

Connecting Piaget's cognitive development theory to technology in the early years.

Joy McLelland | *New Zealand Tertiary College*

The purpose of this article is to connect aspects of Piaget's cognitive development theory to technological practice. The application and implementation of technological experiences will be examined by first defining what technology means in early childhood education followed by how technology can support children's cognitive development. Research suggests that teachers may lack the knowledge of implementing and applying both digital and non-digital technologies due to an inadequate understanding of technological practices (Fox-Turnbull, 2019; Saxena et al., 2020). Therefore, teachers may underutilise rich technological experiences in early childhood centres. Piaget believed that children are able to adapt prior knowledge to understand new ideas through the real-life experiences they have and that they can change old ways of thinking with the introduction of new ideas that they are exposed to (Hargraves, 2021). By utilising the connection between aspects of Piaget's theory and technological practice, the focus can be placed more on the prior knowledge, real-life experiences, and new technological ideas all connected to the child's world, which will promote deeper understanding of both digital and non-digital technologies.

Introduction

The application of Piaget's cognitive development theory can be connected closely to children's technological learning. Piaget held the belief that knowledge is constructed through practical experiences, which reflects the notion that children can develop their cognitive abilities by participating in practical technological experiences and actively engage technological knowledge (Saxena et al., 2020). To connect technological experience to a New Zealand early childhood education context, conceptual knowledge of technology from *Te Whāriki: He whāriki mātauranga mō ngā mokopuna o Aotearoa: Early Childhood Curriculum (Te Whāriki)* (Ministry of Education [MoE], 2017) and *The New Zealand Curriculum* (MoE, 2007) will be explored and unpacked. Furthermore, aspects of Piaget's cognitive development theory will be examined in regard to how this theory links with technology. Lastly, the implementation of technological knowledge, technological practice and the nature of technology will be discussed through the design of a learning environment, and suggestion of communication and evaluation strategies.

Technology in the early years: Conceptual knowledge

In relation to early childhood education, technology can be defined as the development and the progressive use of a variety of skills to support intended purposes. It is about exploring possibilities through the evolution of techniques as well as employing different tools or machines to achieve successful outcomes (Holdom, 2018; Speldewinde & Campbell, 2022). *Te Whāriki* (MoE, 2017) recognises the role that technology can play in children’s lives both as producers and consumers. Furthermore, technology had been described through *The New Zealand Curriculum* as a means to get information, a tool for communication, and the way that the environment is impacted (MoE, 2007). However, the definition in *The New Zealand Curriculum* has since been revised to acknowledge the complexities of technology as an evolving area for 21st century learners, stating technology, as a whole, is about interventions impacting on human possibilities and using practical and intellectual resources for a wide range of opportunities that learners can engage in (MoE, n.d). In today’s society, children encounter digital and non-digital technologies in their everyday life, therefore they are increasingly capable of making sense of the *made-world* (Boström et al., 2021; Saxena et al., 2020).

Technology as an important learning area is further examined in *The New Zealand Curriculum* (MoE, n.d), which separates technology into three strands: technology practice, technology knowledge, and the nature of technology. *Technological practice* refers to learners being able to plan and predict suggested outcomes within an experience, including examining theirs and others’ practice (MoE, n.d). Technological practices can support children to be motivated to succeed in an outcome and therefore promote the implementation processes as a map to the desired outcome. *Technological knowledge* refers to learners understanding materials and the usage of materials including an understanding for purposes of systems and products (MoE, n.d). Furthermore, learners begin to learn about different operations and why they do what they do, and how these can be manipulated. *The nature of technology* refers to learners understanding the impacts that technology has in this world and that they can analyse the vast societal perspectives of entities of technology (MoE, n.d). Additionally, this strand promotes the purposeful use of technology in the past, the present and the future.

In early childhood, connections can be made to the learning area of technology through the strands of belonging, contribution, communication and exploration in *Te Whāriki* (MoE, 2017). Evidence of learning in the strand of belonging shows that children will enjoy learning about the wider and unfamiliar world (MoE, 2017). Children experiencing an environment where their home life is connected and encouraged to be a part of their learning supports the child to have real-world experiences that are meaningful to them (MoE, 2017). Through the contribution strand, technology is linked to children’s “ability to make links between past, present and future”, which connects to the nature of technology strand (MoE, 2017,

p. 37). The communication strand states that children can utilise skills with multiple media and tools, including technological products, in order to create and express their own outcomes, which connects to technological knowledge (MoE, 2017). Lastly, connections can be seen in the strand of exploration where children can experience the ability to pursue projects for a sustained period of time, confidence in problem solving, planning and evaluating desired outcomes, and the “ability to represent discoveries using creative and expressive media, including digital media” (MoE, 2017, p. 47).

Aspects of Piaget’s Cognitive Development Theory: Connections to technology

Piaget claimed that children’s development of learning is strongly influenced by their environment, and that they actively construct their own knowledge by interacting with the people, places, and objects in their surroundings. Mooney (2013) explains that Piaget believed that when children are engaging in hands-on learning, their understanding of concrete thoughts evolves to abstract understandings. For example, if a child sees a picture of a farm animal, the picture is the extent of the knowledge of this subject but if the child physically met the farm animal, their understanding of this subject becomes multilayered. Furthermore, Halpenny and Pettersen (2013) explain that Piaget believed that children’s learning is active and constantly evolving as a result of the environment they are surrounded by. Similarly, Hargraves (2021) shares that Piaget believed knowledge is built on gradually over time through exposure to environmental factors. Therefore, providing real-world experiences will support children’s construction of knowledge more than just hearing about the experience or being instructed to do so.

Due to technological experiences being practical and usually direct manual activities, children develop a deeper understanding and connection to the topics they explore through technology, and they build upon their prior knowledge during these experiences (Boström et al., 2021; Holdom, 2018). Building new knowledge and developing existing knowledge are seen as a process of learning, which is identified through *Te Whāriki* as working theories (Hargraves, 2014; MoE, 2017). Using Piaget’s lens, working theories can be understood as a process of adaptation through assimilation and accommodation (Hargraves, 2014). Assimilation is when new information links to the functioning of an experience or product and accommodation is when prior knowledge of an experience or product evolves as new evidence is explored (Hargraves, 2021; Mooney, 2013). Piaget outlined four stages (sensorimotor stage, preoperational stage, concrete operational stage and formal operational stage) of how a child’s cognitive development progresses and adapts. This theory has been known to be criticized due to the limitations around the strict ages of the stages of maturation (Mooney, 2013). However, each stage embodies evolving perceptions of the world, including different adaptations of knowledge (Hargraves, 2021). The first two stages connect to the context of early childhood and thus will be discussed in this article.

The *sensorimotor stage* primarily focuses on infants' concrete understandings, and their perceptions, reactions and reflexes. The reactions are usually spontaneous with no preplanned intent but progresses into a toddler that intentionally responds to the environment and starts to understand how their reactions cause an impact (Halpenny & Pettersen, 2013). As the infant grows older, the maturation process continues and they experience premeditation, the application of logic, and symbolic representation of things as they occur in familiar settings (Halpenny & Pettersen, 2013). Similarly, if you connect technological practice within this stage, infants and toddlers can build on their ability to plan and execute outcomes. In technological practice, learners have an emerging understanding of how to investigate existing outcomes (MoE, n.d). Piaget referred to this emerging understanding in the sensorimotor stage as schemas (Curtis et al., 2015; Halpenny & Pettersen, 2013; Mooney, 2013). A schema may be described as a repeated action symbolising directed thoughts regarding patterns, ideas or concepts (Curtis et al., 2015). Through schemas, children at this stage can develop learning dispositions in curiosity, creative thinking, investigative skills and exploration (Holdom, 2018; Boström et al., 2021; Speldewinde & Campbell, 2022). For example, a child with a trajectory schema may develop a curiosity in throwing and investigate this action several times or a child may want to explore connecting and disconnecting objects as part of their own creative processes (Curtis et al., 2015).

The *preoperational stage* focuses on young children approximately between the ages of two and four years old and four and seven years old who begin to make meaning out of objects and things. In the symbolic function substage (between two and four), children will start to show an understanding about how the world and things of the world work (Halpenny & Pettersen, 2013). With this knowledge, children begin to demonstrate the ability to plan and predict experiences because they have attained object permanence and they can make sense of the functionality of objects that they are surrounded with, building on from their prior knowledge (Halpenny & Pettersen, 2013; MoE, n.d). When children are engaging in opportunities to build on familiar processes, they can change and adapt their knowledge as more logical evidence is presented to them, supporting learning dispositions such as problem-solving and critical thinking to create modifications within their own designs and products (Boström et al., 2021; MoE, n.d; Speldewinde & Campbell, 2022). Furthermore, children can start to use their initiative and enhance their confidence within their abilities to design outcomes as their perception around operations deepens, which can connect to technological products and systems (Halpenny & Pettersen, 2013; MoE, n.d; Speldewinde & Campbell, 2022).

Implementing technology that enhances cognitive development

While technology is seen in everyday experiences for young children, kaiako (teachers) at times may miss opportunities to extend children's learning in technology. This can be due to the teachers' own knowledge and ability in implementing technological experiences or sharing technological knowledge

(Fox-Turnbull, 2019; Saxena et al., 2020). Research by Saxena et al. (2020) shared that some teachers felt overwhelmed when designing plugged and unplugged technological experiences due to their lack of knowledge. Similarly, Boström et al. (2021) shared that teachers involved in technological knowledge and practice mainly saw their role as facilitators of technological resources rather than the facilitators of technological conceptual knowledge. Moreover, if teachers were active in the process in technological learning, children's outcomes in technological skills would be improved. When the experiences occurring are able to be rich in critical thinking opportunities as well as logical, intellectual growth, specific to the needs of the learners, it supports technological conceptual knowledge to be meaningful to the learner. Additionally, when the teacher has strong technological content knowledge, the quality of the experiences offered as well as the learning occurring increases (Fox-Turnbull, 2019; Saxena et al., 2020). Therefore, the notion of the teacher is no longer a person who instructs and presents information but someone who nurtures inquiry and offers opportunities for children to seek their own developing knowledge for answers to inquiry (Mooney, 2013). This will enhance children's cognitive development and ensure that technological experiences are meaningful and beneficial to their lifelong learning.

Designing a learning environment

From Piaget's perspective, in order to support child-centred learning, teachers need to be intentional with the resources they provide and how the environment is set up for children when they arrive to the early childhood centre. Piaget believed that cognitive development is enhanced through the use of resources that are open-ended and have many possibilities in order for learners at the sensorimotor stage to explore their sense of wonderment, which will increase exploration in children's schemas (Curtis et al., 2015; Mooney, 2013). Open-ended resources that support technological practices can be things such as heuristic resources where children explore how they can use these tools for a purpose. Heuristic resources, such as bowls, utensils, fabric or natural items like shells and rocks, can have an intended purpose but could also be manipulated for the users' purpose (Curtis et al., 2015). Moreover, if teachers are able to intentionally set up spaces where technological items are attractive and enticing, it supports a child's sense of belonging and value in their play. It becomes an experience that is safe for the learner to explore technological possibilities (Curtis et al., 2015).

Learners at the preoperational stage can also benefit from teachers intentionally offering open-ended opportunities for technology as they start to understand the complex processes and functionality of the technological objects. In order for children to be able to construct this knowledge, they need plenty of uninterrupted free play time. Piaget explained that when teachers respect the absorption of knowledge and the time constructing knowledge can take, children's ability to make significant progress in their information attainment is expanded on (Mooney, 2013). In reference back to discussions on technology, this occurs in everyday life for children, therefore providing an environment rich with opportunities to explore everyday systems and products can further support their technological development, ensuring

that there is time both inside and outside to explore (Holdom, 2018; Mooney, 2013). This will provide more active time for teachers to have periods of one-on-one time with children, and to be able to utilise pedagogical content knowledge that the teacher has to nurture spontaneous teachable moments.

Developing communication through a focus on technology

Teachers have the opportunity in spontaneous technological teaching moments, one-on-one times with children and planned technological experiences to engage in a range of communication strategies. First would be to consider the type of active questions that are being asked. Piaget believed that if you ask questions that will help children construct their own knowledge by thinking through the problem on their own, children are more likely to retain the information that they are forming through the knowledge being attained (Mooney, 2013). Therefore, teachers need to think about questions that are open-ended to promote children to consider the 'why' or the 'how' in relation to technological problems or the functioning of products; for example, *why does your bike need pedals? What happens if your pedals weren't on your bike? How do the pedals make your wheels turn?* Where Mooney (2013) suggests to deepen the learning, it helps if the teacher is learning alongside the child. This means that when open-ended questions are asked, these are authentic and meaningful to the child who can begin an inquiry. This can also support the use of thinking out loud and role modelling technological language as the child can see that their teacher is just as interested in working out solutions and exploring possibilities as they seem to be (Holdom, 2018). Language modelling is a form of intentional teaching because it can also support children to be able to become familiar with technological concepts in a positive way. This will motivate children to use the language connected to the action for future designs and purposes (Fox-Turnbull, 2019; Holdom, 2018). While thinking out loud, teachers can also be modelling technological practice and knowledge through reasoning, distilling relevant information and planning out ideas (Fox-Turnbull, 2019).

Evaluating the use of technology

To continue to expand and support children's technological experiences, teachers need to be able to evaluate how implemented technology experiences have supported children's cognitive development. Teachers can gather evidence around how effective the experiences have been for children's learning in order to make decisions around how to extend the learning, overall making improvements to the setting's curriculum (MoE, 2017). A relevant way to gather evidence would be through the evaluative strategy of observation (Curtis et al., 2015; Fox-Turnbull, 2019). Piaget used observation as a tool in learning more about children's cognitive abilities through their strengths and interests (Halpenny & Pettersen, 2013). Observing how children utilise technological tools and the processes towards desired outcomes can show a teacher the adaptation of the knowledge being used. It also supports teachers to take a step back from the experience in order to fully see cognitive development happening individually, as the intended outcomes that we may see could occur may differ to what is actually happening for the child (Curtis et al.,

2015; Fox-Turnbull, 2019). With this in mind, observing the individual processes can lead to an in-depth and critical reflection around our teaching practices, and around how technological knowledge can be expanded by the tweaking of our own knowledge or strategies to implement experiences. This involves “self-generated questioning and self-monitoring of progress” in order to be responsive to children’s prior knowledge, their working theories and learning dispositions, and how continuous planning extends positive outcomes (Fox-Turnbull, 2019, p. 5). Additionally, teachers can gain a deeper understanding of how the curriculum is affecting children's learning outcomes by closely observing and reflecting on their experiences. This knowledge is informed by *Te Whāriki* principles and the achievement objectives outlined in *The New Zealand Curriculum* for technology (MoE, 2007; 2017).

Conclusion

In conclusion, there are strong connections that can be made between Piaget’s cognitive development theory and technology in early childhood education. Technology in an early childhood setting is about learners building an understanding of the functionality of systems and products, and the impact these have in the world around them, which connects to Piaget’s perspective of young children constructing knowledge from the active environment directly related to their surroundings. Kaiako can support and nurture children’s cognitive development through the increased use of technological experiences by utilising the environment, effective communicative strategies and evaluating the experiences and their own knowledge of technology.

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