism is necessary. This project employed ANT (Latour, 2005) as model of social constructivism to work within an ontology that considers the material, non-material and human equal in terms of capacity to exert agency. This theoretical perspective enabled the constitutive actants of the problem to be examined through participatory co-design with educators, focusing on tinkering with unplugged technologies as a form of play-based learning. The findings suggest that educator identified Learning Outcomes from children's tinkering operate as intermediary actants to adhere to play-based learning as a pedagogical approach (Obligatory Passage Point) evident in curriculum documents; and that children's lived experiences in the post-digital also act as an Obligatory Passage Point to incur children's funds of knowledge as an important actant in tinkering networks. Understanding the various actants in tinkering networks with unplugged technologies can alert educators to entry points for technology integration in ECEC, thereby providing a more helpful and stable starting point for educators than descriptions of children's post-digital play as entangled and messy.

REFERENCES

Adler, P. A., & Adler, P. (1987). *Membership Roles in Field Research*. SAGE Publications. https://doi.org/10.4135/9781412984973

Ahlin, E. (2019). Semi-Structured Interviews with Expert Practitioners: Their Validity and Significant Contribution to Translational Research. In *Sage Research Methods Cases Part 2*. SAGE Publications Ltd. https://doi.org/10.4135/9781526466037

Andrews, J., & Yee, W. C. (2006). Children's "funds of knowledge" and their real-life activities: Two minority ethnic children learning in out-of-school contexts in the UK. *Educational Review*, 58 (4), 435–449. https://doi.org/10.1080/00131910600971909

Apperley, T., Jayemanne, D., and Nansen, B. (2016). Postdigital literacies: materiality, mobility and the aesthetics of recruitment. In B. Parry, C. Burnett, and G. Merchant (Eds.) *Literacy, Media, Technology: Past, Present and Future*. Bloomsbury (pp. 203–218).

Arthur, L., Beecher, B., Death, E., Dockett, S., & Farmer, S. (2018). Assessing and planning for children's learning. In L. Arthur (Ed.), *Programming and planning in early childhood settings* (7th ed.). Cengage Learning.

Australian Bureau of Statistics. (2017). Childhood education and care (No. 4402.0). https://www.abs.gov.au/ausstats/abs@.nsf/exnote/4402.0/

Australian Bureau of Statistics. (2016). 2016 Census QuickStats: Ferny Grove. https://www.abs.gov.au/census/find-census-data/quickstats/2016/SED30029

Australian Children's Education & Care Quality Authority [ACECQA]. (2020). Guide to the national quality framework. https://www.acecqa.gov.au/nqf/about/guide

Australian Government Department of Education [AGDE]. (2022). Belonging, being and becoming – the early years framework for Australia V2.0. Australian Government Department of Education for the Ministerial Council. https://www.acecqa.gov.au/sites/default/files/2023-01/EYLF-2022-V2.0.pdf

Australian Government Department of Education [AGDE]. (2023). Early Learning Languages Australia. Retrieved from https://www.education.gov.au/early-learning-languages-australia

Australian Institute of Health and Welfare [AIHW]. (2021). Childcare and early childhood education. Retrieved from https://www.aihw.gov.au/reports/australias-welfare/childcare-and-early-childhood-education Adler, E. Stier., & Clark, R. (2008). How It's Done: An Invitation to Social Research. Thomson/Wadsworth.

Bagnoli, A., & Clark, A. (2010). Focus groups with young people: A participatory approach to research planning. *Journal of Youth Studies*, *13*(1), 101–119. https://doi.org/10.1080/13676260903173504

Barad, K. (2003). Posthumanist performativity: Toward an understanding of how matter comes to matter. *Signs: Journal of women, culture and society*, 28(3), 801–831. https://doi.org/10.1086/345321

Barad, K. (2007). *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Duke University Press. https://doi.org/10.1215/9780822388128

Barbera, E., Garcia, I., & Fuertes-Alpiste, M. (2017). A co-design process microanalysis: Stages and facilitators of an inquiry-based and technology-enhanced learning scenario. *International Review of Research in Open and Distance Learning*, *18*(6), 104–126. https://doi.org/10.19173/irrodl.v18i6.2805

Barbour, R. S., & Morgan, D. L. (2017). *A New Era in Focus Group Research Challenges, Innovation and Practice*. Palgrave Macmillan. https://doi.org/10.1057/978-1-137-58614-8

Baron, L. F., & Gomez, R. (2016). The Associations between Technologies and Societies: The Utility of Actor-Network Theory. *Science, Technology and Society*, *21*(2), 129–148. https://doi.org/10.1177/0971721816640615

Battal, A., Adanır, G. A., & Gülbahar, Y. (2021). Computer Science Unplugged: A Systematic Literature Review. *Journal of Educational Technology Systems*, *50*(1), 24–47. https://doi.org/10.1177/00472395211018801

Bautista, A., Habib, M., Eng, A., & Bull, R. (2019). Purposeful play during learning centre time: from curriculum to practice. *Journal of Curriculum Studies*, *51*(5), 715–736. https://doi.org/10.1080/00220272.2019.1611928

Beaumont-Bates, J. R. (2017). E-Portfolios: Supporting Collaborative Partnerships in an Early Childhood Centre in Aotearoa/New Zealand. *New Zealand Journal of Educational Studies*, *52*(2), 347–362. https://doi.org/10.1007/s40841-017-0092-1

Beecher, C., & Buzhardt, J. (2016). Mobile technology to increase parent engagement. *Interaction Design and Architecture(s)*, *28*(1), 49–68. http://www.mifav.uniroma2.it/inevent/events/idea2010/doc/28_3.pdf

Bell, T., & Vahrenhold, J. (2018). CS unplugged—How is it used, and does it work? In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics): Vol. 11011 LNCS*. Springer International Publishing. https://doi.org/10.1007/978-3-319-98355-4_29

Bennett, N., Wood, L. & Rogers, S. (1997). *Teaching through play. Teachers' thinking and classroom practice.* Open University Press.

Bergold, J., & Stefan, E. (2012). Participatory Research Methods: A Methodological Approach in Motion. *Historical Social Research*, *37*(4), 191–222. https://doi.org/10.17169/fqs-13.1.1801

Berry, D. M. (2014). The post-digital ornament (blog post). In *Stunlaw: Philosophy and Critique for a Digital Age*. http://stunlaw.blogspot.com/2014/06/the-post-digital-ornament.html

Berry, D. M., & Dieter, M. (2015). Thinking Postdigital Aesthetics: Art, computation and design. In *Postdigital Aesthetics: Art, Computation and Design* (pp. 1–11). Macmillan. https://doi.org/10.1057/9781137437204_1

Bers, M. U., Flannery, L., Kazakoff, E. R., & Sullivan, A. (2014). Computational thinking and tinkering: Exploration of an early childhood robotics curriculum. *Computers and Education*, *72*, 145–157. https://doi.org/10.1016/j.compedu.2013.10.020

Bevan, B., Gutwill, J. P., Petrich, M., & Wilkinson, K. (2015). Learning Through STEM-Rich Tinkering: Findings from a Jointly Negotiated Research Project Taken Up in Practice. *Science Education*, *99*(1), 98–120. https://doi.org/10.1002/sce.21151

Bevan, B., Petrich, M., & Wilkinson, K. (2014). Tinkering is serious play. *Educational Leadership*, *72*(4), 28–33. https://www.ascd.org/el/articles/tinkering-is-serious-play

Bianchi, L., & Chippindall, J. (2018). Learning to teach engineering in the primary and KS3 classroom. *A report for the Royal Academy of Engineering*. (Issue October, pp. 1–24). www.raeng.org.uk/tinkering

Bilodeau, A., & Potvin, L. (2018). Unpacking complexity in public health interventions with the Actor-Network Theory. *Health Promotion International*, *33*(1), 173–181. https://doi.org/10.1093/heapro/daw062

Bird, J., & Edwards, S. (2015). Children learning to use technologies through play: A Digital Play Framework. *British Journal of Educational Technology*, *46*(6), 1149–1160. https://doi.org/10.1111/bjet.12191

Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2014). Factors influencing digital technology use in early childhood education. *Computers and Education*, *77*, 82–90. https://doi.org/10.1016/j.compedu.2014.04.013

Blackwell, C. K., Lauricella, A. R., Wartella, E., Robb, M., & Schomburg, R. (2013). Adoption and use of technology in early education: The interplay of extrinsic barriers and teacher attitudes. *Computers and Education*, *69*, 310–319. https://doi.org/10.1016/j.compedu.2013.07.024

Blair, E. (2015). A reflexive exploration of two qualitative data coding techniques. *Journal of Methods and Measurement in the Social Sciences*, *6*(1), 14–29. https://doi.org/10.2458/jmm.v6i1.18772

Boardman, M. (2007). ‘I Know how much this Child has Learned. I have Proof!’ *Australasian Journal of Early Childhood*, *32*(3), 59–66. https://doi.org/10.1177/183693910703200309

Booth, R. G., Andrusyszyn, M. A., Iwasiw, C., Donelle, L., & Compeau, D. (2016). Actor-Network Theory as a sociotechnical lens to explore the relationship of nurses and technology in practice: Methodological considerations for nursing research. *Nursing Inquiry*, *23*(2), 109–120. https://doi.org/10.1111/nin.12118

Borg, M., Karlsson, B., Kim, S., & Mccormack, B. (2012). *Opening up for Many Voices in Knowledge Construction*. Forum Qualitative Sozialforschung Forum: Qualitative Social Research, 13(1). https://doi.org/10.17169/fqs-13.1.1793

Bowler, L., & Champagne, R. (2016). Mindful makers: Question prompts to help guide young peoples’ critical technical practices in maker spaces in libraries, museums, and community-based youth organizations. *Library and Information Science Research, 38*(2), 117–124. https://doi.org/10.1016/j.lisr.2016.04.006

Brey, P. (2009). Philosophy of Technology Meets Social Constructivism: A Shopper's Guide. In D. M. Kaplan (Ed.), *Readings in the philosophy of technology* (pp. 98-111). Rowman and Littlefield.

Brinkmann, S. (2017). *Philosophies of qualitative research*. Oxford University Press.

Broadhead, P. (2006). Developing an understanding of young children's learning through play: The place of observation, interaction and reflection. *British Educational Research Journal*, *32*(2), 191–207. https://doi.org/10.1080/01411920600568976

Brooker, L. (2017). Learning to play, or playing to learn? Children's participation in the cultures of homes and settings. *Young Children's Play and Creativity: Multiple Voices*, 14–25. https://doi.org/10.4324/9781315446844

Bubikova-Moan, J., Hjetland, H. N., & Wollscheid, S. (2019). ECE teachers' views on play-based learning: a systematic review. *European Early Childhood Education Research Journal*, *27*(6), 776–800. https://doi.org/10.1080/1350293X.2019.1678717

Burnett, C., & Merchant, G. (2020). *Undoing the Digital: Sociomaterialism and Literacy*. Taylor & Francis Group. https://doi.org/10.4324/9781003023159

Caldwell, R., & Dyer, C. (2020). The performative practices of consultants in a change network: an actor–network practice perspective on organisational change. *Journal of Organizational Change Management, 33*(5), 941–963. https://doi.org/10.1108/JOCM-10-2019-0318

Callon, M. (1984). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of Saint-Brieuc Bay. *The Sociological Review*, *32*(1), 196–233. https://doi.org/10.1111/j.1467-954X.1984.tb00113.x

Callon, M. (1990). Techno-economic Networks and Irreversibility. *The Sociological Review*, *38*(1_suppl), 132–161. https://doi.org/10.1111/j.1467-954x.1990.tb03351.x

Canosa, A., Graham, A., & Wilson, E. (2018). Reflexivity and ethical mindfulness in participatory research with children: What does it really look like? *Childhood*, *25*(3), 400–415. https://doi.org/10.1177/0907568218769342

Carr, M., Cowie, B., & Davis, K. (2015). *Continuity of Early Learning: Learning Progress and Outcomes in the Early Years Report on the Literature Scan*. Wilf Malcolm Institute of Educational Research, The University of Waikato. https://www.educationcounts.govt.nz/publications/ECE/continuity-of-early-learning-literature-scan

Carroll, N., Richardson, I., & Whelan, E. (2012). Service Science. *International Journal of Actor-Network Theory and Technological Innovation*, *4*(3), 51–69. https://doi.org/10.4018/jantti.2012070105

Çelik, A., & Özdemir, S. (2019). Tinkering learning in classroom: an instructional rubric for evaluating 3D printed prototype performance. *International Journal of Technology and Design Education*, *30*(3), 459–478. https://doi.org/10.1007/s10798-019-09512-w

Chakrabarty, D. (2021). Model Describing Central Tendency of Data. *International Journal of Advanced Research in Science, Engineering and Technology*, *8*(9). www.ijarset.com

Chaudron, S. (2015). *Young Children (0-8) and digital technology: a qualitative exploratory study across seven countries.* EUR 27052. Publications Office of the European Union. JRC93239

Chaudron, S., Gioia, R. Di, & Gemo, M. (2018). *Young Children (0-8) and Digital Technology A qualitative study across Europe*. Publications Office of the European Union. https://doi.org/10.2760/245671

Cheng, Y., Yen, K., Chen, Y., Chen, S., & Hiniker, A. (2018). Why Doesn't It Work? Voice-Driven Interfaces and Young Children's Communication Repair Strategies [Paper presentation]. In Proceedings of the 17th ACM Conference on Interaction Design and Children (Trondheim, Norway) (IDC '18). Association for Computing Machinery, New York, NY, USA, 337–348. https://doi.org/10.1145/3202185.3202749

Chesworth, L. (2016). A funds of knowledge approach to examining play interests: listening to children's and parents' perspectives. *International Journal of Early Years Education*, *24*(3), 294–308. https://doi.org/10.1080/09669760.2016.1188370

Cleland, J., Macleod, A., Cleland, J., Kong, L., & Macleod, A. (2021). A Qualitative Space The visual vernacular: embracing photographs in research. *Perspectives on Medical Education, 10*, 230–237. https://doi.org/10.1007/s40037-021-00672-x

Clements, D. H. (1987). Computers and young children: A review of research. *Young Children, 43*, 34–44. https://www.researchgate.net/publication/232517393

Cober, R., Tan, E., Slotta, J., So, H. J., & Könings, K. D. (2015). Teachers as participatory designers: two case studies with technology-enhanced learning environments. *Instructional Science*, *43*(2), 203–228. https://doi.org/10.1007/s11251-014-9339-0

Cockbill, S. A., May, A., & Mitchell, V. (2019). The Assessment of Meaningful Outcomes from Co-design: A Case Study from the Energy Sector. *She Ji: The Journal of Design, Economics, and Innovation*, *5*(3), 188–208. https://doi.org/10.1016/j.sheji.2019.07.004

Colliver, Y., Hatzigianni, M., & Davies, B. (2020). Why can't I find quality apps for my child? A model to understand all stakeholders' perspectives on quality learning through digital play. *Early Child Development and Care*, *190*(16), 2612–2626. https://doi.org/10.1080/03004430.2019.1596901

Conner, C., D. (2005) *A people's History of Science: Miners, Midwives and "Low Mechanics*". Nation Books

Cook, T. (2012). Where Participatory Approaches Meet Pragmatism in Funded (Health) Research: The Challenge of Finding Meaningful Spaces. *Forum: Qualitative Social Research*, *13*(1). https://doi.org/10.17169/fqs-13.1.1783

Cordes, C., & Miller, E. (2000a). *Fool's Gold: a critical look at computers in childhood.* Alliance for Childhood. Retrieved from https://www.researchgate.net/deref/http%3A%2F%2Fdrupal6.allianceforchildhood.org%2Ffools_gold

Cormier, D., Jandrić, P., Childs, M., Hall, R., White, D., Phipps, L., Truelove, I., Hayes, S., & Fawns, T. (2019). Ten Years of the Postdigital in the 52group: Reflections and Developments 2009–2019. In *Postdigital Science and Education* (Vol. 1, Issue 2). https://doi.org/10.1007/s42438-019-00049-8

Cramer, F. (2014). What is "Post-digital"? *Post-Digital Research*, *3*(1), 11–24. Retrieved from https://aprja.net//issue/view/8400

Cresswell, K., Worth, A., & Sheikh, A. (2010). Actor-Network Theory and Its Role in Understanding the Implementation of Information Technology Developments in Healthcare. *BMC Medical Informatics and Decision Making*, *10*(1), 1–11. https://doi.org/10.1186/1472-6947-10-67

Creswell, J. (2018). *Research design: qualitative, quantitative, and mixed methods approaches* (Fifth Edition.). SAGE Publications, Inc.

Creswell, J. W. (2003). A Framework for Design. In *Research design Qualitative quantitative and mixed methods approaches* (pp. 3–26). Sage Publications.

Creswell, J. W. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (Second Edition.). SAGE Publications.

Creswell, J. W. (2013). Qualitative inquiry & research design: Choosing among five approaches. In *SAGE Publication* (Third Edition.). SAGE Publications.

Creswell, J. W., & Guetterman, T. C. (2021). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (6th Edition). Pearson Education Limited.

Crotty, M. (2003). *The Foundations of Social Research: Meaning and Perspectives in the Research Process* (3rd ed.). Sage Publications.

Dafoe, A. (2015). On Technological Determinism: A Typology, Scope Conditions, and a Mechanism. *Science Technology and Human Values*, *40*(6), 1047–1076. https://doi.org/10.1177/0162243915579283

Danniels E & Pyle A. (2018). Defining Play-based Learning. In R. E. Tremblay, M. Boivin, Peters. RDeV, A. Pyle (Eds.) *Encyclopedia on Early Childhood Development*. https://www.child-encyclopedia.com/play-based-learning/according-experts/defining-play-based-learning. Published: February 2018.

Day, S. (2012). A reflexive lens: Exploring dilemmas of qualitative methodology through the concept of reflexivity. *Qualitative Sociology Review*, *8*(1), 60–85. https://doi.org/10.18778/1733-8077.8.1.04

Department for Education (DfE). 2012. Revised Framework for Early Years Foundation Stage. London: DfE. Retrieved from https://www.educationengland.org.uk/documents/pdfs/2012-eyfs-statutory-framework.pdf

Denzin, N. K., & Giardina, M. D. (2017). Introduction: Qualitative inquiry in neoliberal times. In N. K. Denzin, & M. D. Giardina (Eds.), *Qualitative Inquiry in Neoliberal Times* (pp. 1-16). (International Congress of Qualitative Inquiry Series; Vol. 12). Routledge.

Denzin, N. K., & Lincoln, Y. S. (2017). *The Sage handbook of qualitative research.* SAGE.

Department of Education, Employment and Workplace Relations [DEEWR]. (2009). Belonging, being and becoming – the early years framework for Australia. Barton, ACT: Commonwealth of Australia.

Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., Hall, R., Koschmann, T., Lemke, J. L., Sherin, M. G., & Sherin, B. L. (2010). Conducting Video Research in the Learning Sciences: Guidance on Selection, Analysis, Technology, and Ethics. *Journal of the Learning Sciences*, *19*(1), 3–53. https://doi.org/10.1080/10508400903452884

Dewey, J. (1997). *Experience and education* (1st Touchstone ed.). Simon & Schuster.

Diefenbach, T. (2009). Are case studies more than sophisticated storytelling? Methodological problems of qualitative empirical research mainly based on semi-structured interviews. *Qual Quant*, *43*, 875–894. https://doi.org/10.1007/s11135-008-9164-0

Disney, L., & Geng, G. (2022). Investigating Young Children's Social Interactions During Digital Play. *Early Childhood Education Journal*, *50*(8), 1449–1459. https://doi.org/10.1007/s10643-021-01275-1

Dockett, S. (2010). The challenge of play for early childhood educators. In S. Rogers (Ed.), *Rethinking Play and Pedagogy in Early Childhood Education: Concepts, Contexts and Cultures*, (pp 32–47). Routledge. https://doi.org/10.4324/9780203839478

Dong, C., & Newman, L. (2016). Ready, steady … pause: integrating ICT into Shanghai preschools. *International Journal of Early Years Education*, *24*(2), 224–237. https://doi.org/10.1080/09669760.2016.1144048

DuFon, M. A. (2002). Video recording in ethnographic SLA research: Some issues of validity in data collection. *Language Learning & Technology*, *6*(January), 40–59. http://llt.msu.edu/vol6num1/dufon/default.html

Dunphy, E. (2010). Assessing early learning through formative assessment: Key issues and considerations. *Irish Educational Studies*, *29*(1), 41–56. https://doi.org/10.1080/03323310903522685

Dwyer, A., Jones, C., & Rosas, L. (2019). What digital technology do early childhood educators use and what digital resources do they seek? *Australasian Journal of Early Childhood*, *44*(1), 91–105. https://doi.org/10.1177/1836939119841459

Eckhoff, A. (2019). Participation Takes Many Forms: Exploring the Frameworks Surrounding Children's Engagement in Participatory Research. *Educating the Young Child*, *17*, 3–19. https://doi.org/10.1007/978-3-030-19365-2_1

Educa. (2020). https://www.geteduca.com/

Edwards, S. (2013). Digital play in the early years: A contextual response to the problem of integrating technologies and play-based pedagogies in the early childhood curriculum. *European Early Childhood Education Research Journal*, *21*(2), 199–212. https://doi.org/10.1080/1350293X.2013.789190

Edwards, S. (2014). Towards contemporary play: Sociocultural theory and the digital-consumerist context. *Journal of Early Childhood Research*, *12*(3), 219–233. https://doi.org/10.1177/1476718X14538596

Edwards, S. (2015). New concepts of play and the problem of technology, digital media and popular-culture integration with play-based learning in early childhood education. *Technology, Pedagogy and Education*, 25(4), 513-532 https://doi.org/10.1080/1475939X.2015.1108929

Edwards, S. (2017). Play-based Learning and Intentional Teaching: Forever Different? *Australasian Journal of Early Childhood*, 42(2), 4–11. https://doi.org/10.23965/AJEC.42.2.01

Edwards, S. (2022). Concepts for Early Childhood Education and Care in the Postdigital. *Postdigital Science and Education*. https://doi.org/10.1007/s42438-022-00356-7

Edwards, S., & Cutter-Mackenzie, A. (2013). Pedagogical Play Types: What Do They Suggest for Learning About Sustainability in Early Childhood Education? *International Journal of Early Childhood*, *45*(3), 327–346. https://doi.org/10.1007/s13158-013-0082-5

Edwards, S., Cutter-Mackenzie, A., Moore, D., & Boyd, W. (2017a). Finding the balance: A play-framework for play-based learning and intentional teaching in early childhood education. Every Child, 23(1)(11), 14–15. https://doi.org/10.4324/9781315107134-11

Edwards, S., Henderson, M., Gronn, D., Scott, A., & Mirkhil, M. (2017b). Digital disconnect or digital difference? A socio-ecological perspective on young children's technology use in the home and the early childhood centre. *Technology, Pedagogy and Education*, *26*(1), 1-17. https://doi.org/10.1080/1475939X.2016.1152291

Edwards, S., Straker, L., Oakey, H. (2018). *Discussion paper: Towards an early childhood Australia statement on young children and digital technology*. Retrieved from http://www.earlychildhoodaustralia.org.au/wp-content/uploads/2017/08/ECA-DPG-Disussion-Paper-April-including-appendices_FINAL-2.pdf

Erickson, F. (1982). Audiovisual Records as a Primary Data Source. *Sociological Methods & Research*, *11*(2), 213–232. https://doi.org/10.1177/0049124182011002008

Erickson, F. (2006). Definition and Analysis of Data from Videotape: Some Research Procedures and Their Rationales. In J. L. Green, G. Camilli, & P. B. Elmore (Eds.), *Handbook of complementary methods in education research* (pp. 177–191). Lawrence Erlbaum Associates Publishers.

Erickson, F. (2011). Uses of video in social research: a brief history. *International Journal of Social Research Methodology*, *14*(3), 179–189. https://doi.org/10.1080/13645579.2011.563615

Ertmer, P. A. (1999). Addressing First-and Second-Order Barriers to Change: Strategies for Technology Integration. *Educational Technology Research and Development, 47*(4), 47–61. https://doi.org/10.1007/BF02299597

Ertmer, P. A., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. In J. Konig (Ed.), *Teachers' pedagogical beliefs. Definition and operationalisation, connections to knowledge and performance, development and change* (pp. 149–170). Waxmann.

Ey, L. A., & Spears, B. (2020). Engaging early childhood teachers in participatory co-design workshops to educate young children about bullying. *Pastoral Care in Education*, *38*(3), 230–253. https://doi.org/10.1080/02643944.2020.1788129

Feenberg, A. (2009). What is Philosophy of Technology? In Jones, A.T. & de Vries, M. J.(Eds.) *International Handbook of Research and Development in Technology Education*, 159-166. Sense Publishers.

Feenberg, A. (2017). Critical theory of technology and STS. *Thesis Eleven*, *138*(1), 3–12. https://doi.org/10.1177/0725513616689388

Feenberg, A. (2019). Postdigital or Predigital? *Postdigital Science and Education*, *1*(1), 8–9. https://doi.org/10.1007/s42438-018-0027-2

Fenty, N. S., & Anderson, E. M. K. (2014). Examining Educators' Knowledge, Beliefs, and Practices About Using Technology with Young Children. *Journal of Early Childhood Teacher Education*, *35*(2), 114–134. https://doi.org/10.1080/10901027.2014.905808

Fenwick, T. J., & Edwards, R. (2010). *Actor-Network Theory in Education*. (1st ed.). Routledge. https://doi.org/10.4324/9780203849088

Fenwick, T. J. (2010). (un)Doing standards in education with actor-network theory. *Journal of Education Policy*, *25*(2), 117–133. https://doi.org/10.1080/02680930903314277

Fenwick, T. J., Edwards, R., & Sawchuk, P. (2011). *Emerging Approaches to Educational Research: Tracing the Socio-Material* (1st ed.). Routledge. https://doi.org/10.4324/9780203817582

Fesseha, E., & Pyle, A. (2016). Conceptualising play-based learning from kindergarten teachers' perspectives. *International Journal of Early Years Education*, *24*(3), 361–377. https://doi.org/10.1080/09669760.2016.1174105

Fitzgerald, A., Hackling, M., & Dawson, V. (2013). Through the Viewfinder: Reflecting on the Collection and Analysis of Classroom Video Data. *International Journal of Qualitative Methods*, *12*(1), 52–64. https://doi.org/10.1177/160940691301200127

Fleer, M. (2011). 'Conceptual play': Foregrounding imagination and cognition during concept formation in early years education. *Contemporary Issues in Early Childhood*, *12*(3), 224–240. https://doi.org/10.2304/ciec.2011.12.3.224

Fleet, A., Honig, T., Robertson, J., Semann, A., & Shepherd, W. (2011). *What's pedagogy anyway? Using pedagogical documentation to engage with the Early Years Learning Framework*. 1–28. https://www.childaustralia.org.au/wp-content/uploads/2017/02/Whats-Pedagogy-Anyway.pdf

Fleet, A., & Patterson, C. (2012). Assessing children' s learning: Thinking in the context of the National Quality Standard. *Every Child*, *18*(2), 34–35.

Fleet, A., Patterson, C., & Robertson, J. (2017). *Pedagogical Documentation in Early Years Practice: Seeing Through Multiple Perspectives*. Sage. https://doi.org/10.4135/9781526401540

Foth, M., & Axup, J. (2006). Participatory design and action research: Identical twins or synergetic pair. In Jacucci, Gianni and Kensing, Finn and Wagner, Ina and Blomberg, Jeanette, (Eds). *Proceedings Participatory Design Conference 2006: Expanding Boundaries in Design 2,* pp. 93-96, Trento, Italy. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.91.6342&rep=rep1&type=pdf

Fuller, S., & Jandrić, P. (2019). The Postdigital Human: Making the History of the Future. *Postdigital Science and Education*, *1*(1), 190–217. https://doi.org/10.1007/s42438-018-0003-x

Gabrielson, C. (2015). *Tinkering: Kids learn by making stuff*. O'Reilly Media.

Galletta, A. (2013). *Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication*. New York University Press. https://doi.org/10.18574/nyu/9780814732939.001.0001

Giardina, M. D. (2017). (Post?) qualitative inquiry in sport, exercise, and health: notes on a methodologically contested present. *Qualitative Research in Sport, Exercise and Health*, *9*(2), 258–270. https://doi.org/10.1080/2159676X.2016.1273904

Gibson, M., Press, F., Harrison, L., Wong, S., Cumming, T., Ryan, S., Crisp, K., Richardson, S., Gibbs, L., Cooke, M., & Brown, J. (2023). *Shining a light on early childhood educators' work. A report from the Australian study Exemplary Early Childhood Educators at Work: A multi-level investigation.* Queensland University of Technology.

Gjelaj, M., Buza, K., Shatri, K., & Zabeli, N. (2020). Digital technologies in early childhood: Attitudes and practices of parents and teachers in Kosovo. *International Journal of Instruction, 13*(1), 165–184. https://doi.org/10.29333/iji.2020.13111a

Goldman, R., Erickson, F., Lemke, J., Derry, S. (2007). Selection in video. In Derry, S. (Ed.) *Guidelines for Video Research in Education: Recommendations from An Expert Panel.* Data Research and Development Center (NORC at the University of Chicago), 19-27.

Gonzalez, N., Moll, L.C., & Amanti, C. (Eds.). (2005). *Funds of Knowledge: Theorizing Practices in Households, Communities, and Classrooms* (1st ed.). Routledge. https://doi.org/10.4324/9781410613462

Goodchild, B., & Ferrari, E. (2021). Intermediaries and mediators: an actor-network understanding of online property platforms. *Housing Studies*. https://doi.org/10.1080/02673037.2021.2015297

Goodman, N., Cherrington, S. (2017). Children's Engagement with Their Learning Using E-portfolios. *Asia-Pacific Journal of Research in Early Childhood Education, 11*(3), 17-38.

Gray, D. E., (2022). *Doing research in the real world* (5th edition.). SAGE.

Grieshaber, S. (2010). Departures from Tradition: The Early Years Learning Framework for Australia. *International Journal of Child Care and Education Policy, 4*(2), 33–44. https://doi.org/10.1007/2288-6729-4-2-33

Griffin, T. (2019). A discussion of video as a data collection tool. *Current Issues in Tourism, 22*(18), 2183–2196. https://doi.org/10.1080/13683500.2018.1501009

Gros, B., & López, M. (2016). Students as co-creators of technology-rich learning activities in higher education. *International Journal of Educational Technology in Higher Education, 13*(1). https://doi.org/10.1186/s41239-016-0026-x

Guba, E., & Lincoln, Y. (1994). Competing Paradigms in Qualitative Research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 105–117). Sage.

Guest, G., Namey, E. E., & Mitchell, M. L. (2017). Collecting Qualitative Data: A Field Manual for Applied Research. In *Collecting Qualitative Data: A Field Manual for Applied Research*. SAGE Publications, Ltd. https://doi.org/10.4135/9781506374680

Guillemin, M., & Gillam, L. (2004). Ethics, reflexivity, and "Ethically important moments" in research. *Qualitative Inquiry*, *10*(2), 261–280. https://doi.org/10.1177/1077800403262360

Gutwill, J. P., Hido, N., & Sindorf, L. (2015). Research to practice: Observing learning in tinkering activities. *Curator, 58*(2), 151-68. https://doi.org/10.1111/cura.12105

Habeeb, K. M., & Ebrahim, A. H. (2019). Impact of e-portfolios on teacher assessment and student performance on learning science concepts in kindergarten. *Education and Information Technologies*, *24*(2), 1661–1679. https://doi.org/10.1007/s10639-018-9846-8

Hackett, E. J., Amsterdamska, O., Lynch, M., Wajcman, J., Hackett, E. J., Amsterdamska, O., Lynch, M., & Wajcman, J. (2007). Introduction. In *The Handbook of Science and Technology Studies*. MIT Press.

Hall, R. (2007) Strategies for Video Recording. In Derry, S. (ed.) (2007) *Guidelines for Video Research In Education: Recommendations from An Expert Panel, Data Research and Development Center* (NORC at the University of Chicago) http://drdc.uchicago.edu/what/video-research.html: 8-18

Halverson, E. R., & Sheridan, K. M. (2014). The Maker Movement in Education. *Harvard Educational Review, 84*(4), 495–504. https://doi.org/10.17763/haer.84.4.34j1g68140382063

Hammersley, M. (2012). Methodological Paradigms in Educational Research: British Educational Research Association on-line resource. *British Educational Research Association*, 1–30. http://www.bera.ac.uk/resources/methodological-paradigms-educational-research

Hammersley, M. (2014). Methodological philosophies. In *What is Qualitative Research?* (pp. 21–46). Bloomsbury Academic. https://doi.org/10.5040/9781849666084.ch-002

Harman, G. (2007). The Importance of Bruno Latour for Philosophy. *Cultural Studies Review*, *13*(1). https://doi.org/10.5130/csr.v13i1.2153

Hatch, J. A. (2002). *Doing Qualitative Research in Education Settings.* State University of New York Press. https://ebookcentral-proquest-com.ezproxy1.acu.edu.au

Hatch, M. (2014). *The Maker Movement Manifesto: Rules for innovation in the new world of crafters, hackers, and tinkerers*. McGraw-Hill.

Hatzigianni, M. (2018). Transforming early childhood experiences with digital technologies. *Global Studies of Childhood*, *8*(2), 173–183. https://doi.org/10.1177/2043610617734987

Hatzigianni, M., & Kalaitzidis, I. (2018). Early childhood educators' attitudes and beliefs around the use of touchscreen technologies by children under three years of age. *British Journal of Educational Technology*, *49*(5), 883–895. https://doi.org/10.1111/bjet.12649

Hatzigianni, M., Stephenson, T., Harrison, L. J., Waniganayake, M., Li, P., Barblett, L., Hadley, F., Andrews, R., Davis, B., & Irvine, S. (2023). The role of digital technologies in supporting quality improvement in Australian early childhood education and care settings. *International Journal of Child Care and Education Policy*, *17*(1). https://doi.org/10.1186/s40723-023-00107-6

Havu-Nuutinen, S., Sporea, D., Sporea, A. (2017). Inquiry and Creativity Approaches in Early-Years Science Education. In: Kimonen, E., Nevalainen, R. (Eds.) *Reforming Teaching and Teacher Education*. Sense Publishers. https://doi.org/10.1007/978-94-6300-917-1_4

Heath, C., Hindmarsh, J., & Luff, P. (2010). *Video in Qualitative Research*. SAGE.

Hedges, H. (2011). Rethinking Sponge Bob and Ninja Turtles: Popular Culture as Funds of Knowledge for Curriculum Co-construction [Article]. *Australasian Journal of Early Childhood*, *36*(1), 25–29. https://doi.org/10.1177/183693911103600105

Hedges, H., Cullen, J., & Jordan, B. (2011). Early years curriculum: Funds of knowledge as a conceptual framework for children's interests. *Journal of Curriculum Studies*, *43*(2), 185–205. https://doi.org/10.1080/00220272.2010.511275

Hedges, H. D. (2007). Funds of knowledge in early childhood communities of inquiry (Unpublished doctoral dissertation). Massey University. http://hdl.handle.net/10179/580

Heroman, C. (2017). Making and Tinkering: Bringing Design Challenges to the Classroom. *YC Young Children*, *72*(2), 72–79. https://www.jstor.org/stable/90004128

Higgins, A., & Cherrington, S. (2017). What's the story? Exploring parent–teacher communication through ePortfolios. *Australasian Journal of Early Childhood*, *42*(4), 13–21. https://doi.org/10.23965/AJEC.42.4.02

Hodgens, B. D. (2019). *Feminist Research for 21st-Century Childhoods: Common Worlds Methods.* Bloomsbury Publishing.

Holloway, D., Haddon, L., Green, L., & Stevenson, K. J. (2019). The parent-child-app learning assemblage. In *The Routledge International Handbook of Learning with Technology in Early Childhood* (1st ed., pp. 210–218). Routledge. https://doi.org/10.4324/9781315143040-15

Hood, N., & Tesar, M. (2019). Postdigital Childhoods in the Time of Anthropocene. *Postdigital Science and Education*, *1*(2), 307–310. https://doi.org/10.1007/s42438-019-00062-x

Hooker, T. (2019). Using ePortfolios in early childhood education: Recalling, reconnecting, restarting and learning. *Journal of Early Childhood Research*, *17*(4), 376–391. https://doi.org/10.1177/1476718X19875778

Huang, W., & Looi, C. K. (2020). A critical review of literature on “unplugged” pedagogies in K-12 computer science and computational thinking education. *Computer Science Education*, *31*(1) 1–29. Routledge. https://doi.org/10.1080/08993408.2020.1789411

Hughes, B. (2002). *A Playworker’s Taxonomy of Play Types*. PlayLink.

Ihmeideh, F. M. (2009). Barriers to the use of technology in Jordanian pre-school settings. *Technology, Pedagogy and Education*, *18*(3), 325–341. https://doi.org/10.1080/14759390903255619

Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development*, *58*(2), 137–154. https://doi.org/10.1007/s11423-009-9132-y

Jackson, A. Y. (2013). Posthumanist data analysis of mangling practices. *International Journal of Qualitative Studies in Education*, *26*(6), 741–748. https://doi.org/10.1080/09518398.2013.788762

Jameson, W. M., & Johnson, D. G. (2008). STS and Ethics: Implications for Engineering Ethics. In E.J. Hackett and O. Amsterdamska (Eds.), *The Handbook of Science and Technology Studies*, (pp. 567-582). MIT Press.

Jandrić, P., Knox, J., Besley, T., Ryberg, T., Suoranta, J., & Hayes, S. (2018). Postdigital science and education. *Educational Philosophy and Theory*, *50*(10), 893–899. https://doi.org/10.1080/00131857.2018.1454000

Jandrić, P., Ryberg, T., Knox, J., Lacković, N., Hayes, S., Suoranta, J., Smith, M., Steketee, A., Peters, M., McLaren, P., Ford, D. R., Asher, G., McGregor, C., Stewart, G., Williamson, B., & Gibbons, A. (2019). Postdigital Dialogue. *Postdigital Science and Education*, *1*(1), 163–189. https://doi.org/10.1007/s42438-018-0011-x

Jasanoff, S. (2017). A Field of Its Own: The Emergence of Science and Technology Studies. In Robert Frodeman (ed.), *The Oxford Handbook of Interdisciplinarity*, 2nd edition, Oxford Handbooks. https://doi.org/10.1093/oxfordhb/9780198733522.013.15

Jayemanne, D., Nansen, B., & Apperley, T. H. (2015*). Postdigital Play and the Aesthetics of Recruitment* [Paper presentation]. Digital Games Research Association [DiGRA] 2015 - Proceedings of the 2015 DiGRA International Conference: Diversity of Play, 2013 (pp.1-16). http://www.digra.org/wp-content/uploads/digital-library/117_Apperley_etal_Postdigital-Play-and-the-Aesthetics-of-Recruitment.pdf

Jewitt, C (2012) An Introduction to Using Video for Research. *NCRM Working Paper*. National Centre for Research Methods. Available at: http://eprints.ncrm.ac.uk/2259/4/NCRM_workingpaper_0312.pdf

Jones, C. (2018). Experience and Networked Learning. In N. B. Dohn, S. Cranmer, J. A. Sime, M. de Laat, & T. Ryberg (Eds.), *Networked Learning: Reflections and Challenges* (pp. 39–55). Springer. https://doi.org/10.1007/978-3-319-74857-3_3

Jonker, J., & Pennink, B. W. (2010). Qualitative Research. In J. Jonker & B. Pennink (Eds.) *The Essence of Research Methodology* (pp. 77–96). Springer. https://doi.org/10.1007/978-3-540-71659-4_5

Kallio, H., Pietil€, A.-M., Johnson, M., Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, *72*(12), 2954–2965. https://doi.org/10.1111/jan.13031

Kaufman, J., Leung, S., Perry, C., Tarasuik, J., Highfield, K., Guy, J., & the Swinburne Babylab team. (2017). *Evaluation of the Early Learning Languages Australia apps*: *Final report to the Australian Government Department of Education and Training*. Retrieved from file:///C:/Users/S00233270/Downloads/swinburne-ella-final-report%20(2).pdf

Kerasovitis, K. (2020). Post qualitative research - Reality through the antihierarchical assemblage of non-calculation. *Qualitative Report*, *25*(13), 56–70. https://doi.org/10.46743/2160-3715/2020.4756

Kewalramani, S., & Havu-Nuutinen, S. (2019). Preschool teachers' beliefs and pedagogical practices in the integration of technology: A case for engaging young children in scientific inquiry. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(12). https://doi.org/10.29333/ejmste/109949

Kind, S. (2013). Lively Entanglements: The Doings, Movements and Enactments of Photography. *Global Studies of Childhood*, *3*(4), 427–441. https://doi.org/10.2304/gsch.2013.3.4.427

Kinderm8. (2020). Retrieved from https://kinderm8.com.au/

Kindyhub. (2020). Retrieved from https://www.kindyhub.com.au/

Kivunja, C., & Kuyini, A. B. (2017). Understanding and Applying Research Paradigms in Educational Contexts. *International Journal of Higher Education*, *6*(5), 26. https://doi.org/10.5430/ijhe.v6n5p26

Kline, R. R. (2001). Technological Determinism. *International Encyclopedia of the Social & Behavioral Sciences*, 15495–15498. https://doi.org/10.1016/b0-08-043076-7/03167-3

Knauf, H. (2015). Styles of documentation in German early childhood education. *Early Years*, *35*(3), 232–248. https://doi.org/10.1080/09575146.2015.1011066

Knauf, H. (2018). Learning Stories: An Empirical Analysis of Their Use in Germany. *Early Childhood Education Journal*, *46*(4), 427–434. https://doi.org/10.1007/s10643-017-0863-9

Knauf, H. (2020). Documentation Strategies: Pedagogical Documentation from the Perspective of Early Childhood Teachers in New Zealand and Germany. *Early Childhood Education Journal*, *48*(1), 11–19. https://doi.org/10.1007/s10643-019-00979-9

Knoblauch, H. (2012). Introduction to the special issue of Qualitative Research: video-analysis and videography. *Qualitative Research*, *12*(3), 251–254. https://doi.org/10.1177/1468794111436144

Knowles, J., & Cole, A. (2012). *Handbook of the Arts in Qualitative Research: Perspectives, Methodologies, Examples, and Issues*. SAGE Publications.

Knox, J. (2019). What Does the 'Postdigital' Mean for Education? Three Critical Perspectives on the Digital, with Implications for Educational Research and Practice. *Postdigital Science and Education*, *1*(2), 357–370. https://doi.org/10.1007/s42438-019-00045-y

Kochan, J. (2006). Feenberg and STS: counter-reflections on bridging the gap. *Studies in History and Philosophy of Science Part A*, *37*(4), 702–720. https://doi.org/10.1016/j.shpsa.2006.06.001

Kuby, C. R., & Rowsell, J. (2017). Early literacy and the posthuman: Pedagogies and methodologies. *Journal of Early Childhood Literacy 17* (3), 285–296. https://doi.org/10.1177/1468798417715720

Kuby, C. R. (2019). (Re) imagining multiliteracies research practices with post qualitative inquiry. In N. Kucirkova, J. Rowsell, & G. Falloon (Eds.) *The Routledge International Handbook of Learning with Technology in Early Childhood* (pp. 127-142). Routledge.

Kuhn, T. S. (1962). *The structure of scientific revolutions.* University of Chicago Press.

Kukla, A. (2000). *Social Constructivism and the Philosophy of Science* (1st ed.) Routledge. https://doi.org/10.4324/9780203130995

Lafton, T. (2019). Becoming clowns: How do digital technologies contribute to young children's play? *Contemporary Issues in Early Childhood*, *22*(3), 221–231. https://doi.org/10.1177/1463949119864207

Laski, E. V. (2013). Portfolio Picks: An Approach for Developing Children's Metacognition. *YC Young Children, 68*(3). Retrieved from https://www.proquest.com/scholarly-journals/portfolio-picks-approach-developing-childrens/docview/1438729473/se-2

Lather, P. (2016). Top ten+ list: (Re)thinking ontology in (post)qualitative research. *Cultural Studies - Critical Methodologies, 16*(2), 125–131. https://doi.org/10.1177/1532708616634734

Latour, B. (1987). *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard University Press.

Latour, B. (1999). *Pandora's hope: Essays on the Reality of Science Studies*. Harvard University Press.

Latour, B. (2005). *Reassembling the Social. An Introduction to Actor-Network-Theory*. Oxford University Press.

Latour, B. (2011). Networks, societies, spheres: Reflections of an actor-network theorist. *International Journal of Communication, 5*(1), 796–810. Retrieved from https://ijoc.org/index.php/ijoc/article/view/1094

Latour, B. (2014). Rematerializing Humanities Thanks to Digital Traces [Paper presentation]. *Digital Humanities 2014 Conference (DH2014): Digital Cultural Empowerment. Keynote*. https://www.youtube.com/watch?v=4L2zRoKS0IA

Law, J. (2004). *After Method: Mess in Social Science Research.* Routledge.

Law, J. (2009). Actor Network Theory and Material Semiotics. In Turner, B. S (Eds.) *The New Blackwell Companion to Social Theory* (pp. 141–158). Wiley-Blackwell. https://doi.org/10.1002/9781444304992.ch7

Singleton, D. V. and Law, J. (2005). Object Lessons. *Organization*, 12 (3). 331-355. https://doi.org/10.1177/1350508405051270

LeBaron, C., Jarzabkowski, P., Pratt, M. G., & Fetzer, G. (2018). An Introduction to Video Methods in Organizational Research. *Organizational Research Methods, 21(2)*, 239–260. SAGE Publications. https://doi.org/10.1177/1094428117745649

Lee, J., & Junoh, J. (2019). Implementing Unplugged Coding Activities in Early Childhood Classrooms. *Early Childhood Education Journal*, *47*(6), 709–716. https://doi.org/10.1007/s10643-019-00967-z

Lee, M., & Pohio, L. (2012). *An e-portfolio theoretical approach for Provisionally Registered Teachers* [Paper presentation]. In M. Brown, M. Hartnett & T. Stewart (Eds.), the Australian Society for Computers in Learning in Tertiary Education [ASCILITE] Annual Conference - Future challenges, sustained futures, Wellington, New Zealand (pp.550-559). Retrieved from https://www.ascilite.org/conferences/Wellington12/2012/images/custom/lee%2c_maryann_-_an_e-portfolio.pdf

Lee, W., & Carr, M. (2001). *Documentation of Learning Stories: A Powerful Assessment Tool for Early Childhood* [Paper presentation]. In Dialogue and Documentation: Sharing Our Understanding of Children's Learning and Developing a Rich Early Years Provision, New Zealand (pp. 1-26). Retrieved from http://www.newzealand.anniewhite.cikeys.com/wp-content/uploads/2016/04/Documentation-of-Learning-Stories-Wendy-Lee-Margaret-Carr.pdf

Leggett, N., & Ford, M. (2013). A fine balance: Understanding the roles educators and children play as intentional teachers and intentional learners within the early years learning framework. *Australian Journal of Early Childhood*, *38*(4), 42–50. https://doi.org/10.1177/183693911303800406

Li, B. Y., & Ho, R. T. H. (2019). Unveiling the Unspeakable: Integrating Video Elicitation Focus Group Interviews and Participatory Video in an Action Research Project on Dementia Care Development. *International Journal of Qualitative Methods*, *18*. https://doi.org/10.1177/1609406919830561

Li, M., & Grieshaber, S. (2018). Learning Stories as cross-national policy borrowing: The interplay of globalization and localization in preprimary education in Contemporary China. *Educational Philosophy and Theory*, *50*(12), 1124–1132. https://doi.org/10.1080/00131857.2018.1434073

Liljestrand, J., & Hammarberg, A. (2017). The social construction of the competent, self-governed child in documentation: Panels in the Swedish preschool. *Contemporary Issues in Early Childhood*, *18*(1), 39–54. https://doi.org/10.1177/1463949117692270

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. SAGE Publications.

Lindahl, M. G., & Folkesson, A. M. (2012). ICT in preschool: Friend or foe? The significance of norms in a changing practice. *International Journal of Early Years Education*, *20*(4), 422–436. https://doi.org/10.1080/09669760.2012.743876

Linneberg, M. S., & Korsgaard, S. (2019). Coding qualitative data: a synthesis guiding the novice. *Qualitative Research Journal*, *19*(3), 259-270. https://doi.org/10.1108/QRJ-12-2018-0012

Loke, L., & Kocaballi, A. B. (2016). Choreographic inscriptions: A framework for exploring sociomaterial influences on qualities of movement for HCI. *Human Technology*, *12*(1), 31–55. https://doi.org/10.17011/ht/urn.201605192619

Looi, C. K., How, M. L., Longkai, W., Seow, P., & Liu, L. (2018). Analysis of linkages between an unplugged activity and the development of computational thinking. *Computer Science Education*, *28*(3), 255–279. https://doi.org/10.1080/08993408.2018.1533297

Lopez, V., & Whitehead, D. (2013). Sampling data and data collection in qualitative research. In *Nursing & Midwifery Research: Methods and Appraisal for Evidence-Based Practice* (4th ed., pp. 123–140). Elsevier.

Lower, U. M. (2006). *Interorganisational Standards: Managing web services specification for flexible supply chains*. Physica. https://doi.org/10.1007/3-7908-1654-X

Luck, J. (2008). *Lost in translations: A socio-technical study of interactive videoconferencing at an Australian university* (Doctoral dissertation). Central Queensland University, Australia. Retrieved from http://acquire.cqu.edu.au:8080/vital/access/manager/Repository/cqu:4525

Luff, P., Jirotka, M., Yamashita, N., Kuzuoka, H., Heath, C., & Eden, G. (2013). Embedded interaction: The accomplishment of actions in everyday and video-mediated environments. *ACM Transactions on Computer-Human Interaction*, *20*(1), 1–23. https://doi.org/10.1145/2442106.2442112

Lumivero. (2020). NVivo (Version 12). Retrieved from www.lumivero.com

Lupton, D., & Watson, A. (2021). Towards more-than-human digital data studies: developing research-creation methods. *Qualitative Research*, *21*(4), 463–480. https://doi.org/10.1177/1468794120939235

Lynch, M. (2016). Social Constructivism in Science and Technology Studies. *Human Studies*, *39*(1), 101–112. https://doi.org/10.1007/s10746-016-9385-5

MacKenzie, D., & Wajcman, J. (1985). *The Social Shaping of Technology*. Milton Keynes: Open University Press.

Mackley, H., Edwards, S., Mclean, K., & Cinelli, R. (2022). Building collaborative competencies through play with outdoor loose parts materials in primary school, *Cambridge Journal of Education*, *52*(4), 431-451, DOI: 10.1080/0305764X.2022.2030300

MacLeod, A., Cameron, P., Ajjawi, R., Kits, O., & Tummons, J. (2019). Actor-network theory and ethnography: Sociomaterial approaches to researching medical education. *Perspectives on Medical Education*, *8*(3), 177–186. https://doi.org/10.1007/s40037-019-0513-6

Mao, J. (2018). Reflexivity in Active Participant Observation: An Ethnographic Study of Fast Food Work. In *Sage Research Methods Cases Part 2.* SAGE Publications. https://doi.org/10.4135/9781526428264

Marsh, J. (2000). Teletubby Tales: Popular Culture in the Early Years Language and Literacy Curriculum. *Contemporary Issues in Early Childhood* 1(2), 119-133. https://doi.org/10.2304/ciec.2000.1.2.2

Marsh, J. (2010). Young children's play in online virtual worlds. *Journal of Early Childhood Research*, *8*(1), 23–39. https://doi.org/10.1177/1476718X09345406

Marsh, J. (2017). The Internet of Toys: A Posthuman and Multimodal Analysis of Connected Play. *Teachers College Record, 119*(12), 1–32. https://doi.org/10.1177/016146811711901206

Marsh, J. (2019a). Makerspaces in the Early Years Enhancing Digital Literacy and Creativity. In C. Donohue (Eds.), *Exploring Key Issues in Early Childhood and Technology Evolving Perspectives and Innovative Approaches* (pp. 79–84). Routledge. https://doi.org/10.4324/9780429457425

Marsh, J. (2019b). Researching Young Children's Play in the Post-Digital Age. In Kucirkova, N., Rowsell, J., & Falloon, G. (Eds.), *The Routledge International Handbook of Learning with*

Technology in Early Childhood (pp. 157-169). Routledge. https://doi.org/10.4324/9781315143040

Marsh, J., Arnseth, H. C., & Kumpulainen, K. (2018). Maker Literacies and Maker Citizenship in the MakEY (Makerspaces in the Early Years) Project. *Multimodal Technologies and Interaction*. *2*(3),50, https://doi.org/10.3390/mti2030050

Marsh, J., Plowman, L., Yamada-Rice, D., Bishop, J., & Scott, F. (2016). Digital play: a new classification. *Early Years*, *36*(3), 242–253. https://doi.org/10.1080/09575146.2016.1167675

Marsh, J., Wood, E., Chesworth, L., Nisha, B., Nutbrown, B., & Olney, B. (2019). Makerspaces in early childhood education: Principles of pedagogy and practice. *Mind, Culture, and Activity*, *26*(3), 221–233. https://doi.org/10.1080/10749039.2019.1655651

Martin, L. (2015). The promise of the maker movement for education. *Journal of Pre-College Engineering Education Research*, *5*(1), 30–39. https://doi.org/10.7771/2157-9288.1099

Martinez, S., & Stager, G. (2019). *Invent to learn: making, tinkering, and engineering in the classroom*. Constructing Modern Knowledge Press.

Mascheroni, G., Holloway, D. (2019). Introducing the Internet of Toys. In Mascheroni, G., Holloway, D. (Eds), *The Internet of Toys Practices, Affordances and the Political Economy of Children's Smart Play* (pp. 1-22). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-10898-4_1

Matthews, A. (2019). Design as a Discipline for Postdigital Learning and Teaching: Bricolage and Actor-Network Theory. *Postdigital Science and Education*, *1*(2), 413–426. https://doi.org/10.1007/s42438-019-00036-z

Matthews, A. (2021). Blurring boundaries between humans and technology: postdigital, postphenomenology and actor-network theory in qualitative research. *Qualitative Research in Sport, Exercise and Health*, *13*(1), 26–40. https://doi.org/10.1080/2159676X.2020.1836508

Matuk, C., Gerard, L., Lim-Breitbart, J., & Linn, M. (2016). Gathering Requirements for Teacher Tools: Strategies for Empowering Teachers Through Co-Design. *Journal of Science Teacher Education, 27*/1, 79-110. Springer. https://doi.org/10.1007/s10972-016-9459-2

Mawson, B. (2011). Technological Funds of Knowledge in Children's Play: Implications for Early Childhood Educators. *Australasian Journal of Early Childhood, 36*(1), 30–35. https://doi.org/10.1177/183693911103600106

Maxwell, J. (2009). Designing a qualitative study. In L. Bickman & D. J. Rog (Eds.), *The SAGE Handbook of Applied Social Research Methods* (2nd ed., pp. 318–344). SAGE Publications. https://doi.org/10.4135/9781483348858.n7

Maynard, M., & Purvis, J. (Eds.). (1994). *Researching Women's Lives from a Feminist Perspective*. Routledge. https://doi.org/10.4324/978131504102

Mazzei, L. A., & Jackson, A. Y. (2012). Complicating Voice in a Refusal to "Let Participants Speak for Themselves." *Qualitative Inquiry*, *18*(9), 745–751. https://doi.org/10.1177/1077800412453017

Mazzei, L. A., & Jackson, A. Y. (2017). Voice in the agentic assemblage. *Educational Philosophy and Theory*, *49*(11), 1090–1098. https://doi.org/10.1080/00131857.2016.1159176

McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: new concepts are needed to study research participation effects. *Journal of Clinical Epidemiology*, *67*(3), 267–277. https://doi.org/10.1016/j.jclinepi.2013.08.015

McFadden, A., & Thomas, K. (2016). Parent Perspectives on the Implementation of a Digital Documentation Portal in an Early Learning Centre. *Australasian Journal of Early Childhood*, *41*(4), 86–94. https://doi.org/10.1177/183693911604100411

Means, B., Penuel, W. R., Crawford, V. M., Korbak, C., Lewis, A., Murphy, R. F., Shear, L., Villavicencio, C., Vinson, E. Y., & Yarnall, L. (2001). GLOBE YEAR 6 EVALUATION REPORT: Explaining variation in implementation. *SRI International*. Retrieved from https://www.globe.gov/documents/10157/ddc233c5-2f3e-4048-886a-4453d7d856d5

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative Research: A Guide to Design and Implementation* (4th ed.). John Wiley & Sons.

Mertens, D. M. (2019). *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods* (4th ed.). Sage Publications.

Metin, S. (2020). Activity-based unplugged coding during the preschool period. *International Journal of Technology and Design Education*, 32, 149-165. https://doi.org/10.1007/s10798-020-09616-8

Michael, M. (2017). *Actor-Network Theory: Trials, Trails and Translations*. SAGE Publications. https://doi.org/10.4135/9781473983045

Miettinen, R. (1999). The riddle of things: Activity theory and actor-network theory as approaches to studying innovations. *Mind, Culture, and Activity*, *6*(3), 170–195. https://doi.org/10.1080/10749039909524725

Miles, M., & Huberman, A. (1994). *Qualitative Data Analysis: An Expanded Sourcebook.* Sage Publications.

Miller, E., & Almon, J. (2009). *Crisis in the Kindergarten: Why Children Need to Play in School.* Alliance for Childhood.

Miller, M. G. (2014). Productive and inclusive? How documentation concealed racialising practices in a diversity project. *Early Years*, *34*(2), 146–160. https://doi.org/10.1080/09575146.2014.899998

Mills, T. (2018). What has become of critique? Reassembling sociology after Latour. *British Journal of Sociology*, *69*(2), 286–305. https://doi.org/10.1111/1468-4446.12306

Mitchell, L. (2019). Assessment and Pedagogical Documentation. In: *Democratic Policies and Practices in Early Childhood Education*. pp 87-107. Springer. https://doi.org/10.1007/978-981-13-1793-4_5

Moll, L. C. (2019). Elaborating Funds of Knowledge: Community-Oriented Practices in International Contexts. *Literacy Research: Theory, Method, and Practice*, *68*, 130–138. https://doi.org/10.1177/2381336919870805

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of Knowledge for Teaching: Using a Qualitative Approach to Connect Homes and Classrooms. *Theory Into Practice, 31*(2), 132-141, https://doi: 10.1080/00405849209543534

Monberg, J. (2005). Science and Technology Studies Approaches to Internet Research. *Information Society*, *21*(4), 281–284. https://doi.org/10.1080/01972240591007607

Morgan, D. L. (1996). Focus Groups. *Annual Review of Sociology,* 22, 129–152. http://dx.doi.org/10.1146/annurev.soc.22.1.129

Müller, M., & Schurr, C. (2016). Assemblage thinking and actor-network theory: conjunctions, disjunctions, cross-fertilisations. *Transactions of the Institute of British Geographers*, 41(3). 217-229. https://doi.org/10.1111/tran.12117

Muniesa, F. (2015). Actor-network theory. In J.D.Wright (Ed.) *International Encyclopedia of the Social & Behavioral Sciences* (pp 80–84). Oxford. https://doi.org/10.1016/B978-0-08-097086-8.85001-1

Murcia, K., Campbell, C., & Aranda, G. (2018). Trends in Early Childhood Education Practice and Professional Learning with Digital Technologies. *Pedagogika*, *68*(3) 249-264. https://doi.org/10.14712/23362189.2018.858

Nansen, B. (2020). *Young Children and Mobile Media: Producing Digital Dexterity*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-49875-7_1

Nansen, B., Nicoll, B., Apperley, T. (2019). Postdigitality in Children's Crossmedia Play: A Case Study of Nintendo's Amiibo Figurines. In: Mascheroni, G., Holloway, D. (Eds.) *The Internet of Toys. Studies in Childhood and Youth*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-10898-4_5

National Statement on Ethical Conduct in Human Research (NHRMC, 2007 – Updated 2018) https://www.nhmrc.gov.au/about-us/publications/national-statement-ethical-conduct-humanresearch-2007-updated-2018#block-views-block-file-attachments-content-block-1

Nicholas, M., Paatsch, L., & Nolan, A. (2018). Using Video-Stimulated Interviews to Foster Reflection, Agency and Knowledge-Building in Research. In L. Xu, G. Aranda, W. Widjaja, & D. Clarke (Eds.), *Video-Based Research in Education: Cross-Disciplinary Perspectives*. (pp. 213-226). Taylor & Francis Group. http://ebookcentral.proquest.com/lib/acu/detail.action?docID=5584150.

Nicolopoulou, A. (2010). The Alarming Disappearance of Play from Early Childhood Education. *Human Development*, *53*(1), 1–4. https://doi.org/10.1159/000268135

Nikolopoulou, K., & Gialamas, V. (2015a). Barriers to the integration of computers in early childhood settings: Teachers' perceptions. *Education and Information Technologies*, *20*(2), 285–301. https://doi.org/10.1007/s10639-013-9281-9

Nikolopoulou, K., & Gialamas, V. (2015b). ICT and play in preschool: early childhood teachers' beliefs and confidence. *International Journal of Early Years Education*, *23*(4), 409–425. https://doi.org/10.1080/09669760.2015.1078727

Niederhauser, D. S., & Schrum, L. (2016). Enacting STEM Education for Digital Age Learners: The Maker Movement goes to School. Paper presented at *International Association for Development of the Information Society (IADIS) International Conference on Cognition and Exploratory Learning in the Digital Age* (CELDA) Oct 28-30.

Nishida, T., Kanemune, S., Idosaka, Y., Namiki, M., Bell, T., & Kuno, Y. (2009). A CS Unplugged Design Pattern. ACM SIGCSE Bulletin, 41(1), 231–235. https://doi.org/10.1145/1539024.1508951

Nolan, A., Edwards, S., Salamon, A., Straker, L., Grieshaber, S., Skouteris, H., Henderson, M., Highfield, K., & Bartlett, J. (2022). Young children's agency with digital technologies. *Children and Society*, *36*(4), 541–563. https://doi.org/10.1111/chso.12512

Nordstrom, S. N., & Ulmer, J. B. (2017). Postqualitative Curations and Creations. *Reconceptualizing Educational Research Methodology*, *8*(3) 1-15. Special Issue https://doi.org/10.7577/rerm.2558

Nuttall, J., Edwards, S., Mantilla, A., Grieshaber, S., & Wood, E. (2015). The role of motive objects in early childhood teacher development concerning children's digital play and play-based learning in early childhood curricula. *Professional Development in Education*, *41*(2), 222–235. https://doi.org/10.1080/19415257.2014.990579

Nyland, B., & Alfayez, S. (2012). Learning Stories - crossing borders: Introducing qualitative early childhood observation techniques to early childhood practitioners in Saudi Arabia. *International Journal of Early Years Education*, *20*(4), 392–404. https://doi.org/10.1080/09669760.2012.743097

Nyland, B., & Ng, J. (2016). International perspectives on early childhood curriculum changes in Singapore and Australia. *European Early Childhood Education Research Journal*, *24*(3), 465–476. https://doi.org/10.1080/1350293X.2015.1102416

Ofcom. (2017). Children and Parents: Media Use and Attitudes Report [Online]. Retrieved from https://www.ofcom.org.uk/__data/assets/pdf_file/0020/108182/children-parents-media-use-attitudes-2017.pdf

Organisation for Economic Co-operation and Development [OECD]. (2015). *Starting Strong IV: Monitoring Quality in Early Childhood Education and Care Country Note.* OECD Publishing. https://doi.org/doi. org/10.1787/97892 64233 515-en.

Onwuegbuzie, A. J., & Leech, N. L. (2005). Taking the "q" out of research: Teaching research methodology courses without the divide between quantitative and qualitative paradigms. *Quality and Quantity*, *39*(3), 267–295. https://doi.org/10.1007/s11135-004-1670-0

Orlikowski, W. J. (2007). Sociomaterial Practices: Exploring Technology at Work. *Organization Studies*, *28*(9), 1435–1448. https://doi.org/10.1177/0170840607081138

Orlikowski, W. J., & Scott, S. V. (2008). Sociomateriality: Challenging the Separation of Technology, Work and Organization. *The Academy of Management Annals*, *2*(1), 433–474. https://doi.org/10.1080/19416520802211644

Ospina-Pinillos, L., Davenport, T. A., Ricci, C. S., Milton, A. C., Scott, E. M., & Hickie, I. B. (2018). Developing a Mental Health eClinic to Improve Access to and Quality of Mental Health Care for Young People: Using Participatory Design as Research Methodologies. *Journal of Medical Internet Research*, *20*(5), e188. https://doi.org/10.2196/jmir.9716

Otterborn, A., Schönborn, K. J., & Hultén, M. (2020). Investigating Preschool Educators' Implementation of Computer Programming in Their Teaching Practice. *Early Childhood Education Journal*, *48*(3), 253–262. https://doi.org/10.1007/s10643-019-00976-y

Palaiologou, I. (2016a). Children under five and digital technologies: implications for early years pedagogy. *European Early Childhood Education Research Journal*, *24*(1), 5–24. https://doi.org/10.1080/1350293X.2014.929876

Palaiologou, I. (2016b). Teachers' dispositions towards the role of digital devices in play-based pedagogy in early childhood education. *Early Years*, *36*(3), 305–321. https://doi.org/10.1080/09575146.2016.1174816

Palmer, S. (2006). *Toxic Childhood*. Orion Press.

Papert, S. (1993). *The children's machine: Rethinking school in the age of computer*. Basic Books.

Parisi, S., Rognoli, V., & Sonneveld, M. (2017). Material Tinkering. An inspirational approach for experiential learning and envisioning in product design education. *The Design Journal*, *20*(sup1), S1167–S1184. https://doi.org/10.1080/14606925.2017.1353059

Parten, M. B. (1932). Social participation among pre-school children. *The Journal of Abnormal and Social Psychology*, *27*(3), 243–269. https://doi.org/10.1037/h0074524

Patton, M. (2002). *Qualitative evaluation and research methods* (3rd ed.). Sage Publications.

Payne, L. (2017). Visualization in analysis: developing ANT Analysis Diagrams (AADs). *Qualitative Research*, *17*(1), 118–133. https://doi.org/10.1177/1468794116661229

Pellegrini, A. D. (1991). *Applied Child Study: A Developmental Approach.* L. Erlbaum Associates.

Penn-Edwards, S. (2004). Visual Evidence in Qualitative Research: The Role of Videorecording. *The Qualitative Report*, *9*(2), 266-277. https://doi.org/10.46743/2160-3715/2004.1928

Penuel, W. R., & Gallagher, L. P. (2009). Preparing teachers to design instruction for deep understanding in middle school Earth science. *Journal of the Learning Sciences, 18*(4), 461-508, https://doi.org/10.1080/10508400903191904

Penuel, W. R., Roschelle, J., & Shechtman, N. (2007). Designing formative assessment software with teachers: An analysis of the co-design process. Research and Practice in Technology Enhanced Learning, *2*(1), 51–74. http://dx.doi.org/10.1142/S1793206807000300

Peppler, K. (2013). STEAM-powered computing education: Using E-textiles to integrate the arts and STEM. *Computer*, *46*(9), 38–43. https://doi.org/10.1109/MC.2013.257

Peppler, K., Wohlwend, K., Thompson, N., Tan, V., & Thomas, A. M. (2019). Squishing Circuits: Circuitry Learning with Electronics and Playdough in Early Childhood. *Journal of Science Education and Technology*, *28*(2), 118–132. https://doi.org/10.1007/s10956-018-9752-2

Pettersen, K., Arnseth, H. C., & Silseth, K. (2022). Playing Minecraft: Young children's postdigital play. *Journal of Early Childhood Literacy*, *0*(0) https://doi.org/10.1177/14687984221118977

Pettersen, K., Silseth, K., & Arnseth, H. C. (2022). Rethinking boundaries: Sociomaterial perspectives on digital technologies and early childhoods. In K. Kumpulainen, A. Kjamaa, O. Erstad, A. Makitalo, K. Drotner, S. Jakobsdottir (Eds.) *Nordic Childhoods in the Digital Age: Insights into Contemporary Research on Communication, Learning and Education* (pp. 181–192). Taylor and Francis. https://doi.org/10.4324/9781003145257-19

Piaget, J. (1951). Play, dreams and imitation in childhood. Routledge. https://doi.org/10.4324/9781315009698

Picher, M. E. (2019). *A Cognitive Work Analysis of a Pedagogical Documentation Technology in Ontario' s Kindergarten Program*. [Doctoral Thesis, University of Toronto]. https://hdl.handle.net/1807/97607

Pierce, P. (1994). *Technology Integration into Early Childhood Curricula: Where We've Been, Where We Are, Where We Should Go.* University of North Carolina: Center for Literacy and Disability Studies. (ERIC Document Reproduction Service No. ED 386 901)

Pillow, W. S. (2003). Confession, catharsis, or cure? Rethinking the uses of reflexivity as methodological power in qualitative research. *International Journal of Qualitative Studies in Education*, *16*(2), 175–196. https://doi.org/10.1080/0951839032000060635

Pinch, T. J., & Bijker, W. E. (1984). The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other. *Social Studies of Science*, *14*(3), 399–441. https://doi.org/10.1177/030631284014003004

Pink, S. (2007). *Doing Visual Ethnography*. SAGE Publications. https://doi.org/10.4135/9780857025029

Plowman, L., & McPake, J. (2013). Seven Myths About Young Children and Technology. *Childhood Education*, *89*(1), 27–33. https://doi.org/10.1080/00094056.2013.757490

Plowman, L., McPake, J., & Stephen, C. (2010). The technologisation of childhood? Young children and technology in the home. *Children and Society*, *24*(1), pp. 63–74. https://doi.org/10.1111/j.1099-0860.2008.00180.x

Plowman, L., & Stephen, C. (2005). Children, Play and Computers in Preschool Education. British Journal of Educational Technology, 36, 145-157. http://dx.doi.org/10.1111/j.1467-8535.2005.00449.x

Plumb M, & Kautz K. (2015). Barriers to the integration of information technology within early childhood education and care organisations: A review of the literature [Paper presentation]. *In the Australasian Conference on Information Systems. Adelaide, Australia* (pp.1-14). Retrieved from https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1810&context=buspapers

Purington, A., Taft, J. G., Sannon, S., Bazarova, N. N., & Taylor, S. H. (2017). "Alexa is my new BFF": Social Roles, User Satisfaction, and Personification of the Amazon Echo. *Proceedings of the 2017 Conference Extended Abstracts on Human Factors in Computing Systems (CHI'17) pp 2853-2859.* https://doi.org/10.2466/08.10.21.PR0.111.5.618-620

Pyle, A., & Alaca, B. (2018). Kindergarten children's perspectives on play and learning. *Early Child Development and Care*, *188*(8), 1063–1075. https://doi.org/10.1080/03004430.2016.1245190

Pyle, A., & Danniels, E. (2017). A Continuum of Play-Based Learning: The Role of the Teacher in Play-Based Pedagogy and the Fear of Hijacking Play. *Early Education and Development*, *28*(3), 274–289. https://doi.org/10.1080/10409289.2016.1220771

Queensland Curriculum and Assessment Authority [QCAA]. (2018). *Queensland kindergarten learning guideline*. https://www.qcaa.qld.edu.au/ downloads/p_10/qklg_2019.pdf

Rahi, S. (2017). Research Design and Methods: A Systematic Review of Research Paradigms, Sampling Issues and Instruments Development. *International Journal of Economics & Management Sciences*, *06*(02). doi: 10.4172/2162-6359.1000403.

Rauch, F., Dulle, M., Namsone, D., & Gorghiu, G. (2014). PROFILES Networks: Three International Examples. *Science Education International*, *25*(2), 97–114. Retrieved from http://www.icaseonline.net/sei/june2014/p5.pdf

Resnick, M. (1998). Technologies for Lifelong Kindergarten. *Educational Technology Research and Development*, *46*, 43-55. doi:10.1007/BF02299672

Rintakorpi, K. (2016). Documenting with early childhood education teachers: pedagogical documentation as a tool for developing early childhood pedagogy and practises. *Early Years*, *36*(4), 399–412. https://doi.org/10.1080/09575146.2016.1145628

Rissanen, M. J. (2020). Entangled photographers: Agents and actants in preschoolers' photography talk. *International Journal of Education Through Art*, *16*(2), 271–286. https://doi.org/10.1386/eta_00031_1

Robertson, T., & Simonsen, J. (2012). Challenges and opportunities in contemporary participatory design. *Design Issues*, *28*(3), 3–9. https://doi.org/10.1162/DESI_a_00157

Rogers, S. (2015). Positioning Play in Early Childhood Curriculum, Pedagogy and Assessment. In D. Wyse, L. Hayward, & J. Pandya (Eds.), *The SAGE Handbook of Curriculum, Pedagogy and Assessment* (pp. 590-605). Sage publications. https://doi.org/10.1007/s10465-013-9159-9

Rogoff, B. (2003). *The Cultural Nature of Human Development*. Oxford University Press.

Rohracher, H. (2015). Science and Technology Studies, History of. In Wright, J.D. (Ed.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 200-205). Elsevier. https://doi.org/10.1016/B978-0-08-097086-8.03064-6

Roschelle, J., Penuel, W., & Shechtman, N. (2006). Co-design of Innovations with Teachers: Definition and Dynamics. In Barab, S. A., Hay, K. E., & Hickey, D. T. (Eds.), The International Conference of the Learning Sciences: Indiana University 2006. Proceedings of ICLS 2006, Volume 2 (pp. 606-612). International Society of the Learning Sciences.

Rose, G. (2014). On the Relation between "Visual Research Methods" and Contemporary Visual Culture. *The Sociological Review*, *62*(1), 24–46. https://doi.org/10.1111/1467-954X.12109

Rosenstein, B. (2002). Video Use in Social Science Research and Program Evaluation. *International Journal of Qualitative Methods*, *1*(3), 22–43. https://doi.org/10.1177/160940690200100302

Rubin, K. H., Fein, G. G., & Vandenberg, B. (1983). Play. In E. M. Hetherington (Ed.), *Handbook of Child Psychology, Vol. 4, Socialization, personality, and social development.* (pp. 694–774). Wiley.

Sakr, M., & Oscar, A. (2022). Stretchy time or screen time: how early years practitioners conceptualise time in relation to children's digital play. *Early Years*, *42*(4–5), 391–405. https://doi.org/10.1080/09575146.2020.1744530

Saldana, J. (2009). *The Coding Manual for Qualitative Researchers*. SAGE Publications.

Sanoff, H. (2007). Special issue on participatory design. *Design Studies, 28*(3), 213–215. https://doi.org/10.1016/j.destud.2007.02.001

Saxena, A., Lo, C. K., Hew, K. F., & Wong, G. K. W. (2020). Designing Unplugged and Plugged Activities to Cultivate Computational Thinking: An Exploratory Study in Early Childhood Education. *Asia-Pacific Education Researcher*, *29*(1), 55–66. https://doi.org/10.1007/s40299-019-00478-w

Sayes, E. (2014). Actor–Network Theory and methodology: Just what does it mean to say that nonhumans have agency? *Social Studies of Science, 44*(1), 134–149. https://doi.org/10.1177/0306312713511867

Schriever, V., Simon, S., & Donnison, S. (2020). Guardians of play: early childhood teachers' perceptions and actions to protect children's play from digital technologies. *International Journal of Early Years Education*, *28*(4), 351–365. https://doi.org/10.1080/09669760.2020.1850431

Schrock, A. R. (2014). Education in disguise: Culture of a hacker and maker space. *InterActions: UCLA Journal of Education and Information Studies*, 10(1). Retrieved from http://www.escholarship.org/uc/item/0js1n1qg, eScholarship, University of California.

Schuh, K. L., & Barab, S. A. (2007). Philosophical Perspectives. In D. Jonassen, M. J. Spector, M. Driscoll, M. D. Merrill, J. van Merrienboer, & M. P. Driscoll (Eds.), *Handbook of Research on*

Educational Communications and Technology (pp. 67–82). Routledge. https://doi.org/10.4324/9780203880869

Sendurur, P. (2019). Investigation of pre-service computer science Teachers' CS-unplugged design practices. *Education and Information Technologies*, *24*(6), 3823–3840. https://doi.org/10.1007/s10639-019-09964-6

Sheridan, K., Halverson, E. R., Litts, B., Brahms, L., Jacobs-Priebe, L., & Owens, T. (2014). Learning in the Making: A Comparative Case Study of Three Makerspaces. *Harvard Educational Review*, *84*(4), 505–532. https://doi.org/10.17763/haer.84.4.brr34733723j648u

Siraj-Blatchford, I. (2009). Conceptualising progression in the pedagogy of play and sustained shared thinking in early childhood education: A Vygotskian perspective. *Educational and Child Psychology*, *26*(2), 1–15. http://eprints.ioe.ac.uk/6091/

Siraj-Blatchford, I., & Sylva, K. (2004). Researching pedagogy in English pre-schools. *British Educational Research Journal*, *30*(5), 713–730. https://doi.org/10.1080/0141192042000234665

Sismondo, S. (2004). *An Introduction to Science and Technology Studies*. Blackwell Publishing.

Sismondo, S. (2007). Science and Technology Studies and an Engaged Program. In Hackett, E. J., Amsterdamska, O., Lynch, M., Wajcman, J., (Eds.), *The Handbook of Science and Technology Studies* (pp. 13–31). The MIT Press. Retrieved from https://www.dhi.ac.uk/san/waysofbeing/data/data-crone-wyatt-2007b.pdf

Skop, E. (2006). The methodological potential of focus groups in population geography. *Population, Space and Place*, *12*(2), *113–124.*https://doi.org/10.1002/psp.402

Skolverket [The Swedish National Agency for Education]. (n.d.). An overview of the Swedish education system. Retrieved from http://www.skolverket.se/om-skolverket/andra-sprak-och-lattlast/in-english/the-swedish-education-system

Smilansky, S. (1968). *Effects of Sociodramatic Play on Disadvantaged Pre-School Children*. John Wiley & Sons.

Smith, P. K., Takhvar, M., Gore, N., & Vollstedt, R. (1985). Play in young children: Problems of definition, categorisation and measurement. *Early Child Development and Care*, *19*(1–2), 25–41. https://doi.org/10.1080/0300443850190103

Smith, R. C., & Iversen, O. S. (2018). Participatory design for sustainable social change. *Design Studies*, *59*, 9–36. https://doi.org/10.1016/j.destud.2018.05.005

Spinuzzi, C. (2005). The Methodology of Participatory Design. *Technical Communication*, *52*(2), 163–174. Retrieved from https://repositories.lib.utexas.edu/bitstream/handle/2152/28277/SpinuzziTheMethodologyOfParticipatoryDesign.pdf

Spradley, J. P. (1980). *Participant Observation*. Holt, Rinehart and Winston.

St Pierre, E. (2013). The posts continue: Becoming. *International Journal of Qualitative Studies in Education*, *26*(6), 646–657. https://doi.org/10.1080/09518398.2013.788754

St Pierre, E. A. (2014a). Post Qualitative Inquiry [Paper presentation]. In the Australian Association for Research in Education/New Zealand Association for Research in Education [AARE] Conference. Brisbane (pp.1-31). Retrieved from https://www.aare.edu.au/assets/documents/Elizabeth-Adams-St.-Pierre-ppt-presentation.pdf

St Pierre, E. A. (2014b). A brief and personal history of post qualitative research: Toward "post inquiry". *Journal of Curriculum Theorizing, 30*(2), 2-19. Retrieved from https://www.proquest.com/scholarly-journals/brief-personal-history-post-qualitative-research/docview/1636542201/se-2

St Pierre, E. A. (2018). Writing Post Qualitative Inquiry. *Qualitative Inquiry*, *24*(9), 603–608. https://doi.org/10.1177/1077800417734567

Stalph, F. (2019). Hybrids, materiality, and black boxes: Concepts of actor-network theory in data journalism research. *Sociology Compass*, *13*(11), 1–13. https://doi.org/10.1111/soc4.12738

Steen, M. (2013). Co-design as a Process of Joint Inquiry and Imagination. *Design Issues*, *29*(2), 16–28. https://doi.org/10.1162/DESI_a_00207

Steen, M., Manschot, M., & de Koning, N. (2011). Benefits of Co-design in Service Design Projects. *International Journal of Design*, *5*(2), 53–60. Retrieved from http://www.ijdesign.org/index.php/IJDesign/article/view/890/346

Stephen, C. (2010). Pedagogy: The silent partner in early years learning. *Early Years*, *30*(1), 15–28. https://doi.org/10.1080/09575140903402881

Stephen, C., & Edwards, S. (2017). *Young Children Playing and learning in a Digital Age: A Cultural and Critical Perspective*. Taylor & Francis Group.

Stevenson, K. J. (2020). Young children's creativity in digital possibility spaces. In L. Green, D. Holloway, K. Stevenson, T. Leaver & L. Haddon (Eds.), *The Routledge Companion to Digital Media and Children* (pp. 75-86). Routledge / Taylor & Francis Group.

Storni, C., Binder, T., Linde, P., & Stuedahl, D. (2015). Designing things together: intersections of co-design and actor–network theory. *CoDesign 11*(3–4), 149–151. https://doi.org/10.1080/15710882.2015.1081442

StoryPark (2020). Retrieved from https://main.storypark.com/

Strouse, G. A., McClure, E., Myers, L. J., Zosh, J. M., Troseth, G. L., Blanchfield, O., Roche, E., Malik, S., & Barr, R. (2021). Zooming through development: Using video chat to support family connections. *Human Behavior and Emerging Technologies*, *3*(4), 552–571. https://doi.org/10.1002/hbe2.268

Stuckey, H. (2015). The second step in data analysis: Coding qualitative research data. *Journal of Social Health and Diabetes*, *3*(1), 7-10. https://doi.org/10.4103/2321-0656.140875

Sumsion, J., Grieshaber, S., McArdle, F., & Shield, P. (2014). The 'state of play' in Australia: Early childhood educators and play-based learning. *Australasian Journal of Early Childhood*, *39*(3), 4–13. https://doi.org/10.1177/183693911403900302

Suri, H. (2011). Purposeful sampling in qualitative research synthesis. *Qualitative Research Journal*, *11*(2), 63–75. https://doi.org/10.3316/QRJ1102063

Sutton-Smith, B. (1997). *The Ambiguity of Play*. Harvard University Press.

Tarasuik, J., & Kaufman, J. (2017). When and why parents involve young children in video communication. *Journal of Children and Media*, *11*(1), 88–106. https://doi.org/10.1080/17482798.2016.1233124

Teddlie, C., & Tashakkori, A. (2016). Overview of Contemporary Issues in Mixed Methods Research. In Tashakkori, A., & Teddlie, C., *SAGE Handbook of Mixed Methods in Social & Behavioral Research.* SAGE Publications. https://doi.org/10.4135/9781506335193

Tesar, M., & Hood, N. (2019). Policy in the time of Anthropocene: Children, childhoods and digital worlds. Policy Futures in Education, *17*(2), 102–104. https://doi.org/10.1177/1478210319831830

Thompson, C., Lewis, D. J., & Taylor, S. J. C. (2017). The Use of Video Recording in Longitudinal Focus Group Research. In R. S. Barbour and D. L Morgan (Eds.), *A New Era in Focus Group Research: Challenges, Innovation and Practice* (pp. 207–224). Palgrave Macmillan. https://doi.org/10.1057/978-1-137-58614-8_10

Trawick-Smith, J. (2012). Teacher-child play interactions to achieve learning outcomes: risks and opportunities. In R. Pianta (Ed.), *Handbook of Early Childhood Education* (pp. 259–277). Guilford Press.

Tsitouridou, M. & Vryzas, K. (2003). Early Childhood Teachers' Attitudes towards Computer and Information Technology: The Case of Greece. *Information Technology in Childhood Education Annual*, *2003*(1), 187-207. Association for the Advancement of Computing in Education (AACE). Retrieved from https://www.learntechlib.org/primary/p/18869/.

Tzuo, P. W. (2007). The Tension between Teacher Control and Children's Freedom in a Child-centered Classroom: Resolving the Practical Dilemma through a Closer Look at the Related Theories. *Early Childhood Education Journal*, *35*(1), 33–39. https://doi.org/10.1007/s10643-007-0166-7

Uecker, B, Viska, P. (2020). *Swoosh, Glide and Rule Number 5.* E-Safety Commissioner. https://www.esafety.gov.au/parents/children-under-5/picture-book-and-song/swoosh-glide-and-rule-number-5

Vallberg-Roth, A.C. (2012). Different forms of assessment and documentation in Swedish preschools. *Tidsskrift for Nordisk Barnehageforskning*, *5*. https://doi.org/10.7577/nbf.479

Veen, W. (1993). The role of beliefs in the use of information technology: Implications for teacher education or teaching the right thing at the right time. *Journal of Information Technology for Teacher Education*, *2*(2), 139–153. https://doi.org/10.1080/0962029930020203

Verenikina, I., & Kervin, L. (2011). iPads, Digital Play and Preschoolers. *He Kupu*, *2*(5), 4-16. Retrieved from https://ro.uow.edu.au/edupapers/1205/

Vidal-Hall, C., Flewitt, R., & Wyse, D. (2020). Early childhood practitioner beliefs about digital media: integrating technology into a child-centred classroom environment. *European Early*

Childhood Education Research Journal, *28*(2), 167–181. https://doi.org/10.1080/1350293X.2020.1735727

Voogt, J., Pieters, J., & Roblin, N. P. (2019). Collaborative curriculum design in teacher teams: Foundations. *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, 5–18. https://doi.org/10.1007/978-3-030-20062-6_1

Vossoughi, S., & Bevan, B. (2014). *Making and Tinkering: A Review of the Literature*. National Research Council Committee on Out of School Time STEM, 67, 1-55. Retrieved from http://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_089888.pdf

Vygotsky, L. S. (1967). Play and Its Role in the Mental Development of the Child. *Soviet Psychology*, *5*(3), 6–18. https://doi.org/10.2753/RPO1061-040505036

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.

Vygotsky, L. S. (1987). The Development of Scientific Concepts in Childhood. In R. W. Rieber & A. S. Carton (Eds.), *The Collected Works of LS Vygotsky* (pp. 167–241). Springer US. https://doi.org/10.1007/978-1-4613-1655-8_9

Wager, A. A., & Parks, A. N. (2016). Assessing early number learning in play. *ZDM - Mathematics Education*, *48*(7), 991–1002. https://doi.org/10.1007/s11858-016-0806-8

Wahyuni, D. (2012). The Research Design Maze: Understanding Paradigms, Cases, Methods and Methodologies. *Journal of Applied Management Accounting Research*, *10*(1), 69-80. Retrieved from https://www.proquest.com/scholarly-journals/research-design-maze-understanding-paradigms/docview/1034602171/se-2

Walker, R. (1993). Finding a silent voice for the Researcher: Using photographs in Evaluation and Research. In M. Schartz (Ed.), *Qualitative Voices in Educational Research* (pp.72-39). Falmer.

Watson, A., Lupton, D., & Michael, M. (2021). Enacting intimacy and sociality at a distance in the COVID-19 crisis: the sociomaterialities of home-based communication technologies. *Media International Australia*, *178*(1), 136–150. https://doi.org/10.1177/1329878X20961568

Weisberg, D. S., Hirsh-Pasek, K., & Golinkoff, R. M. (2013). Guided play: Where curricular goals meet a playful pedagogy. *Mind, Brain, and Education*, *7*(2), 104–112. https://doi.org/10.1111/mbe.12015

Wells, T. C. (2021). Landing in the Post Qualitative. *Qualitative Inquiry*, *27*(2), 171–174. https://doi.org/10.1177/1077800420941045

Westbroek, H., Vries, B. De, Walraven, A., Handelzalts, A., & McKenney, S. (2019). Teachers as Co-designers: Scientific and Colloquial Evidence on Teacher Professional Development and Curriculum Innovation. In J. Pieters, J. Voogt and P. Roblin (Eds.), *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning* (pp. 35–54). https://doi.org/10.1007/978-3-030-20062-6

Winner, L. (1993). Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology. *Science, Technology & Human Values*, *18*(3), 362–378. https://doi.org/10.1177/016224399301800306

Wint, E. (2011). Reflexivity in practice: Developing a new attitude as part of teaching and engaging in participatory research and development. *Journal of Progressive Human Services*, *22*(1), 68–83. https://doi.org/10.1080/10428232.2010.523678

Wohlend, K., Scott, J., Yi, J., Deliman, A., & Kargin, T. (2018). Hacking Toys and Remixing Media: Integrating Maker Literacies into Early Childhood Teacher Education Karen. In S. Danby, M.

Fleer, C. Davidson, M. Hatzigianni (Eds.) *Digital Childhoods. International Perspectives on Early Childhood Education and Development*, vol 22. Springer. https://doi.org/10.1007/978-981-10-6484-5_10

Wohlwend, K., & Peppler, K. (2015). All rigor and no play is no way to improve learning. *Phi Delta Kappan*, *96*(8), 22–26. https://doi.org/10.1177/0031721715583957

Wohlwend, K., Peppler, K., Keune, A., & Thompson, N. (2017). Making sense and nonsense: Comparing mediated discourse and agential realist approaches to materiality in a preschool makerspace. Journal of Early Childhood Literacy, 17(3), 444–462. https://doi.org/10.1177/1468798417712066

Wood, E. (2007). New directions in play: consensus or collision? *Education 3-13, 35*(4), 309–320. https://doi.org/10.1080/03004270701602426

Wood, E. (2010). Developing integrated pedagogical approaches to play and learning. In P. Broadhead, J. Howard, & E. Wood (Eds.), *Play and Learning in the Early Years: From Research to Practice* (pp. 19-34). Sage.

Wood, E., Nuttall, J., Edwards, S., & Grieshaber, S. (2019). Young children's digital play in early childhood settings Curriculum, pedagogy and teachers' knowledge. In O. Erstad, R. Flewitt, B. Kümmerling-Meibauer, & I. Pereira (Eds.), *Routledge handbook of digital literacies in early childhood* (pp. 214–226). Routledge.

Wood, E., Specht, J., Willoughby, T., & Mueller, J. (2008). Integrating computer technology in early childhood education environments: Issues raised by early childhood educators. *Alberta Journal of Educational Research, 54*(2), 210–226.

Wood, E., Willoughby, T., & Specht, J. (1998). What's happening with computer technology in early childhood education settings? *Journal of Educational Computing Research*, *18*(3), 237–243. https://doi.org/10.2190/RR6W-EJLL-RBLF-MRJ9

Wyatt, S. (2008). Technological determinism is dead; Long live technological determinism. In E. Hackett, O. Amsterdamska, M. Lynch, & J. Wajcman (Eds.), *Handbook of Science and Technology Studies* (pp. 165-180). MIT Press.

Yelland, N. J. (1998). Empowerment and control with technology for young children. *Educational Theory and Practice, 20*(2), 45–55.

Yelland, N. (2011). Reconceptualising Play and Learning in the Lives of Young Children. *Australasian Journal of Early Childhood, 36*(2), 4–12. https://doi.org/10.1177/183693911103600202

Yilmaz, K. (2013). Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. *European Journal of Education Research, Development and Policy 48*(2), 311-325. https://doi.org/10.1111/ejed.12014

Yin, R. K. (2016). *Qualitative Research from Start to Finish* (2nd ed.). The Guilford Press.

Yost, H., & Fan, S. (2014). Social media technologies for collaboration and communication: Perceptions of childcare professionals and families. *Australasian Journal of Early Childhood, 39*(2), 36–41. https://doi.org/10.1177/183693911403900206

Zabatiero, J., Straker, L., Mantilla, A., Edwards, S., & Danby, S. (2018). Young children and digital technology: Australian early childhood education and care sector adults' perspectives. *Australasian Journal of Early Childhood*, *43*(2), 14–22. https://doi.org/10.23965/AJEC.43.2.02

APPENDICES

Appendix A: Orientation Meeting PowerPoint Presentation

ACU INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION

Research aim

To find out your perspectives on what the children learn from an intentional play-based learning approach to tinkering

Benefits

- Innovative approach to using technology with children to promote play and learning
- Findings will be used to inform children's advocacy organisations such as Early Childhood Australia

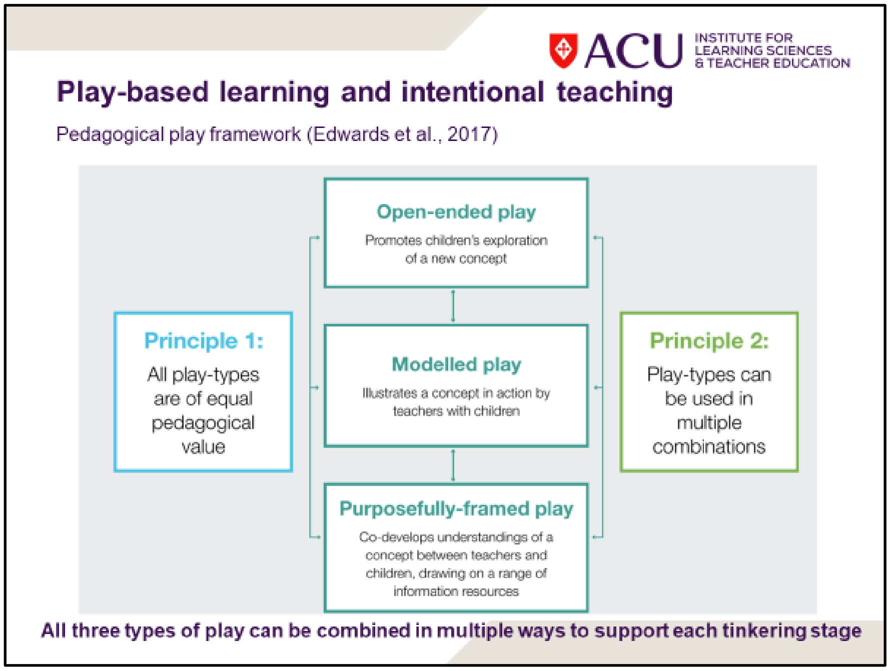
ACU INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION

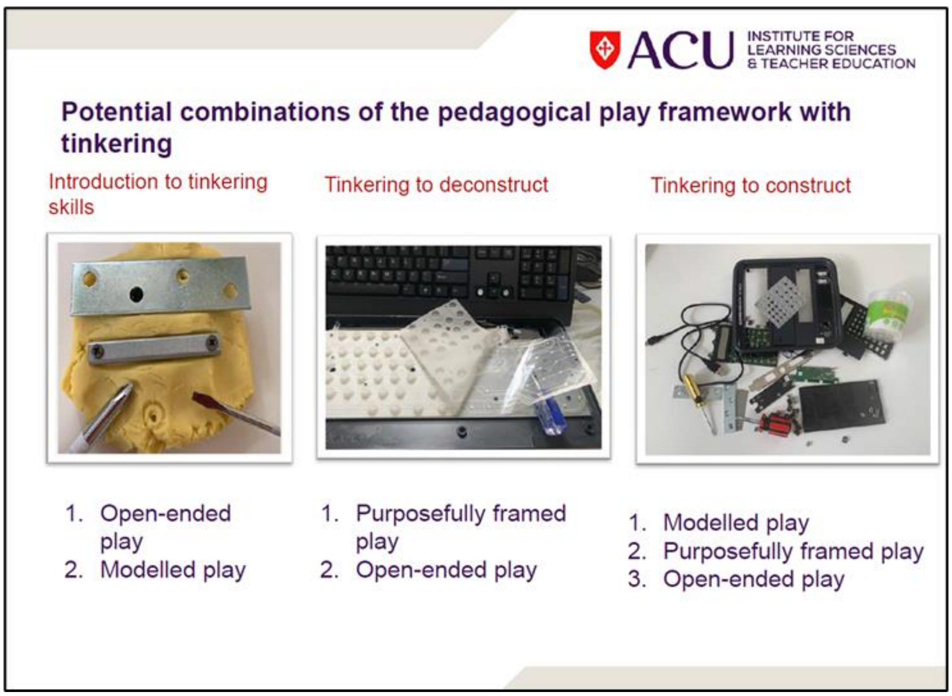
What is tinkering?

- Hands-on direct interaction with tools and materials
- Open-ended iterative exploration
- Creative problem solving
- Playful inquisitive mindsets
- Learning through doing (constructionism)
- Learning through sharing ideas and collaboration (social constructivism)

Stages of tinkering in this project

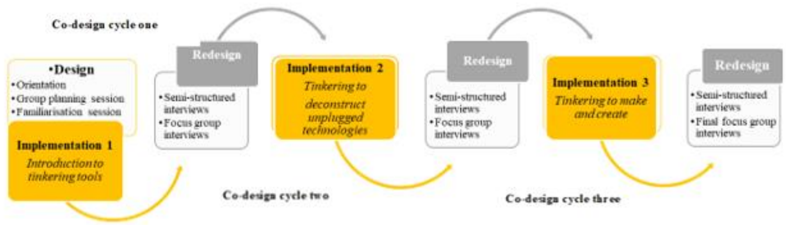
1. Introduction to tinkering tools
2. Deconstruction of non-working technologies into loose parts materials
3. Construction with loose parts materials


ACU INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION
Play-based learning and intentional teaching
Pedagogical play framework (Edwards et al., 2017)
Open-ended play
Promotes children's exploration of a new concept
Principle 1:
All play-types are of equal pedagogical value
Modelled play
Illustrates a concept in action by teachers with children
Principle 2:
Play-types can be used in multiple combinations
Purposefully-framed play
Co-develops understandings of a concept between teachers and children, drawing on a range of information resources
All three types of play can be combined in multiple ways to support each tinkering stage


ACU INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION
Potential combinations of the pedagogical play framework with tinkering
Introduction to tinkering skills
Tinkering to deconstruct
Tinkering to construct
1. Open-ended play
2. Modelled play
1. Purposefully framed play
2. Open-ended play
1. Modelled play
2. Purposefully framed play
3. Open-ended play

ACU INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION

Organisation of study



ACU INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION

Proposed timeline of study

Data collection	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Orientation (online)	60 mins											
Group planning workshop		90 mins										
Familiarisation with each room/children			60 mins									
Implementation 1:Introduction to tinkering tools				60 mins								
Semi-structured interviews					30 mins							
Group focus interview						45 mins						
Implementation 2: Tinkering to deconstruct unplugged technologies							60 mins					
Semi-structured interviews								30 mins				
Group focus interview									45 mins			
Implementation 3: Tinkering to make and create										60 mins		
Semi-structured interviews)											30 mins	
Final focus group interview												60 mins

Appendix B: Australian Catholic University Ethics Approval (HERC 2021-57H)

[2021-57H] - Ethics application approved!

RE Kylie Pashley on behalf of Res Ethics
To Suzy Edwards; Honor Mackley
Cc Res Ethics

Reply Reply All Forward
Mon 17/05/2

Dear Applicant,

Chief Investigator: Professor Susan Edwards
Co-investigators: Dr Karen McLean, Dr Renata Cinelli
Student Researcher: Honor Mackley
Ethics Register Number: 2021-57H
Project Title: Tinkering in play-based settings: Developing Early Childhood Education learning outcomes through 'hands on' manipulations of non-working technologies.
Date Approved: 17/05/2021
End Date: 31/05/2022

This is to certify that the above human ethics application has been reviewed by the Australian Catholic University Human Research Ethics Committee (ACU HREC). The application has been approved for given above.

Continued approval of this research project is contingent upon the submission of an annual progress report which is due on/before each anniversary of the project approval. A final report is due upon c of the project. A report proforma can be downloaded from the ACU Research Ethics website.

Researchers are responsible for ensuring that all conditions of approval are adhered to and that any modifications to the protocol, including changes to personnel, are approved prior to implementatio addition, the ACU HREC must be notified of any reportable matters including, but not limited to, incidents, complaints and unexpected issues.

Researchers are also responsible for ensuring that they adhere to the requirements of the National Statement on Ethical Conduct in Human Research, the Australian Code for the Responsible Conduct c and the University's Research Code of Conduct.

Any queries relating to this application should be directed to the Ethics Secretariat (res.ethics@acu.edu.au). Please quote your ethics approval number in all communications with us.

We wish you every success with your research.

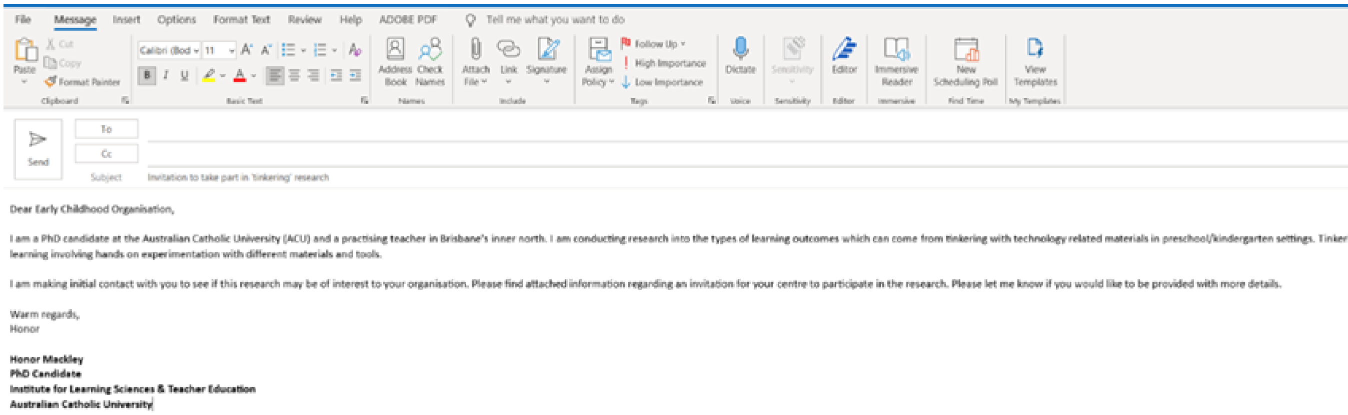
Kind regards,

Kylie Pashley
on behalf of ACU HREC Chair, Assoc Prof. Michael Baker

Senior Research Ethics Officer | Research Services | Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
T: +61 2 9739 2646 E: res.ethics@acu.edu.au

THIS IS AN AUTOMATICALLY GENERATED RESEARCHMASTER EMAIL

Appendix C: Invitation Emails to Services to Participate in a Research Project



To

Cc

Subject Invitation to take part in 'tinkering' research

Dear Early Childhood Organisation,

I am a PhD candidate at the Australian Catholic University (ACU) and a practising teacher in Brisbane's inner north. I am conducting research into the types of learning outcomes which can come from tinkering with technology related materials in preschool/kindergarten settings. Tinker
learning involving hands on experimentation with different materials and tools.

I am making initial contact with you to see if this research may be of interest to your organisation. Please find attached information regarding an invitation for your centre to participate in the research. Please let me know if you would like to be provided with more details.

Warm regards,
Honor

Honor Mackley
PhD Candidate
Institute for Learning Sciences & Teacher Education
Australian Catholic University

Appendix D: Australian Catholic University (HERC 2021-57H) [Modified Ethics Approval to Include Pilot-Study]

[2021-57H] - Ethics Modification Approved

RE Res Ethics
To Honor Mackley; Suzy Edwards

Reply | Reply All | Forward

Mon 12/07/2021 3:55 PM

Dear Susan

Ethics Register Number : 2021-57H
Project Title : Tinkering in play-based settings: Developing Early Childhood Education learning outcomes through 'hands on' manipulations of non-working technologies.
End Date : 31/05/2022

Thank you for submitting the request to modify form for the above project.

The Chair of the Human Research Ethics Committee has approved the following modification(s):
Inclusion of a pilot project with one educator and small group of students.

subject to:

We wish you well in this ongoing research project.

Kind regards,
Res Ethics EMAIL ONLY

Research Ethics Officer | Research Services | Office of the Deputy Vice-Chancellor (Research)
on behalf of ACU HREC Chair, Assoc Prof. Michael Baker
Australian Catholic University
T: 02 9739 2646 E: res.ethics@acu.edu.au

THIS IS AN AUTOMATICALLY GENERATED RESEARCHMASTER EMAIL

Appendix E: Pilot-Study Educator Information Letter

AUSTRALIAN CATHOLIC UNIVERSITY

PARTICIPANT INFORMATION LETTER: PILOT PROJECT
(Educators)

PROJECT TITLE: 'Tinkering' in play-based settings
APPLICATION NUMBER: 2021-57H
PRINCIPAL INVESTIGATOR: Professor Susan Edwards
LEAD RESEARCHER: Honor Mackley

Dear participant,

You are invited to participate in a pilot research project described below.

What is the pilot research project about?
This pilot project forms part of a larger research project which investigates the activity of 'tinkering' with technology related materials in a play-based setting. Tinkering is a physical hands-on activity involving creative experimentation with a range of materials and non-working digital technologies. Non-working technologies are technologies that no longer function or are in disrepair. Examples include: computer mice; keyboards; DVD players; old landline phones; and printers. Tinkering involves taking these technologies apart into smaller components using tools such as screwdrivers and tweezers for example, and then using these parts to create something new. The purpose of this pilot project is to test out the research protocols and research design prior to the commencement of a full-scale research project. Participants in the pilot project will not be involved in the full - scale research project.

Who is undertaking this project?
The lead researcher on this project is Honor Mackley. Honor is a PhD candidate at the Australian Catholic University, and a very experienced teacher registered with the Queensland College of Teachers (QCT). Honor has previous research experience working with children in play-based learning settings.
The principal investigator is Professor Susan Edwards (Australian Catholic University). Professor Edwards has extensive experience in research, working with young children, families and educators using technologies for play and learning.

What are the benefits of the pilot research project?
This pilot project is important because it will inform the identification of play-based learning approaches to tinkering activities which will then be implemented in a full-scale research project. This pilot project will also inform safety protocols and the feasibility of using a range of resources in a full-scale project. This pilot research project will occur before the commencement of the full-scale study. Participants in the pilot project will not participate in the full-scale research project.

Who can take part in this research?
All educators and children are welcome to participate in this project, upon return of consent forms.

What will I be asked to do?
If you decide to participate in this pilot project, you will be invited to:

- Attend one planning session with the researcher of approximately one hour duration at your service.
- Participate in two tinkering sessions with a group of children in your care (4–5-year-olds). Each tinkering session will be of one hour duration.
- Give permission for the researcher to make observation notes which will be used to inform research protocol for the full-scale research project.

AUSTRALIAN CATHOLIC UNIVERSITY

You will be provided a letter of certification from the Australian Catholic University detailing your commitment and activities completed for the purposes of professional learning recognition.

Are there any risks associated with participating in this project?

All tinkering activities will be jointly planned with you and the researcher. This means that you will be involved in designing the activities according to your needs as an educator and the needs of the children in your group. This project will have no impact on your employment following participation in the event you choose to participate. There is a small risk that you may be identifiable due to the low numbers of participants required for this pilot project. In order to mitigate this risk, all data will be de-identified. This means that you will be invited to choose a pseudonym (false name) for yourself to protect your privacy. Data will be stored on a secure password-protected central system. Your contact details will be kept separate from data.

You may withdraw from these activities at any time. If necessary, participants can access counselling through your organisation's usual workplace employee assistance program (EAP).

Can I withdraw from the pilot study?

Participation in this pilot study is entirely voluntary. You are not under any obligation to participate. If you agree to participate, you can withdraw from the pilot study at any time without adverse consequences. If you withdraw from the study, then all data collected about you before your withdrawal from the study will be shredded and all stored electronic data will be deleted.

Who will know of the results of the project?

Individual data will not be reported in this study, all data will be summative. Findings will be communicated to all educator and parent participants through a brief final report.

The findings from this project may be published in academic journals and shared at conferences. All collected data will be stored on a secure password-protected central computer system. Your contact details will be kept separate from your data.

Who do I contact if I have questions about the project?

If you have any questions about the project at any time, please contact Susan Edwards at suzy.edwards@acu.edu.au

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics and Integrity Committee care of the Office of the Deputy Vice-Chancellor(Research):

Manager, Ethics and Integrity
c/o Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and thoroughly investigated. You will be informed of the outcome.

AUSTRALIAN CATHOLIC UNIVERSITY

I want to participate! How do I sign up?

We will visit your Kindergarten to confirm your participation. We will provide you with a consent form and ask you for your contact details. The lead researcher will then contact you to arrange your participation in the project.

Yours sincerely,

Professor Susan Edwards

Director Early Childhood Futures

Institute for Learning Sciences & Teacher Education

Australian Catholic University

suzy.edwards@acu.edu.au

Honor Mackley

PhD Candidate

Institute for Learning Sciences & Teacher Education

Australian Catholic University

honor.mackley@myacu.edu.au

Appendix F: Consent Form: Pilot-Study (Educators)

CONSENT FORM: PILOT STUDY
(Educators)
Copy for Researcher / Copy for Participant to Keep

PROJECT TITLE:	'Tinkering' in play-based settings
APPLICATION NUMBER:	2021-57H
PRINCIPAL INVESTIGATOR:	Professor Susan Edwards
LEAD RESEARCHER:	Honor Mackley

I .... *(the participant)* have read and understood the information provided in the Participant Information Letter: Pilot Project (Educators). Any questions I have asked have been answered to my satisfaction.

I agree to participate in this 'tinkering' pilot project. I understand that my participation in this project involves:

☐ Attending one planning session at my service with the researcher.

☐ Participating in two tinkering sessions with children in my care at my service.

☐ Giving permission for the researcher to make observation notes which will be used to inform research protocol for the full-scale research project.

☐ Understanding that I will not be part of the full-scale research project.

I understand that all research data collected for this study and used in publications will not be identifiable. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify me in any way.

I understand that I can withdraw from this pilot study at any time without adverse consequences. I understand that all data collected about me prior to my withdrawal from the pilot study will be shredded and all stored electronic data will be deleted. I give permission for myself to participate in this study.

My selected pseudonym (false name) is ....

NAME ....

SIGNATURE: ....DATE: ....

Honor Mackley

SIGNATURE OF LEAD INVESTIGATOR .. .. DATE: ....

Appendix G: Parent/Caregiver Information Letter: Pilot-Study

AUSTRALIAN CATHOLIC UNIVERSITY

PARENT/CAREGIVER INFORMATION LETTER: PILOT PROJECT

PROJECT TITLE: 'Tinkering' in play-based settings
APPLICATION NUMBER: 2021-57H
PRINCIPAL INVESTIGATOR: Professor Susan Edwards
LEAD RESEARCHER: Honor Mackley

Dear Parents/Caregivers,

You are invited to give permission for your child to participate in the pilot research project described below.

What is the project about?
This pilot project forms part of a larger research project which investigates the activity of 'tinkering' with technology related materials in a play-based setting. Tinkering is a physical hands-on activity involving creative experimentation with a range of materials and non-working digital technologies. Non-working technologies are technologies that no longer function or are in disrepair. Examples include: computer mice; keyboards; DVD players; old landline phones; and printers. Tinkering involves taking these technologies apart into smaller components using tools such as screwdrivers and tweezers for example, and then using these parts to create something new. The purpose of this pilot project is to test out the research protocols and research design prior to the commencement of the full-scale research project. Participants in the pilot-project will not be involved in the full-scale research project.

Who is undertaking this project?
The lead researcher on this project is Honor Mackley. Honor is a PhD candidate at the Australian Catholic University, and a very experienced teacher registered with the Queensland College of Teachers (QCT). Honor has previous research experience working with children in play-based learning settings.
The principal investigator is Professor Susan Edwards (Australian Catholic University). Professor Edwards has extensive experience in research, working with young children, families and educators using technologies for play and learning.

What are the benefits of the research project?
This pilot project is important because it will inform the identification of play-based learning approaches to tinkering activities which will then be implemented in the full-scale research project. This pilot project will also inform safety protocols and the feasibility of using a range of resources in a full-scale project. This pilot research project will occur before the commencement of the full-scale study. Your child will not be participating in the full-scale research project.

Who can take part in this research?
All children are welcome to participate in tinkering during this project.

What will my child be asked to do?
Your child will be invited to participate in two tinkering sessions. Guided by your child's educator, each tinkering session will take approximately one hour. During those sessions, your child will be:

- Introduced to tinkering related tools and guided through how to deconstruct a range of technology related materials into smaller loose parts components
- Encouraged to creatively explore and construct using the smaller loose parts components
- Asked to give permission for the researcher to make observation notes of their tinkering activities which will be used to inform research protocol for the full-scale research project

AUSTRALIAN CATHOLIC UNIVERSITY

Are there any risks associated with participating in this project?

There is a minor risk of injury when tinkering using tools such as screwdrivers and pincer tools like tongs. All tools provided will be age appropriate and designed for young children's use. Children will be closely instructed on how to use the tools and will be actively supervised at all times by their experienced educator. All tools will be counted before and after each tinkering session and safely stored in a locked container. Children will also be provided with eye protection in the form of safety goggles.

There is a small risk that your child may be identifiable due to the low numbers of participants required for this project. In order to mitigate this risk, all data will be de-identified. This means you will be invited to choose a pseudonym (false name) for your child to protect their privacy. All collected data will be stored on a secure password-protected central computer system. Your contact details will be kept separate from data. Your child may withdraw from these activities at any time.

Can my child withdraw from the study?

Participation in this study is entirely voluntary. Your child is not under any obligation to participate. If you agree for your child to participate, you can withdraw your child from the study at any time without adverse consequences. If you withdraw your child from the study, then all data collected about your child before your withdrawal from the study will be shredded and all stored electronic data will be deleted.

In addition, your child will be asked before each of the two tinkering sessions if they are happy to participate through the use of daily assent form. If your child indicates that they do not want to participate in that session, your child will be under no obligation to do so.

If you do not agree for your child to participate in this research project, your child will not be excluded from the tinkering activity.

Who will know of the results of the project?

Individual data will not be reported in this study, all data will be summative. Findings will be communicated to all educator and parent participants through a brief final report.

The findings from this project may be published in academic journals and shared at conferences. None of the video footage will be used in publications or at conferences and any photographs of your child will be de-identified.

Who do I contact if I have questions about the project?

If you have any questions about the project at any time, please contact Susan Edwards at suzy.edwards@acu.edu.au.

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics and Integrity Committee care of the Office of the Deputy Vice-Chancellor (Research):

Manager, Ethics and Integrity
c/o Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

AUSTRALIAN CATHOLIC UNIVERSITY

Any complaint or concern will be treated in confidence and thoroughly investigated. You will be informed of the outcome.

I want my child to participate! How do I sign up?
A consent form for you to sign and an assent for your child is available at your centre. We will visit your Kindergarten to answer any questions and confirm your child's participation.

Yours sincerely,

Professor Susan Edwards

Director Early Childhood Futures
Institute for Learning Sciences & Teacher Education
Australian Catholic University
suzy.edwards@acu.edu.au

Honor Mackley

PhD Candidate
Institute for Learning Sciences & Teacher Education
Australian Catholic University
honor.mackley@myacu.edu.au

Appendix H: Parent/Caregiver Consent Form: Pilot-Study

PILOT PROJECT CONSENT FORM

For Parents/Caregivers

Copy for Researcher / Copy for Participant to Keep

PROJECT TITLE:	'Tinkering' in play-based learning
APPLICATION NUMBER:	2021-57H
PRINCIPAL INVESTIGATOR:	Professor Susan Edwards
LEAD RESEARCHER:	Honor Mackley

I .... *(parent/caregiver of the participant)* have read and understood the information provided in the Information letter to Parents/caregivers. Any questions I have asked have been answered to my satisfaction.

I agree to my child participating in this pilot project about tinkering with technology related materials. I understand that my child's participation in this project involves:

- ☐ My child taking part in two tinkering sessions with technology related materials at their service.
- ☐ Giving permission for the researcher to make observation notes about my child's tinkering which will be used to inform research protocol for the full scale research project.
- ☐ Understanding that my child will not be part of the full scale project.

I understand that all material collected for this pilot study and used in publications will not be identifiable. I agree that research data collected for the pilot study may be published or may be provided to other researchers in a form that does not identify my child in any way.

I understand that I can withdraw my child from this pilot study at any time without adverse consequences. I understand that all data collected about my child prior to withdrawal from the study will be shredded and all stored electronic data will be deleted.

I give permission for my child,..., to participate in this study.

My child's selected pseudonym (false name) is ....

NAME ....

SIGNATURE: .... DATE: ....

Honor Mackley

SIGNATURE OF LEAD INVESTIGATOR .. .. DATE: ....

Appendix I: Pilot-Study Assent Form (Child)

PILOT PROJECT ASSENT FORM
(For Child)

PROJECT TITLE: 'Tinkering' in play-based settings
APPLICATION NUMBER: 2021-57H
PRINCIPAL INVESTIGATOR: Professor Susan Edwards
LEAD RESEARCHER: Honor Mackley

Dear participant,

Please indicate your assent or dissent beside each image.

Yes, I want to tinker with technologies

No, I do not want to tinker with technologies

Yes, I give permission for the researcher to take notes about me

No, I do not give permission for the researcher to take notes about me

NAME OF PARENT/CAREGIVER...

NAME OF CHILD..

SIGNATURE OF PARENT/CAREGIVER: .... DATE:..........................

SIGNATURE OF LEAD INVESTIGATOR .... Honor Mackley DATE: ....

Appendix J: Pilot-Study Daily Assent Form (Child)

AUSTRALIAN CATHOLIC UNIVERSITY

PILOT POJECT DAILY ASSENT FORM (For Child)

PROJECT TITLE: 'Tinkering' in play-based settings
APPLICATION NUMBER: 2021-57H
PRINCIPAL INVESTIGATOR: Professor Susan Edwards
LEAD RESEARCHER: Honor Mackley

Child's Name: ……………………………………………………………………………

	Please tell me how you feel today	
Day 1 of research	Happy to tinker today and for the researcher to take notes	Not interested today
Day 2 of research	Happy to tinker today and for the researcher to take notes	Not interested today

Honor Mackley

SIGNATURE OF LEAD INVESTIGATOR .. ……………………………………………

DATE: ……………………………….

Appendix K: Invitation to be Involved in a Research Project – Early Childhood Centre

AUSTRALIAN CATHOLIC UNIVERSITY

Invitation to be involved in a research project
(Early Childhood Centres)

PROJECT TITLE:	'Tinkering' in play-based settings
APPLICATION NUMBER:	HERC 2021-57H
PRINCIPAL INVESTIGATOR:	Professor Susan Edwards
LEAD RESEARCHER:	Honor Mackley

What is the project about?

This project investigates the activity of 'tinkering' with technology related materials in a play-based setting. Tinkering is a physical hands-on activity involving creative experimentation with a range of materials and non-working digital technologies. Non-working technologies are technologies that no longer function or are in disrepair. Examples include: computer mice; keyboards; DVD players; old landline phones; and printers. Tinkering involves taking these technologies apart into smaller components using tools such as screwdrivers and tweezers for example, and then using these parts to create something new. The purpose of this project is to identify the types of learning, as per the Early Years Learning Framework (EYLF), that educators perceive as arising from preschool/kindergarten aged children's tinkering with technology related materials.

Who is undertaking this project?

The lead researcher on this project is Honor Mackley. Honor is a PhD candidate at the Australian Catholic University, and a very experienced teacher registered with the Queensland College of Teachers (QCT). Honor has previous research experience working with children in play-based learning settings.
The principal investigator is Professor Susan Edwards (Australian Catholic University). Professor Edwards has extensive experience in research, working with young children, families and educators using technologies for play and learning.

What are the benefits of the research project?

This project is important because it aims to identify types of learning that educators may perceive as arising from children's tinkering with technology related materials. This project may benefit educators' learning about using technologies with children in ways that promote children's play and learning. The project will inform children's advocacy organisations such as Early Childhood Australia, other educators and families about innovative ways of using technologies in play and learning.

Who can take part in this research?

All educators and children are welcome to participate in this project, upon return of consent forms. Children who are not participating in the project are also welcome to join in the tinkering activities, however no data (photographs, video footage or learning documentation) will be collected from non-consenting children. Data will only be collected from children whose parents have returned consent forms on their behalf.

What will educators and children at your centre be asked to do?

Along with participants from other centres, educators will be invited to contribute in the co-designing of three tinkering sessions for preschool/Kindergarten aged children. Children in a participating educator's class group will invited to participate in the three tinkering sessions at their centre. If an educator from your centre decides to participate in this project, they will be invited to:

- Attend an online orientation session
- Attend a face-to-face group planning workshop, led by the lead researcher, to co-design three tinkering sessions around the following:

  Tinkering session 1: Introduction to tinkering related tools and loose parts materials

Are there any risks associated with participating in this project?

There is a minor risk of injury when tinkering using tools such as screwdrivers and pincer tools like tongs. All tools provided will be age appropriate and designed for young children's use. Children will be closely instructed on how to use the tools and will be actively supervised at all times by their experienced educator. All tools will be counted before and after each tinkering session and safely stored in a locked container. Children will also be provided with eye protection in the form of safety goggles.

There is a small risk that your child may be identifiable due to the low numbers of participants required for this project. In order to mitigate this risk, all data will be de-identified. This means you will be invited to choose a pseudonym (false name) for your child to protect their privacy. All collected data will be stored on a secure password-protected central computer system. Your contact details will be kept separate from data. Your child may withdraw from these activities at any time.

Can my child withdraw from the study?

Participation in this study is entirely voluntary. Your child is not under any obligation to participate. If you agree for your child to participate, you can withdraw your child from the study at any time without adverse consequences. If you withdraw your child from the study, then all data collected about your child before your withdrawal from the study will be shredded and all stored electronic data will be deleted.

In addition, your child will be asked before each of the two tinkering sessions if they are happy to participate through the use of daily assent form. If your child indicates that they do not want to participate in that session, your child will be under no obligation to do so.

If you do not agree for your child to participate in this research project, your child will not be excluded from the tinkering activity.

Who will know of the results of the project?

Individual data will not be reported in this study, all data will be summative. Findings will be communicated to all educator and parent participants through a brief final report.

The findings from this project may be published in academic journals and shared at conferences. None of the video footage will be used in publications or at conferences and any photographs of your child will be de-identified.

Who do I contact if I have questions about the project?

If you have any questions about the project at any time, please contact Susan Edwards at suzy.edwards@acu.edu.au.

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics and Integrity Committee care of the Office of the Deputy Vice-Chancellor (Research):

Manager, Ethics and Integrity
c/o Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and thoroughly investigated. You will be informed of the outcome.

I want my child to participate! How do I sign up?
A consent form for you to sign and an assent for your child is available at your centre. We will visit your Kindergarten to answer any questions and confirm your child's participation.

Yours sincerely,

Professor Susan Edwards

Director Early Childhood Futures
Institute for Learning Sciences & Teacher Education
Australian Catholic University
suzy.edwards@acu.edu.au

Honor Mackley

PhD Candidate
Institute for Learning Sciences & Teacher Education
Australian Catholic University
honor.mackley@myacu.edu.au

Appendix L: Participant Information Letter (Educators)

AUSTRALIAN CATHOLIC UNIVERSITY

PARTICIPANT INFORMATION LETTER
(Educators)

PROJECT TITLE:	'Tinkering' in play-based settings
APPLICATION NUMBER:	2021-57H
PRINCIPAL INVESTIGATOR:	Professor Susan Edwards
LEAD RESEARCHER:	Honor Mackley

Dear participant,

You are invited to participate in the research project described below.

What is the project about?
This project investigates the activity of 'tinkering' with technology related materials in a play-based setting. Tinkering is a physical hands-on activity involving creative experimentation with a range of materials and non-working digital technologies. Non-working technologies are technologies that no longer function or are in disrepair. Examples include: computer mice; keyboards; DVD players; old landline phones; and printers. Tinkering involves taking these technologies apart into smaller components using tools such as screwdrivers and tweezers for example, and then using these parts to create something new. The purpose of this project is to identify the types of learning, as per the Early Years Learning Framework (EYLF), that educators perceive as arising from preschool/kindergarten aged children's tinkering with technology related materials.

Who is undertaking this project?
The lead researcher on this project is Honor Mackley. Honor is a PhD candidate at the Australian Catholic University, and a very experienced teacher registered with the Queensland College of Teachers (QCT). Honor has previous research experience working with children in play-based learning settings.
The principal investigator is Professor Susan Edwards (Australian Catholic University). Professor Edwards has extensive experience in research, working with young children, families and educators using technologies for play and learning.

What are the benefits of the research project?
This project is important because it aims to identify types of learning that educators may perceive as arising from children's tinkering with technology related materials. This project may benefit your own learning about using technologies with children in ways that promote children's play and learning. The project will inform children's advocacy organisations such as Early Childhood Australia, educators and families about innovative ways of using technologies in play and learning.

Who can take part in this research?
All educators and children are welcome to participate in this project, upon return of consent forms. Children who are not participating in the project are also welcome to join in the tinkering activities, however no data (photographs, video footage or learning documentation) will be collected from non-consenting children. Data will only be collected from children whose parents have returned consent forms on their behalf

What will I be asked to do?
Along with three other educators from different services, you will be invited to contribute in the co-designing of the three tinkering sessions for preschool/kindergarten aged children at your service. If you decide to participate in this project, you will be invited to:

- Attend an online orientation session
- Attend a face-to-face group planning workshop, led by the lead researcher, to co-design three tinkering sessions around the following:

ACU
AUSTRALIAN CATHOLIC UNIVERSITY

Tinkering session 1: Introduction to tinkering related tools and loose parts materials
Tinkering session 2: Guided deconstruction of non-working digital technologies into smaller loose parts components
Tinkering session 3: Creative exploration and construction with smaller loose parts components

- Give permission for the lead researcher to conduct a 'trial' observation session to familiarise the children with the researcher and video camera
- Give permission for the lead researcher to video record and take photographs of you and the children during each of the three tinkering sessions
- Participate in three online one-on-one interviews with the researcher to discuss your perspectives of what the children are learning from tinkering
- Participate in two group educator focus sessions to share your perspectives on what the children are learning during tinkering
- Share documentation relating to children's learning as a result of the tinkering sessions. Documentation includes standard methods of gathering evidence about a child's learning in relation to the Early Years Learning Framework (EYLF). For example, screen shots of information uploaded to digital platforms e.g., Storypark, and/or written records of children's learning.
- Attend a final group workshop to share perspectives

How much time will this project take?

This project will be conducted over a 12 week period at participating services, and will involve a time commitment of approximately 4 hours during contact teaching time, and 7.5 hours during non-contact teaching time:

- Week 1: 90 minutes for the orientation session (online)
- Week 2: 90 minutes for the group planning workshop (face-to-face)
- Week 3: 1 hour for the trial/familiarisation session (face-to-face)
- Weeks 4,7 & 10: 1 hour for each tinkering session(face to face)
- Weeks 5, 8 & 11: 30 minutes for each one-on-one interviews(online)
- Weeks 6 & 9: 60 minutes for each focus group educator sessions (online)
- Week 12: 60 minutes final workshop (face-to-face)

Each participating educator will be provided a letter of certification from the Australian Catholic University detailing their commitment and activities completed for the purposes of professional learning recognition.

Are there any risks associated with participating in this project?

All tinkering activities will be jointly co-designed with educators and the researcher. This means that you will be involved in planning and designing the activities according to your needs as an educator and the needs of the children in your group. This project will have no impact on your employment in the event you choose to participate.

There is a small risk that you may be identifiable due to the low numbers of participants required for this project. In order to mitigate this risk, all data will be de-identified. This means that your face and/or identifiable features will be blurred out and pixelated. In addition, you will be invited to choose a pseudonym (false name) for yourself to protect your privacy. Data will be stored on a secure password-protected central system. Your contact details will be kept separate from data.

There may be some inconvenience by participating in an interview or discomfort due to being photographed or video recorded using technologies with children. You may withdraw from these activities at any time. If necessary, participants can access counselling through your organisation's usual workplace employee assistance program (EAP).

AUSTRALIAN CATHOLIC UNIVERSITY

Can I withdraw from the study?

Participation in this study is entirely voluntary. You are not under any obligation to participate. If you agree to participate, you can withdraw from the study at any time without adverse consequences. If you withdraw from the study, then all data collected about you before your withdrawal from the study will be shredded and all stored electronic data will be deleted.

Who will know of the results of the project?

Individual data will not be reported in this study, all data will be summative. Findings will be communicated to all educator and parent participants through a brief final report.

The findings from this project may be published in academic journals and shared at conferences. None of the video footage will be used in publications or at conferences, and any photographs of you or children in your care will be de-identified. All collected data will be stored on a secure password-protected central computer system. Your contact details will be kept separate from your data.

Who do I contact if I have questions about the project?

If you have any questions about the project at any time, please contact Susan Edwards at suzy.edwards@acu.edu.au

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics and Integrity Committee care of the Office of the Deputy Vice-Chancellor(Research):

Manager, Ethics and Integrity
c/o Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and thoroughly investigated. You will be informed of the outcome.

I want to participate! How do I sign up?

We will visit your Kindergarten to confirm your participation. We will provide you with a consent form and ask you for your contact details. The lead researcher will then contact you to arrange your participation in the project.

Yours sincerely,

S. Edwards

Professor Susan Edwards

Director Early Childhood Futures

Honor Mackley

Honor Mackley

PhD Candidate

Appendix M: Consent Form (Educators)

AUSTRALIAN CATHOLIC UNIVERSITY

CONSENT FORM
(Educators)
Copy for Researcher / Copy for Participant to Keep

PROJECT TITLE:	'Tinkering' in play-based settings
APPLICATION NUMBER:	2021-57H
PRINCIPAL INVESTIGATOR:	Professor Susan Edwards
LEAD RESEARCHER:	Honor Mackley

I .... *(the participant)* have read and understood the information provided in the Participant Information Letter (Educators). Any questions I have asked have been answered to my satisfaction. I agree to participate in this 'tinkering' project. I understand that my participation in this project involves:

☐ Attending one online orientation session.

☐ Attending one face-to-face group planning workshop, led by the lead researcher, to co-design three tinkering sessions.

☐ Giving permission for the lead researcher to conduct a 'trial' observation session to familiarise the children with the researcher and video camera.

☐ Giving permission for the lead researcher to video record and take photographs of you and the children during each of the three tinkering sessions.

☐ Participating in three online one-on-one interviews with the researcher to discuss your perspectives on what the children are learning from tinkering

☐ Participating in two group educator focus sessions to share your perspectives on what the children are learning during tinkering

☐ Sharing documentation relating to children's learning as a result of the tinkering sessions. Documentation includes standard methods of gathering evidence about a child's learning in relation to the Early Years Learning Framework (EYLF).

☐ Attend a final group workshop to share final perspectives

I understand that all material collected for this study and used in publications will not be identifiable and that if any identifying images are used, my permission will be sought. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify me in any way.

I understand that I can withdraw from this study at any time without adverse consequences. I understand that all data collected about me prior to my withdrawal from the study will be shredded and all stored electronic data will be deleted. I give permission for myself to participate in this study.

My selected pseudonym (false name) is ....

NAME ....

SIGNATURE: .... DATE: ....

Honor Mackley

SIGNATURE OF LEAD INVESTIGATOR .. .. DATE: ....

Appendix N: Parent/ Caregiver Information Letter

AUSTRALIAN CATHOLIC UNIVERSITY

PARENT/CAREGIVER INFORMATION LETTER

PROJECT TITLE: 'Tinkering' in play-based settings
APPLICATION NUMBER: 2021-57H
PRINCIPAL INVESTIGATOR: Professor Susan Edwards
LEAD RESEARCHER: Honor Mackley

Dear Parents/Caregivers,

You are invited to give permission for your child to participate in the research project described below.

What is the project about?
This project investigates the activity of 'tinkering' with technology related materials in a play-based setting. Tinkering is a physical hands-on activity involving creative experimentation with a range of materials and non-working digital technologies. Non-working technologies are technologies that no longer function or are in disrepair. Examples include: computer mice; keyboards; DVD players; old landline phones; and printers. Tinkering involves taking these technologies apart into smaller components using tools such as screwdrivers and tweezers for example, and then using these parts to create something new. The purpose of this project is to identify the types of learning, as per the Early Years Learning Framework (EYLF), that educators perceive as arising from preschool/kindergarten aged children's tinkering with technology related materials.

Who is undertaking this project?
The lead researcher on this project is Honor Mackley. Honor is a PhD candidate at the Australian Catholic University, and a very experienced teacher registered with the Queensland College of Teachers (QCT). Honor has previous research experience working with children in play-based learning settings.
The principal investigator is Professor Susan Edwards (Australian Catholic University). Professor Edwards has extensive experience in research, working with young children, families and educators using technologies for play and learning.

What are the benefits of the research project?
This project is important because it aims to identify types of learning that educators perceive as arising from children's tinkering with technology related materials. This may help educators to integrate technology use into play and learning in Kindergarten settings. The project will inform children's advocacy organisations such as Early Childhood Australia, educators and families about innovative ways of using technologies in play and learning.

Who can take part in this research?
All children are welcome to participate in tinkering during this project. Non-consenting children are also welcome to join in the tinkering activities, however no data (photographs, video footage or learning documentation) will be collected from non-consenting children. Data will only be collected from children whose parents have returned consent forms on their behalf.

What will my child be asked to do?
Your child will be invited to participate in three inter-related tinkering sessions. Guided by your child's educator, each tinkering session will take approximately one hour. If you would like your child to participate in the tinkering sessions, your child will be invited to:

- Take part in three tinkering sessions guided by their educator at their service:
  Tinkering session 1: Introduction to tinkering related tools and loose parts materials
  Tinkering session 2: Guided deconstruction of non-working technologies into smaller loose parts components

AUSTRALIAN CATHOLIC UNIVERSITY

Tinkering session 3: Creative exploration and construction with the smaller loose parts components

- Give permission for the lead researcher to take photographs of your child tinkering with technology related materials
- Give permission for the lead researcher to take video recordings of your child tinkering with technology related materials
- Give permission for the lead researcher to look at documentation relating to your child's learning arising from tinkering. Documentation includes standard methods of gathering evidence about a child's learning in relation to the Early Years Learning Framework (EYLF). For example, screen shots of information uploaded to digital platforms and/or written records of children's learning.

Are there any risks associated with participating in this project?

There is a minor risk of injury when tinkering using tools such as screwdrivers and pincer tools like tongs. All tools provided will be age appropriate and designed for young children's use. Children will be closely instructed on how to use the tools, and will be actively supervised at all times by their experienced educator. All tools will be counted before and after each tinkering session and safely stored in a locked container. Children will also be provided with eye protection in the form of safety goggles.

There is a small risk that your child may be identifiable due to the low numbers of participants required for this project. In order to mitigate this risk, all data will be de-identified. This means that your child's face and/or identifiable features will be blurred out and pixelated. In addition, you will be invited to choose a pseudonym (false name) for your child to protect their privacy. All collected data will be stored on a secure password-protected central computer system. Your contact details will be kept separate from data. Your child may withdraw from these activities at any time.

Can my child withdraw from the study?

Participation in this study is entirely voluntary. Your child is not under any obligation to participate. If you agree for your child to participate, you can withdraw your child from the study at any time without adverse consequences. If you withdraw your child from the study, then all data collected about your child before your withdrawal from the study will be shredded and all stored electronic data will be deleted.

In addition, your child will be asked before each of the three tinkering sessions if they are happy to participate through the use of daily assent form. If your child indicates that they do not want to participate in that session, your child will be under no obligation to do so.

If you do not agree for your child to participate in this research project, your child will not be excluded from the tinkering activity. However, your child will not be video recorded or photographed and no data about your child will be collected.

Who will know of the results of the project?

Individual data will not be reported in this study, all data will be summative. Findings will be communicated to all educator and parent participants through a brief final report.

The findings from this project may be published in academic journals and shared at conferences. None of the video footage will be used in publications or at conferences and any photographs of your child will be de-identified.

Who do I contact if I have questions about the project?

If you have any questions about the project at any time, please contact Susan Edwards at suzy.edwards@acu.edu.au.

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number). If you have any complaints or concerns about the conduct of the project, you may write to the Manager

AUSTRALIAN CATHOLIC UNIVERSITY

of the Human Research Ethics and Integrity Committee care of the Office of the Deputy Vice-Chancellor (Research):

Manager, Ethics and Integrity
c/o Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and thoroughly investigated. You will be informed of the outcome.

I want my child to participate! How do I sign up?
A consent form for you to sign and an assent for your child is available at your centre. We will visit your Kindergarten to answer any questions and confirm your child's participation.

Yours sincerely,

Professor Susan Edwards

Director Early Childhood Futures
Institute for Learning Sciences & Teacher Education
Australian Catholic University
suzy.edwards@acu.edu.au

Honor Mackley

PhD Candidate
Institute for Learning Sciences & Teacher Education
Australian Catholic University
honor.mackley@myacu.edu.au

Appendix O: Consent Form (Parents/Caregivers)

ACU
AUSTRALIAN CATHOLIC UNIVERSITY

CONSENT FORM
For Parents/Caregivers
Copy for Researcher / Copy for Participant to Keep

PROJECT TITLE:	'Tinkering' in play-based learning
APPLICATION NUMBER:	2021-57H
PRINCIPAL INVESTIGATOR:	Professor Susan Edwards
LEAD RESEARCHER:	Honor Mackley

I .... *(parent/caregiver of the participant)* have read and understood the information provided in the Information letter to Parents/Caregivers. Any questions I have asked have been answered to my satisfaction.

I agree to my child participating in this project about tinkering with technology related materials. I understand that my child's participation in this project involves:

- ☐ My child taking part in three tinkering sessions with technology related materials at her/his service.
- ☐ Having photographs taken of my child tinkering with technology related materials taken at his/her service.
- ☐ Having a research team member complete video-recordings of my child tinkering with technology related materials at his/her service.
- ☐ Having documentation relating to my child's learning from tinkering shared with the researcher. Documentation includes standard methods of gathering evidence about a child's learning in relation to the Early Years Learning Framework (EYLF). For example, screen shots of information uploaded to digital platforms and/or written records of children's learning.

I understand that all material collected for this study and used in publications will not be identifiable and that if any identifying images are used, my permission will be sought. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify my child in any way.
I understand that I can withdraw my child from this study at any time without adverse consequences. I understand that all data collected about my child prior to withdrawal from the study will be shredded and all stored electronic data will be deleted.

I give permission for my child,.., to participate in this study.

My child's selected pseudonym (false name) ....

NAME ....

SIGNATURE: .... DATE: ....

Honor Mackley

SIGNATURE OF LEAD INVESTIGATOR .. .. DATE: ....

Appendix P: Full-Scale Assent Form (Child)

AUSTRALIAN CATHOLIC UNIVERSITY

ASSENT FORM (For Child)

PROJECT TITLE: 'Tinkering' in play-based settings
APPLICATION NUMBER: 2021-57H
PRINCIPAL INVESTIGATOR: Professor Susan Edwards
LEAD RESEARCHER: Honor Mackley

Dear child participant,

Please indicate your assent or dissent beside each image.

Yes, I want to tinker with technologies

No, I do not want to tinker with technologies

Yes, you can take photographs of me tinkering with technologies

No, you cannot take photographs of me tinkering with technologies

Yes, you can video-record me tinkering with technologies

No, you cannot video-record me tinkering with technologies

NAME OF PARENT/CAREGIVER.. NAME OF CHILD..

SIGNATURE OF PARENT/CAREGIVER: .... DATE: ....

Honor Mackley

SIGNATURE OF LEAD INVESTIGATOR .... DATE: ....

Appendix Q: Full-Scale Daily Assent Form (Child)

ASSENT FORM
(For Child)

PROJECT TITLE: 'Tinkering' in play-based settings
APPLICATION NUMBER: 2021-57H
PRINCIPAL INVESTIGATOR: Professor Susan Edwards
LEAD RESEARCHER: Honor Mackley

Child's Name: ....

	Please tell me how you feel today	
Day 1 of research	Happy to tinker and be videoed/photographed	Not interested today
Day 2 of research	Happy to tinker and be videoed/photographed	Not interested today
Day 3 of research	Happy to tinker and be videoed/photographed	Not interested today

Honor Mackley

SIGNATURE OF LEAD INVESTIGATOR .... DATE: ....

Appendix R: Semi-Structured Interview Questions

Implementation 1: introduction to tinkering tools

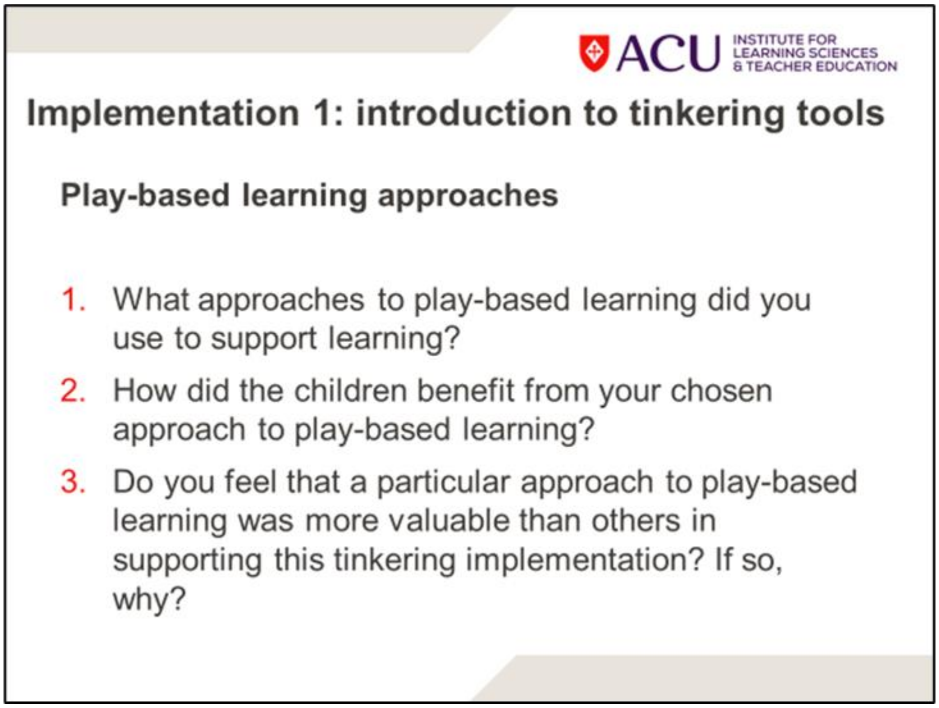
Learning outcomes

1. Overall, how do you feel that this tinkering session went?
2. What do you think the consenting children were learning relative to learning outcomes associated with the QKLG/EYLF?
3. Do you notice anything the children were learning that is not indicated in the QKLG/EYLF?

Implementation 1: introduction to tinkering tools

Engagement with materials

1. How do you feel the children engaged with the materials? For example, how they touched, talked and used the materials.
2. Where there some materials that you felt the children spent more time/less time engaging with?
3. Did you notice if a child talked about any aspects of the tinkering in relation to digital technologies they are familiar with at home or at the service?


ACU INSTITUTE FOR LEARNING SCIENCES & TEACHER EDUCATION
Implementation 1: introduction to tinkering tools
Play-based learning approaches
1. What approaches to play-based learning did you use to support learning?
2. How did the children benefit from your chosen approach to play-based learning?
3. Do you feel that a particular approach to play-based learning was more valuable than others in supporting this tinkering implementation? If so, why?

Appendix S: Coding Structure for Educator Identified Learning Outcomes: Child to Great Grand-Child nodes

Child node	Grand-child node	Great grand-child node	Examples of educator identified Learning Outcomes
Identity (QCAA, 2018)	1. Building a sense of security and trust 2. Acting with independence and perseverance 3. Building a confident self-identity	• feeling safe, accepted and supported • developing a sense of belonging and confidence in others • managing routines • developing agency in decision making • being willing to keep trying	• I noticed definitely a strong sense of identity - I think they showed independence and perseverance in developing their agency in their own decision making
Connectedness (QCAA, 2018)	1. Building positive relationship 2. Showing respect for diversity 3. Showing respect for environments	• connecting with and relating to others • understanding rights and responsibilities • responding to others with respect • developing awareness of bias • learning about others' cultures •caring for the kindergarten • exploring interactions between people and environments	• They also participated so well, and they were all so interested in each other's work, as well sharing their work with the educators -calling over to educators to show their work off, describing every part of what they made. • Connecting and showing respect for the things at the end, definitely tidying up, and looking after the things you brought in to share with us, and everybody looking after it all which was really good. • Placing their lids and their containers together, so looking after all the resources that were given.
Wellbeing (QCAA, 2018)	1. Building a sense of autonomy 2. Exploring ways to be healthy and safe 3. Exploring ways to promote physical wellbeing	• developing self-regulation • developing resilience • being healthy • staying safe • developing control and strength • developing awareness of the senses	• It was so nice to see them building things on their own • I think mine definitely touched on the wellbeing...some of the kids if they didn't have their safety glasses on the others would be on top of that 100% ...they were very so aware of that • some materials like the screwdrivers can be a little sharp so they knew that they had to be careful

			when manipulating them • She was really using her manipulation skills to turn the screwdriver • Very much the wellbeing- fine motor by using their hands to explore and investigate
Active learning (QCAA, 2018)	1. Building positive dispositions towards learning 2. Showing confidence and involvement in learning 3. Using technologies for learning and communication	• showing curiosity and enthusiasm for learning • problem-solving, investigating and reflecting on learning • Being imaginative and creative • applying knowledge in different contexts • sharing ideas and discoveries • Showing interest in technologies • using technologies	• Using their curiosity, imagination ...something different for them to explore so they were curious about what it was, it engaged a large majority of them and engaged them for a long time which you know not everything does • They are actually hypothesising and testing and experimenting with things • They were using their inquiry skills to explore it further and "what's this for" -the linking of what they are learning about technology to their actual keyboards and mice – "oh yeah this is what a keyboard is and this is what's inside it" • They spent a long time just going through all of that and talking about each thing – "oh it's a controller", pulling it all apart and using the keyboards to build houses ...you know exploring the loose parts and connecting them together •But once they realised what they could do then they could keep going on their own... • They were learning what inputs are, what outputs are, they were thinking more about what technologies were used for because I was using elements from the room, so this is an interactive whiteboard because before they called it a tv, now they are going, "it's not a tv, it's an interactive whiteboard! And they know that the iPad has multiple uses - it's a camera, keyboard, they've got them at home you know and a computer as well, so they are understanding a bit more about how those things work....

Communicating (QCAA, 2018)	1. Exploring and expanding language 2. Exploring literacy in personally meaningful ways 3. Exploring numeracy in personally meaningful ways	• using language/s, including signing • listening and responding engaging with different texts • exploring sounds and letters • exploring reading and writing • exploring mathematical concepts in everyday life • exploring counting and patterns	• When I first had them as a group, we discussed things like is there any sharp objects and then when they actually had the screwdrivers and things in their hands then they called me over and said they are not sharp, and it was good to see them use that language to me and with each other • And to be able to communicate with each other as well and also to me about how they felt the resources were which was really cool to see them describing and using language to describe how the materials felt • When they did finish they wanted to share it, and so they were inviting the educators and the other children into their learning, their interpretations of what they had made, "Oh look I put the screws in here", or, "I put the brackets here and I did this with the screwdrivers", so they are actually using the language which is surprising because I didn't actually realise that they knew this, so that is good. • The language that was used that had previously been used by you and myself during the weeks caught up to them as well because they reheard it and made connections to that so that was really cool • And even the children's wording ...like device- using that actual word for what they have created as well. • When she was explaining it to me the language she was using was just incredible, it was literally all we have been talking about like the input and um emergency button ...it was just amazing!

Appendix T: Coding Structure for Manifestations with Illustrative Examples from the Data

Child node	Grandchild node	Examples
Versions of technology	• Vacuum cleaners • Binocular machines • Star Wars ships • Keyboards • iPads • Computers • Phones • Robots • Gamers (relating to commonly played video games e.g., Nintendo™, PlayStation™)	• She was making a **vacuum cleaner** so she was putting the screws in and getting the brackets and she had two brackets sticking out so that was her controls for the vacuum cleaner • She made a **binocular machine** or microscope with the little parts, and everything like with the switches and things like that ...it was really cool • They started using their creative imagination "oh well I'm going to make a **Star Wars ship**" and they come up with their own creative ideas • They got the play dough back out and they were making their own **keyboards** • It's interesting to see how they made an iPad, and they knew obviously **devices** like that and they were able to put those little keys down and go "well this is what my mum and dad has or I have one of these at home so....." • Another one had used the wire from the keyboard into the playdough and was making that as their computer, and things like that ...so making their **own version of technology** • They were just pushing the keys into the play dough saying this is my **robot** • I think others were making **gamers** ..controllers • Every child said that they just love making things, making controllers, using the technologies in their play
Real life non-digital things	• Tacos • Fish • Houses	• So, mine were making a lot of real life things like the **tacos** so they were **making real life non-digital things** • I had some kids like making **fish** using the cupcake liner as wings or things like that, • The **fish**- just every part was used, her playdough, the loose parts and then the miscellaneous stuff you bought in too, it was like just so cool to see how intricate the little details were like the fish lips and the eyes and all parts of it • They were pulling it all apart and using the keyboards to build **houses** ...yeah and you know exploring the loose parts and connecting them together