Rupe Rere Nui: Place-based Storytelling in Robotics with Māori-medium Students

Ruth Lemon, Waipapa Taumata Rau – University of Auckland
ruth.lemon@auckland.ac.nz
Craig Sutherland, Waipapa Taumata Rau – University of Auckland
cj.sutherland@auckland.ac.nz
Allan Fowler, Waipapa Taumata Rau – University of Auckland
allan.fowler@auckland.ac.nz

ABSTRACT

This paper is part of a larger study involving the design and implementation of a prototype of a low-cost programming environment or tangible user interface (TUI) where students use robots to navigate a geographical map in telling and re-telling stories associated with that place. The geographical map that was initially developed depicted the Wellington region (the lower North Island of New Zealand), as the lead researcher for this project had connections to Wellington. The story-telling focused on the narratives of Kupe, a Māori explorer and one of the first to discover New Zealand. However, in response to an inner-city Auckland school, we designed a map that would support the children's engagement with local landmarks, as expressed in a waiata (song) called *Rupe Rere Nui*. Māori kaumatua (elder), Wally Penetito, exhorts teachers to 'start where your feet are', emphasising the importance of place-based learning or localised curriculum.

This paper's focus lies in an unexpected research outcome and the resulting **pedagogical possibilities**: the importance of responsive curriculum design when you are working in classroom contexts. The study contributes to the field of localised curriculum with a focus on the place of storytelling and the incorporation of non-technical subjects, such as place-based narratives, into a robotics system. The use of paper-based commands with young children aged between 5-9 years of age has been evaluated over a range of settings and the working prototype has been refined as a result of trials with teachers and children in classrooms.

Key Words: place-based education, local curriculum, screen-free robotics.

1. CONTEXT AND INTRODUCTION

This paper is part of a larger study involving the design and implementation of a prototype of a low-cost programming environment or tangible user interface (TUI) where students engage with geographical maps, as they programme their robots and tell them which locations to visit, telling stories associated with that place (Naude et al., 2023). The focus of this paper is on an unexpected outcome from the research, that may lead to further study. One of the classes in one of the schools that we visited, inner-city Auckland students in a Māori-medium educational context, decided that they would like to develop their own map and focus on the major landmarks around their school.

1.1. Definitions

Connotations and denotations of terms can be very subjective and a single term can hold a range of meanings. Key terms in this research that require definition include: Māori-medium; place-based learning or localised curriculum; computational thinking; hangarau or technology; and young children.

The Māori-medium education sector in Aotearoa New Zealand originated as a series of community initiatives as direct challenges to the previous century and a half of colonisation and the English-only language policy that had been implemented in the education sector. So Māori-medium students are those who are enrolled in classes where over 50 percent of their learning is conducted in te reo Māori (Māori language) with mātauranga Māori (Māori knowledge) as the foundational knowledge-base for all teaching and learning in these educational contexts which range from kōhanga reo for babies, toddlers and very young children, through to whare wānanga, or institutions of higher learning for adult students. This paper will focus on students who are part of a specific whānau rumaki reo (an immersion classroom set within an English-medium school), which is one type of Māori-medium schooling for children aged between 5 and 12 years of age.

Place-based learning or localised curriculum is a blanket term encompassing the range of pedagogical practices that focus on learning about and connecting to place (Yemini et al., 2023). This concept of place transcends geography, the physical context of place, and includes the experience of the individual in that place; the group(s) of people that connect to and are in relationship to that place; and external impacts on the concept of place (such as economics and politics; see Ardoin et al., 2012 for a breakdown of a leading framework for place-based education). A recent framework breaks down the dimensions of place-based education as consisting:

- Learning in place (where just the setting has changed, i.e., not in the classroom)
- Study of the place (what happens in and around the place)
- Learning from the place
- Learning for the sake of the place (Granit-Dgani, 2021).

Te Whakaaro Rorohiko or Computational Thinking and its popularised definition involves “the thought processes involved in formulating a problem and expressing its solution(s) in such a way that a computer – human or machine – can effectively carry it out” (Wing, 2014, para.5). The focus in this paper lies in identifying the most effective pedagogical strategies to utilise with young children when engaging in paper-based coding.

Hangarau refers to the Māori-medium curriculum document that parallels, but is not the same as the English-medium Technology curriculum document. The terms will not be used interchangeably in this paper, and Hangarau will be the key term, as the focus of this paper is on students engaging with storytelling and these robots in a Māori-medium educational context.

In the literature, young children, early childhood, junior primary and early elementary have been used interchangeably to refer to the target age-group, children under the age of 9-years-old. In the New Zealand education sector, early childhood generally refers to babies, toddlers and young children from birth to 5, that are enrolled in early childhood educational settings in Aotearoa New Zealand. This part of the educational sector is guided by a different curriculum framework, Te Whāriki (Ministry of Education, 2017c), and is outside of the scope for this paper. When we are talking about working with young children, we are focusing on students in their first years of primary or elementary schooling, between 5-9 years of age.

1.2. Two national curriculum frameworks

There are two national curriculum frameworks guiding teaching and learning for children between 5 and 18 years-old in Aotearoa: Te Marautanga o Aotearoa (Ministry of Education, 2017a) and The New Zealand Curriculum (Ministry of Education, 2017b). The former supports Māori-medium educators, and is informed by mātauranga Māori (Māori knowledge) and te reo Māori (Māori language). The latter supports English-medium educators. Digital Technologies and Hangarau Matihiko were introduced as additional components of the Technology and the Hangarau curricula respectively in 2017. Computational Thinking or Te Whakaaro Rorohiko was introduced to the curricula as part of this development. Currently, both curriculum documents are undergoing a refresh, which is two years into a six year cycle (see curriculumrefresh.education.govt.nz). The evolving nature of the curriculum was an important consideration for the wider study, and will be discussed further below.

1.3. A study in the use of TUIs with young children

The wider project was called Te Haerenga a Kupe or The Journeys of Kupe. The project had two general goals: To initialise a transdisciplinary research project bringing together engineering, design, and education to explore how young children can use physical components to program robots; and to evaluate and improve an existing robotic programming environment. The improvements included modifying the system so that it was age appropriate for 5-9-year-old children and incorporating New Zealand-based content in the teaching and learning experiences that are planned and delivered with young children.

2. A BRIEF OVERVIEW OF RELATED LITERATURE

The key areas of focus were:

- How have TUIs been used with 5-9 year-old children and were any considerations made regarding the inclusion or exclusion of Graphical User Interfaces (GUIs) or Audio and Video User Interfaces?

- What pedagogical approaches are most effective in the teaching of programming concepts with young children?

2.1. How have TUIs been used with 5-9-year-old children?

Seminal researcher Ishii (2008) defines TUIs as giving "physical forms to digital information" (p.xvi), both representing their digital equivalent and serving to control it. Ishii explains the properties and design requirements of TUIs: the mapping of a tangible representation to underlying digital information; the mechanisms for interaction with these representations (directly manipulated by the user's hands, or motor- and magnet-driven approaches); and the importance of the perceptual links between both. Prior to Ishii's introduction of TUIs in 1997, Graphical User Interfaces had evolved from the initial Control User Interface (the latter requiring knowledge of programming and codes to facilitate the operation of and interaction with digital information). GUIs and TUIs have since been extended with Audio, Video and Hybrid interfaces. The trends in the included studies informed the thinking for this study and are expanded on in this section.

Studies were initially categorised by the particular form that the intervention took (i.e., whether the focus lay on a TUI, a GUI, a hybrid interface or another form of interface) and the groups of children who were engaging with this/these interface(s). There were combinations of TUI, GUI (Papadakis, 2022; Cheng et al., 2023), and hybrid (Strawhacker et al., 2013) systems in working with young children with autism (Nonnis & Bryan-Kinns, 2019), with intellectual disability (Beccaluva et al., 2021), with visual impairment (Lang et al., 2023; Pires et al., 2021) and exploring the challenges of inclusive, sustainable robotics when working with low-income communities (Yang et al., 2022). Most of the studies were conducted in a range of classroom contexts, with the exception targeting the preparation of pre-service teachers for teaching computational thinking in school (Angeli & Jaipal-Jamani, 2018). One study focused solely on the robotic system and its tangible and virtual interface to the exclusion of any discussion of classroom context (Bakala et al., 2023).

Studies were then categorised by the application of TUI, GUI, and hybrid systems in different curriculum areas: including mathematics (Drăgănoiu et al., 2022; Pires et al., 2021), literacy (Bezuidenhout, 2021; Fan et al., 2018; Lang et al., 2023), and STEM as integrated disciplines (Çetin & Demircan, 2020; Nikolopoulou, 2022; Tselegkaridis & Sapounidis, 2022), with a small base of studies extending STEM into play-based learning (Aranda et al., 2022) or focusing on more general skills, such as memory (Beccaluva et al., 2021), spatial skills (Baykal et al., 2018), or on a very specific knowledge context – such as farm-to-table food knowledge (Ye et al., 2023). Pugnali et al. (2017) conducted a comparative study into the development of computational thinking with children aged between 4-7-years-old, when using a GUI (Scratch Jr) or when using a TUI (KIBO). Across the activities, and drawing from Brennan and Resnick's (2012) framework, the children working with KIBO outperformed the Scratch Jr group, arguably due to the more explicit nature of the tangible programming tool. There were only a couple of studies that focused more generally on specific curriculum frameworks or pedagogical approaches to teaching and learning this content, including the Montessori approach (Ahmed Sayed Ali et al., 2021) and the links between Technology-Based Embodied Learning and tangible tools (Zhong et al., 2021).

2.2. 2.2 What pedagogical approaches are most effective when teaching computer science?

The diverse range of studies, discussed very briefly in the previous section form the foundation of the argument for the import of pedagogical pluralism (Aranda & Ferguson, 2018). Basically, the design of the learning should be aimed at the specific needs of the children in each of the contexts being researched. We would like to link this concept with the pedagogical principle of designing rich tasks for children to explore computer programming concepts, that would have low floors, high ceilings and wide walls – meaning they would be adaptable and accessible to a wide range of students (Resnick & Silverman, 2005). Alper et al (2012) extend on the metaphor by adding ramps, ladders and frames of interest. Although their focus is on educating students with disability, the principle is one that is incorporated into the daily practise of many teachers, who are looking for ways to provide options in a learning task that challenges, extends and builds on the learning for all students in the class.

Three main models have been identified in teaching computer science: 1) As a separate subject, with a focus on programming; 2) As a vehicle to develop digital literacy; and 3) A combination of the first two models. Each of the three conceptualisations result in different curriculum, resourcing and teaching requirements (Fessakis et al., 2018). Bers (2019) advocates for teachers to see the parallels between teaching computer science to young children and teaching another literacy. Zeng et al. (2023) conduct a systematic literature review as they refine an earlier framework developed by Brennan and Resnick (2012) so that it is age-appropriate for young children under 8-years-old.

Sapounidis and Demetriadis (2017) argue that the establishment of knowledge through play is pedagogically important, along with the cycle where decision making reinforces students' reasoning. Their focus on TUIs as lowering the age threshold to teach programming concepts. What are the unique opportunities that tangible programming offers to the field of educational robotics? Skills developed include critical thinking skills and problem solving. They recommend further research systematically exploring the "cognitive and social advantages of TUIs compared to traditional GUI solutions" (p.212).

2.3. 2.3. Key Lessons Learnt

Complexity arises from the number of extraneous factors that directly impact the results of these studies (which includes teaching style, expectations, use of resources, diversity in learners, the curriculum used in the class). Generally, researchers concluded that the studies needed to be as specific and narrowly focused as possible, to be able to generate robust findings. However, the techniques employed in exploring developmentally appropriate delivery transcended the mode that researchers had chosen, with pseudo-language seen as important in the development of TUI, GUI and hybrid content.

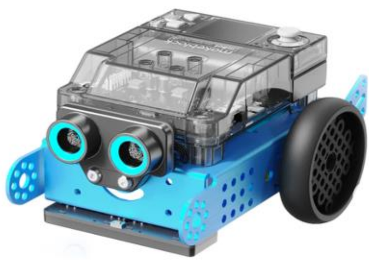
Whether the study was a small pilot study or a big data project over multiple years, involving hundreds of children, researchers focused on the pedagogical design of the delivery of concepts and how to refine the design of concepts when challenges in the communication of those ideas were identified. Generally, children were part of the research circle, and their teachers or families were also involved, dependent on the specific research context. The involvement of teachers and families was generally to facilitate a sustainable approach to the intervention (if the intent was that the intervention would be ongoing), but also to support and strengthen communication of thinking during the research process.

This study identifies the teaching of computer science as aligning with the third model discussed in the previous section; that is, programming as a discipline; and computer science as a vehicle to develop digital literacy. The authors agree with Bers (2019), in that the teaching of computer science to young children should be approached as the teaching of a new literacy. These considerations influenced the method for this study, discussed below.

3. 3. METHOD

3.1. System Design

Figure 1
The mBot neo



The key criteria that our choice of system was based on were:

- The robot and the components should be cheap and available internationally;
- Materials to use for the TUIs should be widely available;
- That a geographic map (see Figure 3) would provide the context for the students' learning experiences;
- That people without technical backgrounds would be able to easily modify the end system.

Based on the above criteria and our literature review we chose the mBot neo for the base of our system (see Figure 1). We complemented this with Raspberry Pi, a smart camera, and CyberPi (Naude et al., 2023). There were two paper-based components: the maps (see Figure 3), and the command cards (see Figure 2), which included the following commands:

(i) Forward: move the robot in the direction of the camera.
(ii) Stop: turn the robot's motors off.
(iii) Turn left: turn the robot to the left, relative to the camera at the front of the robot.

(iv) Turn right: turn the robot to the right.
(v) Speech: record five seconds of speech from the user.
(vi) Location: replay the recorded speech from the user.

Figure 2
The Command Cards Children Used to Programme the Robots

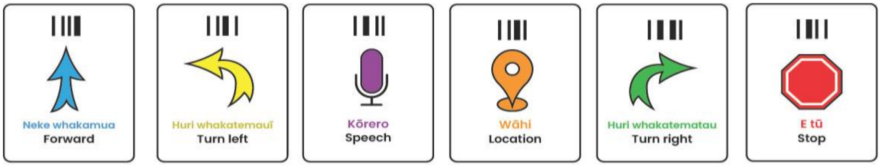
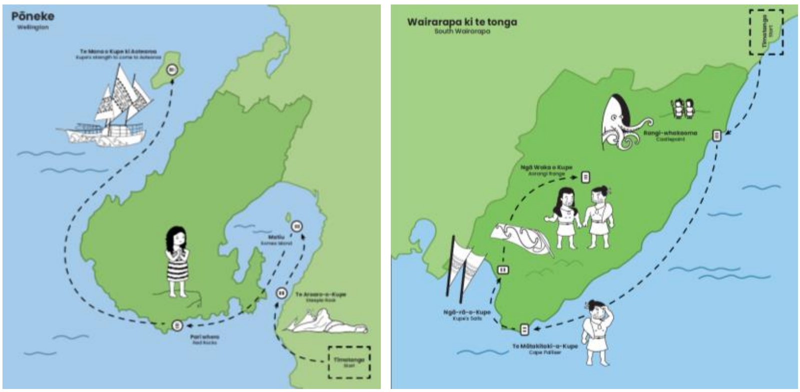


Figure 3
Maps of the Wellington Region, and the Journeys of Kupe the Māori Explorer



3.2. Data gathering and participants

Over 2022, we organised 12 visits to eight different schools. During these visits, over 300 children used the system. Most visits involved a single class, but some visits involved either multiple classes or sub-groups within a class. The smallest number of children in a session was nine children, and the largest was over 60. The median session size was 14 children.

Whakaaro hātepe and hanga hātepe (algorithmic thinking and writing algorithms) were the tupuranga whakairo rorohiko or computational thinking progressions that were the focus of the learning experiences. The choice of algorithms aligned with Brennan and Resnick's (2012) framework and was supported by the inclusion of patuiro (debugging) as an integral part of the learning experience.

Data were gathered using multiple avenues. Each of the mBots recorded a log of their programmed actions during each session. We recorded field notes and observations. Children shared their feedback both during the sessions (as a particular problem or thought arose) and at the end of the session (usually orally, although one class wrote a big book that they shared with us to communicate their learning with the mBot neos. Teachers shared their feedback during the session, or after the session (either orally or via email)).

3.3. Pedagogical decisions: How each session ran

Each session, we would sit the students in a circle, introduce the robots and explain how they worked. We would demonstrate how the command cards worked. We then introduced the location cards and demonstrated how the children needed to navigate between the different numbers. Because the students were young children, we ensured that, as part of the introduction of the robots, there was an explanation of tikanga (What practices were going to support the children in turn-taking? What practices would support the children in looking after the robots?) The children were then split into groups (either by the teachers or the researchers, depending on the teacher's preference).

A child was nominated as the group leader. They took the first turn, then designated the next person in the group who would take their turn. Each child received a full set of command cards; each group was given a robot, a set of number cards, and once the initial activity was complete, we moved the children onto the maps of the Wellington region (see Figure 3) so they could engage with the narratives that, at this stage, had been prepared on cards. During this time, the researchers would circulate and provide support as needed. The duration of the session variedin relation to the children's interest levels.

All sessions lasted between 20-40 minutes. Typically, older children would lose interest in the robots sooner. They were able to figure out how the robots and commands worked and quickly adapt to changes. In contrast, younger children generally took longer to understand how the robots worked. They needed more help when they encountered problems.

4. FINDINGS: AN UNEXPECTED RESEARCH OUTPUT

This paper focuses on a school that was visited three times and the way in which the principles of place-based education were applied in response to feedback from the children and the teachers, so that the children were able to engage with narratives of the area in which they go to school. In each of the visits, we invited feedback: How could the system be improved? What had worked well? What was challenging? When this school was sharing their feedback, the children decided that it would be more significant to them and their learning, if the narratives they focused on belonged to central Auckland – the area their school was in, that they chose to connect to as students and teachers.

We sat with the group and they shared a mōteatea (traditional chant) composed by Hareruia Aperahama for the group. This mōteatea is called Rupe Rere Nui, Rupe being a New Zealand pigeon, referred to in personified form as Rupe. Rupe's great flight was marked out on a map and we have begun the process of developing a map that can focus on the narratives of this central Auckland group of students (see Figure 4).

Figure 4
The Initial Markings on the Map made with Students (at left) and the Current Iteration of the Map Being Developed (at right).

5. INITIAL CONCLUSIONS AND FURTHER RESEARCH

It is interesting that, of the eight schools we visited (all within the Auckland region), there was only one class in one school that asked about their place: Could we make our own map of the places to which we connect? The group decided that they wanted something they would be able to engage with in the long-term, related to the place where their school connected. We believe place-based education is vital and were happy to respond to the students' requests. We wonder if this question was raised by this group, because of the centrality of place-based education in Māori-medium educational contexts. With the current curriculum refresh, there is the potential for this to grow across the educational sector. We highly recommend further research and the development of modules, so that the schools we work with, are able to easily adapt the materials and develop local maps where teachers and young children can work together and engage in storytelling about the places they choose to connect to on a daily basis.

6. REFERENCES

Ahmed Sayed Ali, S., Chettaoui, N., Atia, A., Bouhlel, M.S., & Mohamed Abdel Mohaiman, D. (2021). A futuristic design vision of tangible user interfaces on enhancing Montessori. *Interactive Learning Environments, 2021,* 1-16. https://doi.org/10.1080/10494820.2021.1987275

Alper, M., Hourcade, J.P. & Gilutz, S. (2012). Adding reinforced corners: Designing interactive technologies for children with disabilities. *Interactions. 19*(6), 72–75. https://doi.org/10.1145/2377783.2377798

Angeli, C., & Jaipal-Jamani, K. (2018). Preparing Pre-service teachers to promote computational thinking in school classrooms. In M.S. Khine (Ed.), *Computational Thinking in the STEM disciplines:*

Foundations and research highlights (pp.127-150). Springer. https://doi.org/10.1007/978-3-319-93566-9

Aranda, G.,Campbell, C., Ferguson, J., & Speldewinde, C. (2022). Introducing digital technologies into play-based learning in early childhood. In S. Papadakis & M. Kalogiannakis (Eds.), STEM, robotics, mobile apps in early childhood and primary education: Technology to promote teaching and learning (pp.525-551). Springer. https://doi.org/10.1007/978-981-19-0568-1

Aranda, G., & Ferguson, J. P. (2018). Unplugged Programming: The future of teaching computational thinking? *Pedagogika, 68*(3), 279-292. https://doi.org/10.14712/23362189.2018.859

Ardoin, N.M., Schuh, J.S., & Gould, R.K. (2012). Exploring the dimensions of place: A confirmatory factor analysis of data from three ecoregional sites. *Environmental Education Research, 18*(5), 583–607. https://doi.org/10.1080/13504622.2011.640930

Bakala, E., Tejera, G., Visca, J., Hitta, S., & Hourcade, J. P. (2023). Programmable floor robot Robotito and its Tangible and Virtual Interface. In *Interaction Design and Children (IDC'23), June19–23, 2023, Chicago, IL, USA* (pp 745-747). https://doi.org/ 10.1145/3585088.3594486

Baykal, G.E., Veryeri Alaca, I., Yantaç, A.E., & Göksun, T. (2018). A review on complementary natures of tangible user interfaces (TUIs) and early spatial learning. *International Journal of Child-Computer Interaction, 16*, 104–113. https://doi.org/10.1016/j.ijcci.2018.01.003

Beccaluva, E., Riccardi, F., Gianotti, M., Barbieri, J., & Garzotto, F. (2021). VIC —A Tangible User Interface to train memory skills in children with Intellectual Disability. *International Journal of Child-Computer Interaction, 32*, 100376. https://doi.org/10.1016/j.ijcci.2021.100376

Bers, M.U. (2019). Coding as another language: A pedagogical approach for teaching computer science in early childhood. *Journal of Computers in Education, 6*(4), 499-528. https://doi.org/10.1007/s40692-019-00147-3

Bezuidenhout, H.S. (2021). An early grade science, technology, engineering and mathematics dialogue reading programme: The development of a conceptual framework. *South African Journal of Childhood Education 11*(1), a1038. https://doi.org/10.4102/sajce.v11i1.1038

Brennan, K., & Resnick, M. (2012). New frameworks for studying and assessing the development of computational thinking [Paper presentation]. *Proceedings of the 2012 annual meeting of the American educational research association*, Vancouver, Canada. https://web.media.mit.edu/~kbrennan/files/Brennan_Resnick_AERA2012_CT.pdf

Çetin, M., & Demircan, H.Ö. (2020). Empowering technology and engineering for STEM education through programming robots: A systematic literature review. *Early Child Development And Care, 190*(9), 1323–1335. https://doi.org/10.1080/03004430.2018.1534844

Cheng, R., Dangol, A., Tabio Ello, F.M., Wang, L., & Dasgupta, S. (2023). Concepts, practices, and perspectives for developing computational data literacy: Insights from workshops with a new data programming system. In *Interaction Design and Children (IDC'23), June 19–23, 2023, Chicago.* https://doi.org/10.1145/3585088.3589364

Drăgănoiu, R., Moldoveanu, F., Morar, A., & Moldoveanu, A. (2023). DigiMathArt: A game-based approach to learning Mathematics and Programming. *Interactive Learning Environments, 2023,* 1-23. https://doi.org/10.1080/10494820.2023.2205903

Fan, M., Antle, A. N., Hoskyn, M., & Neustaedter, C. (2018). A design case study of a tangible system supporting young English language learners. *International Journal of Child-Computer Interaction, 18*, 67–78. https://doi.org/10.1016/j.ijcci.2018.08.001

Fessakis, G., Komis, V., Mavroudi, E., & Prantsoudi, S. (2018). Exploring the scope and the conceptualization of computational thinking at the K-12 classroom level curriculum. In M.S. Khine (Ed.), *Computational Thinking in the STEM disciplines: Foundations and research highlights* (pp.181-212). Springer. https://doi.org/10.1007/978-3-319-93566-9

Granit-Dgani, D. (2021). *Paths to place-based education.* The Mofet Institute. Hebrew.

Ishii, H. (2008). Invited paper. Tangible bits: Beyond pixels. In *Proceedings of the Second International Conference on Tangible and Embedded Interaction (TEI'08),* Feb 18-20, Bonn, Germany. https://doi.org/10.1145/1347390.1347392

Lang, F., Schmidt, A., Pues, V., & Machulla, T-K. (2023). BrailleBuddy: A Tangible User Interface to support children with visual impairment in learning Braille. *CHI '23, April 23–28, 2023, Hamburg, Germany*. https://doi.org/10.1145/3544548.3580844

Ministry of Education. (2017a). *Te Marautanga o Aotearoa.* Learning Media.

Ministry of Education. (2017b). *The New Zealand Curriculum.* Learning Media.

Ministry of Education. (2017c). *Te Whāriki He whāriki mātauranga mō ngā mokopuna o Aotearoa*. *Early childhood curriculum.* Learning Media.

Naude, E., Fowler, A., Lemon, R., & Sutherland, A.J. (2023). Kupe's journey: Building a low-cost, screen-free robotic programming environment for children. In *2023 20th International Conference on Ubiquitous Robots* (UR), Honolulu, USA (pp.710-715). https://doi.org/10.1109/UR57808.2023.10202226

Nikolopoulou, K. (2022). Digital technology in early STEM education: Exploring its supportive role. In S. Papadakis & M. Kalogiannakis (Eds.), STEM, robotics, mobile apps in early childhood and primary education: Technology to promote teaching and learning (pp.103-115). Springer. https://doi.org/10.1007/978-981-19-0568-1

Nonnis, A. & Bryan-Kinns, N. (2019). Mazi: A Tangible toy for collaborative play between children with autism. In *IDC '19, June 12–15, Boise, USA* (pp.672-675). https://doi.org/10.1145/3311927.3325340

Papadakis, S. (2022). Apps to promote computational thinking and coding skills to young age children: A pedagogical challenge for the 21st century learners. *Educational Process International Journal, 11*(1), 7-13. https://dx.doi.org/10.22521/edupij.2022.111.1

Pires, A. C., Bakala, E., González-Perilli, F., Sansone, G., Fleischer, B., Marichal, S., & Guerreiro, T. (2021). Learning maths with a tangible user interface: Lessons learned through participatory design with children with visual impairments and their educators. *International Journal of Child-Computer Interaction, 32*(2022), 100382. https://doi.org/10.1016/j.ijcci.2021.100382

Pugnali, A., Sullivan, A., & Bers, M. U. (2017). The impact of user interface on young children's computational thinking. *Journal of Information Technology Education: Innovations in Practice, 16*, 171-193. http://www.informingscience.org/Publications/3768

Resnick, M., & Silverman, B. (2005). Some reflections on designing construction kits for kids. *Proceedings of the 2005 conference on Interaction design and children* (Boulder, Colorado, Jun), 117–122.

Sapounidis, T., & Demetriadis, S. (2017). Educational robots driven by tangible programming languages: A review on the field. In D. Alimisis, M. Moro, & E. Menegatti (Eds.), *Educational robotics in the makers era* (pp.205-214). Springer. https://doi.org/10.1007/978-3-319-55553-9

Strawhacker, A., Sullivan, A., & Bers, M. U. (2013). TUI, HUI, HUI: Is a bimodal interface truly worth the sum of its parts? In *IDC '13: Proceedings of the 12th International Conference on Interaction Design and Children* (pp.309-312). https://doi.org/10.1145/2485760.2485825

Tselegkaridis, S., & Sapounidis, T. (2022). A systematic literature review on STEM research in early childhood. In S. Papadakis & M. Kalogiannakis (Eds.), STEM, robotics, mobile apps in early childhood and primary education: Technology to promote teaching and learning (pp.117-134). Springer. https://doi.org/10.1007/978-981-19-0568-1

Wing, J. M. (2014, Jan 10). Computational thinking benefits society [blog post]. In *Social Issues in Computing*. http://socialissues.cs.toronto.edu

Yang, W., Luo, H., & Su, J. (2022). Towards inclusiveness and sustainability of robot programming in early childhood: Child engagement, learning outcomes and teacher perception. *British Journal of Educational Technology, 2022*(53), 1486-1510. https://doi.org/10.1111/bjet.13266

Ye, H., Wu, T., Kim, L. H., Fan, M., & Tong, X. (2023). WooGu: Exploring an Embodied Tangible User Interface for supporting children to learn farm-to-table food knowledge. In *Interaction Design and Children (IDC'23), June 19–23, Chicago, USA* (pp.681-687). https://doi.org/10.1145/3585088.3593876

Yemini, M., Engel, L., & Simon, A. B. (2023) Place-based education – A systematic review of literature. *Educational Review,* 1-22. https://doi.org/10.1080/00131911.2023.2177260

Zeng, Y., Yang, W., & Bautista, A. (2023). Computational thinking in early childhood education: Reviewing the literature and redeveloping the three-dimensional framework. *Educational Research Review 39*, 1-16. https://doi.org/10.1016/j.edurev.2023.100520

Zhong, B., Su, S., Liu, X., & Zhan, Z. (2021). A literature review on the empirical studies of technology-based embodied learning. *Interactive Learning Environments,* 1-20. https://doi.org/10.1080/10494820.2021.1999274