Computational Thinking for Young Indigenous Learners in New Zealand

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Abstract

Computational thinking, a key component for digital technologies, is defined as an approach to problem-solving, designing computer systems, and understanding related human behaviours, while drawing on fundamental ideas of computing. It is critical that all young students acquire computational thinking skills during their school age. Technology practice is most successful when embedded within authentic contexts, thus this paper presents a study that facilitated the learning of two concepts of computational thinking: sequencing and orientation within culturally embedded technology practice. The study examines what pedagogies most effectively facilitate computational thinking learning for young Māori learners? In particular, what is the role of using authentic contexts in young Māori learners learning computational thinking? and what teaching strategies engage students effectively? The four-week study was undertaken at a local Primary School with a high Māori roll in a low socioeconomic area. The findings suggested that the learning is more effective when the concepts of computation thinking were embedded in the students' cultural and local environment (language, places, stories) through the learning context and the pedagogical strategies.

Key Words: digital technologies, computational thinking, authentic technological practice indigenous knowledge.

Introduction

Digital technologies have facilitated developing a context-rich teaching and learning environment that increases learners' participation in quality authentically situated technology education (Snape & Fox-Turnbull, 2013) (The progress of society in various fields (economic, educational, industrial, and social) today is strongly coupled to the integration of digital technologies (Caballero-Gonzalez et al., 2019), among which computational thinking is being recognized as an important foundation skill. However, teachers need to be well equipped to teach digital technologies to ensure their students 'capabilities and dispositions position them for a future in high-tech industries and rapidly changing work conditions (Falloon, 2015). This has led to an increasing interest in developing computational thinking at the primary school level before students are 10 years old (Bell et al., 2014). To this end in 2016 the Ministry of Education in New Zealand announced the expansion of *Digital Technologies* in the technology curriculum, making it compulsory all students from aged 5-15 years (Fox-Turnbull, 2019; Petersen, 2021). The extended *Digital Technologies* covers concepts of computational thinking and designing and developing digital outcomes (Bell & Roberts, 2016; Ministry of Education, 2017a).

Implementation of the revised technology curriculum in New Zealand has seen an influx of professional development providers and companies supply schools, teachers and students with a plethora digitally-based activities and equipment that students enjoy, however there is a distinct risk that activities of this nature resort to being skills-based, rather than situated within authentic

technology practice, despite the curriculum clearly stating that all learning should be situated within authentic learning contexts (Ministry of Education, 2017b).

In addition, while the teachers are trying to take advantage of students' enthusiasm about robotics and gaming to augment students' engagement in a technology-integrated curriculum increasing the participation of indigenous students, females and underrepresented minorities in STEM careers remains the challenge (Leonard et al., 2016).

Drawing from a range of theoretical perspectives, Snape & Fox-Turnbull, (2011) state that authentic learning in technology most effectively takes place when the students are engaged in activities that mirror the skills and knowledge of the culture of authentic technological tasks and are situated within the world of the students. Authentic learning experiences based on diversity and inclusion help students develop a sense of belonging and positive attitudes to STEM-related fields (Singer et al., 2020). explored how the students blended the elements of culture and placed them into artefacts they created (Leonard et al., 2016).

It is important for teachers to understand the contextual and philosophical underpinnings of Te Ao Māori (Māori world view) to enhance and support student engagement in learning (Mahuta, 2012). From a Māori perspective, cultural and social expectations are not only for whom technologies are designed and developed but should be reflective of one's own cultural, and social understandings and expectations emphasising the significance of incorporating Māori cultural practices in order to facilitate better student engagement, such as whakawhānaungatanga (the process of establishing relationships, relating well to others) and the need to consider and incorporate environment, in particular the time, space, and place into teaching and learning (Tiakiwai & Tiakiwai, 2010).

The United nations Declaration of the Rights of Indigenous Peoples states that all indigenous people have a equal right to employment and education (Haitana et al., 2020) Rhodes and Dixon (2023) suggest that in New Zealand educators have developed a few activities based on the principles of whanaungatanga (relationships) and tangata whenuatanga (people of the land) for all learners, however there is little literature on specially motivating and engaging young Māori learners to develop computational thinking. The study reports the development of computational thinking skills for young New Zealand's indigenous Māori students situated within authentic cultural practice and context.

Literature Review

Two key aspects are relevant in the literature: learning digital technologies and computational thinking in the primary schooling sector and working with young Māori learners in culturally authentic contexts. Computational thinking assists learners in understanding of problems and determining the correct tools and methods for solving problems (Mohaghegh & McCauley, 2016; Zeng et al., 2023). Brennan and Resnick (2012) identify three key dimensions of computational thinking that are relevant to and needed by young learners to gain foundational understandings for a future in designing and developing technological outcomes. These are 1) computational concepts such as sequencing, iterations and loops, , 2) computational practices such as testing and debugging, reusing or remixing others' work, and abstracting and modularising, 3) computational perspectives, where learners seeing themselves as more than consumers but rather digital participants who express and question themselves and connect with others. Zeng et al. (2023) found the above framework

appropriate for children, but care needs to be taken to ensure all students can see the relevance and importance of their learning.

In order to effectively teach computational thinking teachers, need both pedagogical content knowledge and content knowledge. . Studies in the last few years suggest many teachers undergo considerable professional development to understand and effectively teach computational thinking and highlight the need to prepare teachers in junior classrooms irrespective of the resources provided to them (Bell et al., 2014; Bell & Duncan, 2015; Duncan et al., 2017; Geldreich et al., 2018; Yadav et al., 2016). Bell and Roberts (2016) report teachers with little or no experience teaching computational thinking-related topics have identified unexpected opportunities for integrating computational thinking with other subjects such as maths or into the activities that enhance the development of collaborative skills among students. Therefore, reluctant teachers may be convinced to add computational thinking to an already crowded curriculum if they can see multiple connections and benefits for their students, when they do they find it engaging for their students (Bell & Henderson, 2022). Learning how to teach and teaching activities that are "unplugged" can assist teachers to develop both (Bell & Henderson, 2022)."Unplugged" is considered a pedagogical approach and are activities are those that engage students in a range of activities that assist the understanding of key concepts important to computational thinking such as sequencing or orientation without digital devices (Munasinghe et al., 2023).
Kaupapa Māori is perceiving the world from a Māori perspective and normalising Māori values, behaviours, and understandings. It is underpinned by the implementation of Māori processes and understandings within a Māori philosophical framework (Hargraves, 2020; Hoskins & Jones, 2017). In terms of computational thinking in Kaupapa Māori, Mohaghegh and McCauley (2016) state that there is little research on the development of Māori students, and there is a need to promote technology and computer science to Māori students and for Māori to be trained as developers and creators of technology and digital solutions, rather than just users and consumers of existing technologies. Thus, it is of critical importance to include computational thinking in the curriculum that is particularly accessible to groups of people who are technology consumers but are not traditionally pictured as employed in the fields of computer science and technology, such as Māori, minority ethnic groups, and women.

Learners need to see their cultural practices in the learning (Tiakiwai & Tiakiwai, 2010). Leonard et al. (2016) found that students can fuse culture and place it into their game design in digital technologies. Teachers' beliefs about culturally responsive teaching, attitudes toward computational thinking, and STEM practices need to be flexible to different contexts. According to Leonard et al. (2018) using culture as a hook to engage underserved students to learn essential computational thinking skills is virtually unresearched.

This literature review identifies that learning to think computationally is vital for students to thrive in our current and possible future digital worlds, however, to ensure ongoing and engagement and sense-making computational thinking must take place within authentic contexts. In addition, there is very little research into how young Māori leaning are best situated to learn computational thinking, thus the research question for this study is 'What pedagogies most effectively facilitate computational thinking learning for young Māori learners?' with the sub questions of i) What is the role of using authentic contexts in young Māori learners learning computational thinking? And ii) What teaching strategies engage students effectively in learning computational thinking?

Methodology and Methods

Qualitative methodology underpinned by theoretical concepts of Kaupapa Māori (Hoskins & Jones, 2017) and Constructionism (Papert & Harel, 1991) guided this study. Within a constructionist paradigm, meaning is constructed by people as they engage with the world they interpret, which facilitates sense-making of the same reality in different ways (Crotty, 1998). Kaupapa Māori enables the rethink of academic conventions by including cultural expression, values, and ethics, and aims to achieve higher academic standards for Māori (Hoskins & Jones, 2017). It promotes Māori-centered approaches in terms of questions, methods, motivations (Stewart, 2021). This research was not undertaken by Māori; however, it was implemented using a Māori perspective with an aim of increasing learning outcomes for Māori (Hoskins & Jones, 2017; Stewart, 2021). Kaupapa Māori Research uses methodological innovation, and qualitative research design (Drawson et al., 2017; Haitana et al., 2020) and is designed to guide and inform the approaches to research with Māori (Haitana et al., 2020).

The four-week study was undertaken towards the end of 2022 with a total twelve students and two teachers (Table 1) at a local Primary School located at Ngāruawahia, a significant place for Māori culture and history. Ethical consent was obtained through the participating university. Purposeful sampling was used to identify a school with a high Māori roll in a low socioeconomic area.

Table 1: Study Participants

Teacher Pseudonym	**Ethnicity**	**Sex**	**Years teaching**	**Years at this school**
Whaea* M (WM)	Māori	F	7	5
Whaea O (WO)	Pakeha**	F	10 months at start of study	1
Student Pseudonym		**Sex**	**Age**	**School year**
Peta	Māori	M	6	2
Colin	Māori/Pakeha	M	7	3
Ahere	Māori	F	7	3
Ihaka	Māori	M	7	3
Bobby	Pacifica	M	5	1
Gerald	Pakeha	M	6	2
Sua	Pacifica	M	5	1
Danny	Māori	F	6	2
Ana	Māori	F	5	1
Kali	Māori	F	6	3

Ihu	Māori	M	6	6
Hanna	Pakeha	F	5	1

** Term used for respected females- literally means mother, aunty. Often used in schools with high proportion of Māori students*

*** Term used in New Zealand for non-Māori, usually of European descent*

The learning was divided in three phases: introduction, preparation and completion. In each phase, students engaged in constructing their learning through a set of scaffolded activities to better understand the notions of sequencing and orientation in relation to coding Bee-bots, with the long-term aim of the students designing an App to assist newcomers to navigate their way around their school.

Introduction Phase (Week one)

This phase introduced three important concepts of sequencing, orientation and map, followed by a series of activities that practice students' understanding of steps, ordering and turning left and right. The teachers used "going to the bathroom" and a Māori legend story, 'How Maui slowed the Sun' to illustrate the concept of breaking a problem into a sequence of steps, and in correct order. To test the knowledge, the students played a treasure hunt game with 6 by 6 grid map on the school ground as shown in Figure 1. Six to seven students were divided into two groups, Robot group and instruction group. The Robot group navigated through the map toward the cell holding the treasure according to the instructions (turn left, turn right, move forward X steps) provided by the instruction group. At the end of session, students had a free play with Bee-bots, programming the Bee-bot to travel in a square (Figure 2).

Figure 1. Treasure hunt game

Figure 2. Bee-Bots free play

Preparation Phase (Week two)

This phase prepares the students for Bee-bots coding that requires the students working as pairs, following four steps (1) work out a pathway to the destination on a grid map (Figure 3); (2) mark the pathway on the map using arrows; (3) program the pathway as a sequence of arrows; (4) test their program on the map and make corrections if necessary. One activity required the students with their dog to navigate to the marae meeting a friend and gathering kumara (sweet potato) on the way by placing forward, back, left and right arrows on the template provided. Figure 4 shows the student wrote down the pathway on a separate sheet as a program (on

the right) for Beet-bot (a sequences of left/right, forward arrows) and tested the program on a bigger map with Bee-bots (Figure 5).

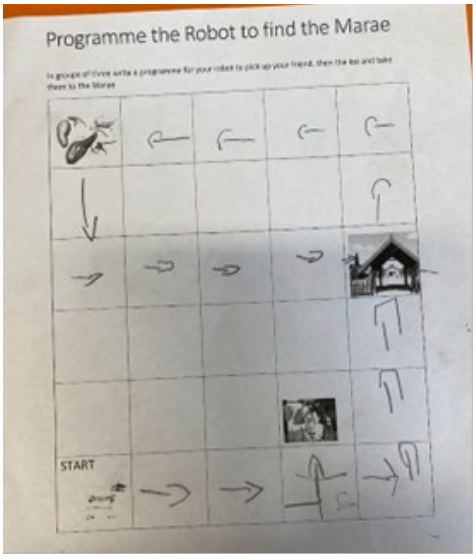

Figure 3: Peta, Kaihautu and Bobby's programme to take the dog to the marae, collecting a friend and kai (food) in the way

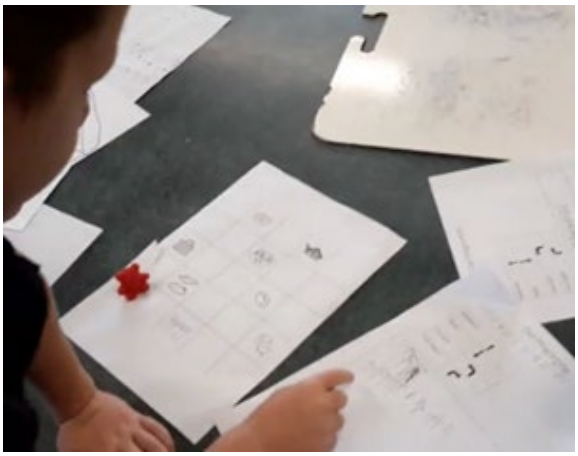

Figure 4. Coding a pathway and testing it on a mini map with *Teddy manipulative*

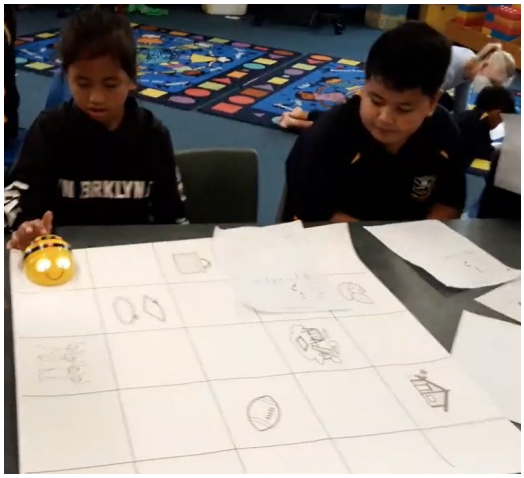

Figure 5: Test the program with Bee-Bot

Completion phase (Week three and four)

During this phase, the students were tested what they have learned so far. They were required to (1) build a school map with locations that they wanted their parents/friends to visit; (2) select a pathway on the school map (3) program Bee-bots to follow the pathway. The school map, initially blank, was a 6 x 6 grid with the significant locations or landmarks of the school such as reception office, playgrounds, pool, hall, a mobile dental unit on truck, mini garden with local plants, courts places on them. As shown in Figure 5, shows an example, location pictures were selected and drawn by the students after a whole class trip of walking around the school field. After finishing the map, the students selected a pathway to visit the locations of choose and write the sequence of code (turn left, right, go straight arrows) on a working sheet and test it on their mini map. Finally, they entered their program to Beet-bots and tested it on the lager school map. If the program failed to work, the teachers showed them which steps went wrong and encouraged the students to fix the sequence and come back to re-try.

An abiding principle of qualitative analysis is fitness-for-purpose (Cohen et al., 2011). Data was analysed using thematic analysis aiming to understand the students' learning in computational thinking within authentic technology-related contexts. The researchers coded and recorded the data to identify key themes with the aim to understand meaningful reality as suggested by Crotty (1998).

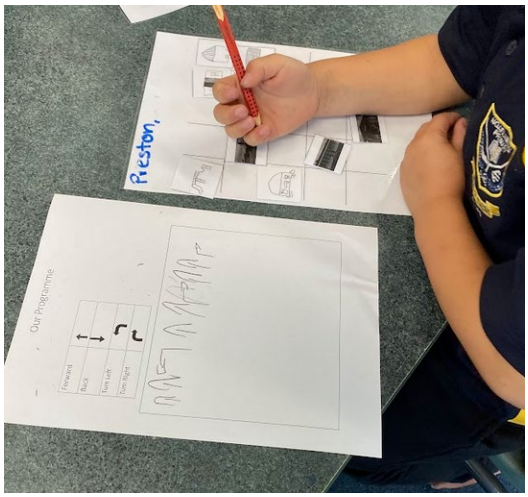

Figure 6: Programme their own journey around their school, having situated specific places.

Findings

Students in the study learned computational thinking concepts from a te Ao Māori perspective. During the unit teachers acted as experts and provided a co-constructed, self-directed learning environment that allowed students to approach tasks on their own terms. Three key themes were identified: culturally situated context, culturally informed pedagogy and student engagement that demonstrated a developing understanding of the computational thinking concepts.

Culturally Situated Context

Students in the study learned computational thinking concepts from a te Ao Māori perspective. The end goal was for the students to write a simple programme to assist visitors to assist members of their

whanau (Māori term for wider family and central in Māori culture) to navigate the school. The teachers made sure the context they introduced to the students was relevant to them and their whānau. The extract below illustrates how the teachers set up the context with their students.

> WM: WO and I were talking tonight, there's the disco and we have lots of new tamariki[children] who have come to our school and some of their whānau probably don't know where the hall is, they probably don't know where to park their car. If we [have] got nothing to give them, to show them where everything is they might get lost. We have lots of gates, there's a gate down that field, the gate in the car park or the gate at the technologies block.
>
> WO: and the gate at the schoolhouse.

By setting this scene the students understood that there was a genuine need to the proposed study. The students were then encouraged to think about and articulate their ideas about technology, firstly by exploring a few well-known applications (apps). They were given a range of apps to play with in the first lesson.

The next day the thinking then shifted to how this learning might be applied to their situation. In the extract below Whaea O drew on the previous day's learning about apps to the current issue-of whānau getting lost coming to school.

> WO: I think you are onto something. Do you remember yesterday we looked at maps on the iPad? Imagine, if we had an app, so that I could pull out my phone there was a map of the school, and it could tell me where to go. I could tap in and go I want to go to Room 7.

However, one student realised that there was potentially already a solution to the problem, by asking 'Siri'.

> Student: Whaea you could just ask Siri.
>
> WO: Okay let's see if Siri knows how to get to Room 7. Open Siri. Siri, how do I get to Room 7?
> [Siri inaudible talking]
> WO: It is giving me instructions to a restaurant called Room 7 in America.

In addition to situating students' learning in an authentic culturally appropriate context teachers also deployed several pedagogical strategies that also aligned with tikanga Māori (Māori culture).

Culturally Informed Pedagogy

Culturally informed pedagogy is reflected in four aspects: learning context, use of te reo Māori, relationship building and ownership of learning. First, as illustrated below, the teachers set up a context relevant to the students' lived experience and their whānau using story-telling, daily routines and role-plays.

> WM: WO and I were talking tonight, there's the disco and we have lots of new tamariki[children] who have come to our school and some of their whānau

probably don't know where the hall is, they probably don't know where to park their car. If we [have] got nothing to give them, to show them where everything is they might get lost. We have lots of gates, there's a gate down that field, the gate in the car park or the gate at the technologies block.

WO: and the gate at the schoolhouse.

Examples are that students were taught the importance of sequencing through engagement with a Māori legend, 'How Maui slowed the Sun', WO reminds students the story of Māui taming Tama-nui-te-Rā and shows them the cards and how they need to be organised into the correct order of events' (observation notes 2 November). One activity required the students with their dog to navigate to the marae meeting a friend and gathering kumara (sweet potato) on the way by placing forward, back, left and right arrows on the template provided (Figure 4).

Other examples include role-plays that are related to the students' everyday lives to illustrate sequencing such as going to toilets shown below.

WO: You imagine if you were a computer or a robot right. So I am a robot and WM is going to tell me what to do and I am going to do it.
WM: Sit down, stand up, turn around, take two steps maui [left], and three steps matou [right].
WO follows the instructions in order
Student: You have to tell the directions
WO: Yeah, so from the start, what happens first and then next. So sequencing for going to the wharepaku [toilet], what do you do first?
Student: Open the door
WO: Then we…
Student: Lock the door
WO: Then we…
Student: Pull our pants down.

Whaea O and Whaea M also used role play integrated with elements of storytelling to present tasks to the students. For example, they pretend to take a call from "nan" who gives a set of instructions to follow.

WO (as nan): Kia ora my moko [hello grandchild]
WM (as students): Oh! kia ora Nan [hello Nan]
WO: Moko, I am very stressed out right now, I'm not coping. Nan is going to have a heart attack. I need the kumara, I need the kumara for the hui [meeting]. You need to go and get the kumara, real quick, real quick. We are not going to be strolling, we're running. Get the kumara, then get me and then you need to take me to the marae for the hui, I need to be there in about five minutes.
WM: Ok so get the kumara, pick you up, take you to the marae?

Second, use of te reo Māori was frequent and natural, constantly inserted as a part of everyday classroom dialogue as demonstrated by Whaea O, with English words added by the writer as she gives instructions for one of the activities.

> WO Yeah otherwise it gets pakaru [broken] and then just doesn't work properly.
>
> WO: Your job is to figure out, some of you are going straight to the marae [communal meeting house]. Some of you need to start here, we all start at the same place. Then we need to go pick up our friends. Then we need to go and get the kai [food] and then we need to go to the marae. You need to figure out how many steps forward you need to take to get to your friend, then you are going to have to turn left or right to get to the kai.

Third, strong relationships were developed and established between older and younger students and between students and teachers. Tuakana/Tēina teaching where tuakana meaning older, more capable students and tēina meaning their younger peers is key to T Ae Māori [Māori word view]. In this case the older Year 3 were grouped or paired with younger peers from Years 0-2. The extract from researcher observation notes demonstrates this.

> Students are directed to read the packs and use the pictures as clues to put the story in the right order. Tuakana have been put in charge as leaders of each group. WO directs the class to use the title page as the first step of the sequence.

The teacher in the classroom developed very strong relationships with their students. The classroom climate was one where failure was accepted and respected and then turned into opportunities for learning as evidenced by researcher observation notes, "Groups who were unsuccessful were shown which part of their sequence was incorrect and were sent away happily to reconfigure and test again" (observation notes 24 November).

The fourth pedagogical strategy related to students' ownership and co-construction of their own learning. Initially using the template illustrated in Figure 4.

> WO: Who knows what this might be? Ahere?
> Ahera It might be a map.
> WO: That's right, it is a map. What can you see on the map?
> Multiple students: A marae, kumara, kete [basket]
> WO: Your job is to figure out [where you want to do and what you want to do], some of you are going straight to the marae. Some of you need to start here. Then we need to go pick up our friends. Then we need to go and get the kai and then we need to go to the marae. You need to figure out how many steps forward you need to take to get to your friend, then you are going to have to turn left or right to get to the kai. You might want to draw how you are going to get there.

After completing this task, the students were given the option of writing code for a Bee-bot to navigate their pathway, selecting their own starting point (Figure 5). To scaffold learning for those who found coding Bee-bot difficult, some students began by writing and practicing their coding using a 'teddy bear' manipulative (Figure 4).

Next the students walked around the school and drew pictures of significant school landmarks and then placed them on their own blank map. "Students create their own maps that mirror the locations of the class's big map. The locations have been chosen and designed by the students based on real locations in the school" (Observation notes 21 November 2022). Students then wrote code to 'navigate' around the school (Figure 6).

> WO: You can start anywhere, I might want to start over here, or I might want to start over here. Or maybe my main entrance, the office, my office might be over here. [points to different spaces on the map while talking] Right do we have the pictures?

Student Engagement and Emerging Understanding of Computational Thinking and Coding

Sequencing and orientation to the two concepts of computational thinking specifically taught in the unit. The extract below showed that most children could identify left and right. "Almost all of the students raised their left hand, a few realised their mistake and changed" (observation notes 3 November). Some tēina needed prompts, for example letters on their hands as Bobby mentions below.

> WM: It's like they were a computer, and you were inputting directions
> WO: Yeah, you guys were computers, and I was giving you information and you were following my instructions.
> Bobby: The reason I was there was because of the letters
> WM: Oh, the letters, but what about when we took the letters away, you still knew
> WO: Right, who can hold up for me their left hand?

Students clearly understood what the term sequencing meant.

> WO: Who knows what sequencing means? What does sequencing mean? If I say you going to put this in, you are going to sequence these pictures in…?
> Student: Order!
> WO: Yeah, you are putting things in order. Remember when we did umm
> Student: I remember what order is, you put them in the right order.

As illustrated below, students appeared to gain an understanding of map layout in relation to their school, incorporating orientation and sequencing relevant coding in context.

> WO: So, what do you think we need to make it look like a map?
> Student: We need pictures on it. ……..
> WO: What kind of map is going to be of?
> Student: The school
> WO: Oh, so what does it need on there? It needs…
> Student: The office……
> WO: Someone is going to choose because the office is the front of the school isn't it? So if I was a manuhiri, a visitor, I would start at the office, because I have to sign in. [Kali is then invited to stick a picture representing the office on the 5x5 grid map. She places the picture of the office on the lowest left-side corner of the grid]

> WO: OK, so do you think that's a good place to put the office?
> Multiple students: No
> WO: Why not? What's next to the office?
> Bobby: The car park
> WO: Where's the car park going to go? Over here [indicates off the map]
> Multiple students: No
> WO: [Indicates to the student to return to the grid map] Haere mai! (hello), so where would be a good place if we know…the office is in the…?
> Student: Middle
> WO: The office is in the middle
> Gerald: I know where the middle is [Kali picks up the picture of the office and places it in the centre column and the lowest row of the grid]

Some of the students developed an understanding of the concept of a map and its use for navigation. This set them up for the necessity of sequencing the places to be visited in relation to the map (Figure 5) and therefore giving a foundation for the sequencing of a programme for navigation.

By the end of the unit, the data suggests that all students understood the concept of programming a robot (Bee-Bot) by giving it multiple sequenced instructions at once (forward, backward, left, or right). The tuakana (older students) individually programmed the Bee-Bot and did specific tasks using sequencing and demonstrating an understanding of orientation. They undertook self-correct debugging in relation to mapping a route. "After showing the kaiako his programme on paper, Ihaka entered his programme into the Bee-Bot and completed the task on his first attempt" [observation notes 24 November 2022].

> Gerald is testing his programme on the map by using a manipulative and checking that each step in his programme works. After showing the kaiako, Gerald enters his programme into the BeeBot and signals it to start. His bot lost traction in the beginning and did not path correctly. He was given a different BeeBot and so re-entered his programme. Gerald was able to complete the task on his first attempt. Ahere fails on her first attempt and then succeeds on her second attempt. Ihu succeeds on his second attempt. Peta was able to complete the task on his first attempt and Sua was able to complete the task on his first attempt. Two groups utilized the backward movement feature as part of their sequence [observation notes 24 November].

However, some of the tēina (younger students) confused 'forward' with 'up', "One student, while entering his sequence into the Bee-Bot, had it facing right but input his sequence as if the bot was facing up". Others had difficulty transferring a three-dimensional journey on a map to the linear positioning of code on a page. For example, "Ihaka attempted to test his sequence, however, once the directions were off the map and in a sequenced line, he could not replicate his sequence on the map" [observation notes 15 November]. To assist with this the teachers introduced a manipulative (plastic teddy) which the students used to test their code one step at a time before entering the whole sequence into Bee-Bots.

> Without manipulatives, the students struggled to visualise the sequence working. It may be that the students perceived the left and right turn directions as turning a corner as opposed to a 90 ° rotation.

Another issue the students experienced was the assumption that the 'turn' command in Bee-Bot included a step forward. This was either corrected by the teachers and researchers working with the students or self-discovered. "[Researcher 3] clarifies this with Colin and explains that the turn does not include movement and that we stay still when we turn" [Observation Notes 14 November].

Discussion

As the tauira (students) in this study were predominantly Māori, a te Ao Māori perspective involved them interacting with content that was based on Māori values and beliefs, using Māori learning practices and engaging with te reo Māori. The concepts of computation thinking were embedded in the students' cultural context in two ways: through the learning context and through the pedagogical strategies. With regards to context, kaiako (teachers) use a te Ao Māori focus as part of their Kaupapa (plan) to establish an authentic learning context for their tauira (students) where their cultural identity and everyday lives are reflected in their classroom activities. The context of tasks undertaken, and the purpose of the tasks were contextualised through the tauira's connection to their land and to their whanau. For example, a Māori legend was used in the introduction to the importance of sequencing, the sequencing objectives are the physical locations of their school and town, and the elements of home and whanau life are integrated into the lessons in storytelling. The final test programme requires students to direct Beebot to pick up 'Nan', get a kete [basket] and gather kūmara (sweet potato) before arriving at the marae. Such an approach aligned with the findings of Leonard et al. (2018) that the students were engaged in a space they were already familiar with and they can see themselves as developers and consumers of technology as well, which is the need for teaching computational thinking that Litts et al. (2021) emphasise.

With regards to teaching strategies, te Ao Māori is used through wānanga (programme of work) and ako (learning), and tauira who were struggling with understanding their own identity as Māori and with the learning concepts were given a safe space to express themselves free from judgement. Firstly, the integration of te reo Māori was seamless throughout the unit. As the words were intermittently changed between English and te reo Māori, kaiako (teachers) would not stop to offer a translation. This encourages the tauira to focus on the lesson and shows that their language is valued in the classroom. Secondly, the kaiako do not assume there is only one way to learn and assume all tauira can learn with existing knowledge and skills. Their multifaceted approach to learning gave tauira the confidence to explore digital technology according to their own strengths. To be specific, the kaiako were very vocal and explicit about learning, showing the tauira that they did not have all the answers and that they were sharing the same risks as the tauira in the learning experience. Thirdly, the kaiako used Tuakana/Tēina, allowing students to work together and assist each other as strong relationships between whanau and school are critical to engaging Māori learners. Berryman and Forde (2017) promote school home relationships which require teachers to be aware of the students' cultural backgrounds and their own cultural biases. Ensuring they feel comfortable and welcome at school is an important part of this.

Finally, Bee-Bots were used throughout the unit and as a final assessment tool and the students were thoroughly engaging. Is using Bee-Bots necessary in learning computational thinking? A person

could walk on a map on the floor following the written sequenced instructions from a peer. However, the movement of the Bee-Bot in the three-dimensional setting to a linear two-dimensional set of arrows, a form of abstraction, tests students' abstraction skill, one of the challenging aspects of computation thinking. Therefore, we argue that a significant advantage of Bee-Bots was that they were programmed, trailing, and debugged as a whole or partial programme rather than step-by-step as was evident with the testing with people role-playing robots.

Limitations

Several limitations of the study were identified. Learning with manipulatives was introduced quite late in the study. This scaffold would have been useful earlier on to assist the transition from 3D thinking to 2D lines of code. This may have reduced some student confusion. In addition, opportunities to teach debugging were not capitalised on. However, debugging became a critical aspect when testing code and therefore should have been taught in parallel with the other two concepts. Unfortunately, the unit was not completed, and students did not reach the point where they could apply their learning to code the actual app. This was partly due to COVID 19 absences and an underestimation of how long the learning took. Despite this, data suggests that tauira were engaged, developing understanding about the role of sequencing and orientation in relation to coding a simple robot.

Future Research

The next step in the research project will include specific foci on testing and debugging and further development of the ideas of looping, abstraction, algorithmic thinking, and decomposition with students who are slightly older than those from this study. In addition, the researchers are working on the development of a digital app which will enable students to develop code for the exploration of their local environment, thus enhancing the concepts of authenticity and connection between learning and the students' lived-worlds.

Conclusion

This study investigated the teaching and learning of two specific computation thinking aspects (navigation and orientation) within Brennan and Resnick's (2012) three-dimensional framework—computational concepts, computational practices and computational perspectives. Students were introduced to and engaged with two specific concepts—sequencing and orientation—through programming Bee-Bots and undertook authentic technology practice to determine the reason for their learning. We particularly focused on computational perspectives which were a critical component that encouraged students to understand programming as an important aspect in te Ao Māori them and themselves as Māori. This study suggests that role-play and manipulatives are appropriate scaffolds to basic programming but not an end point.

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