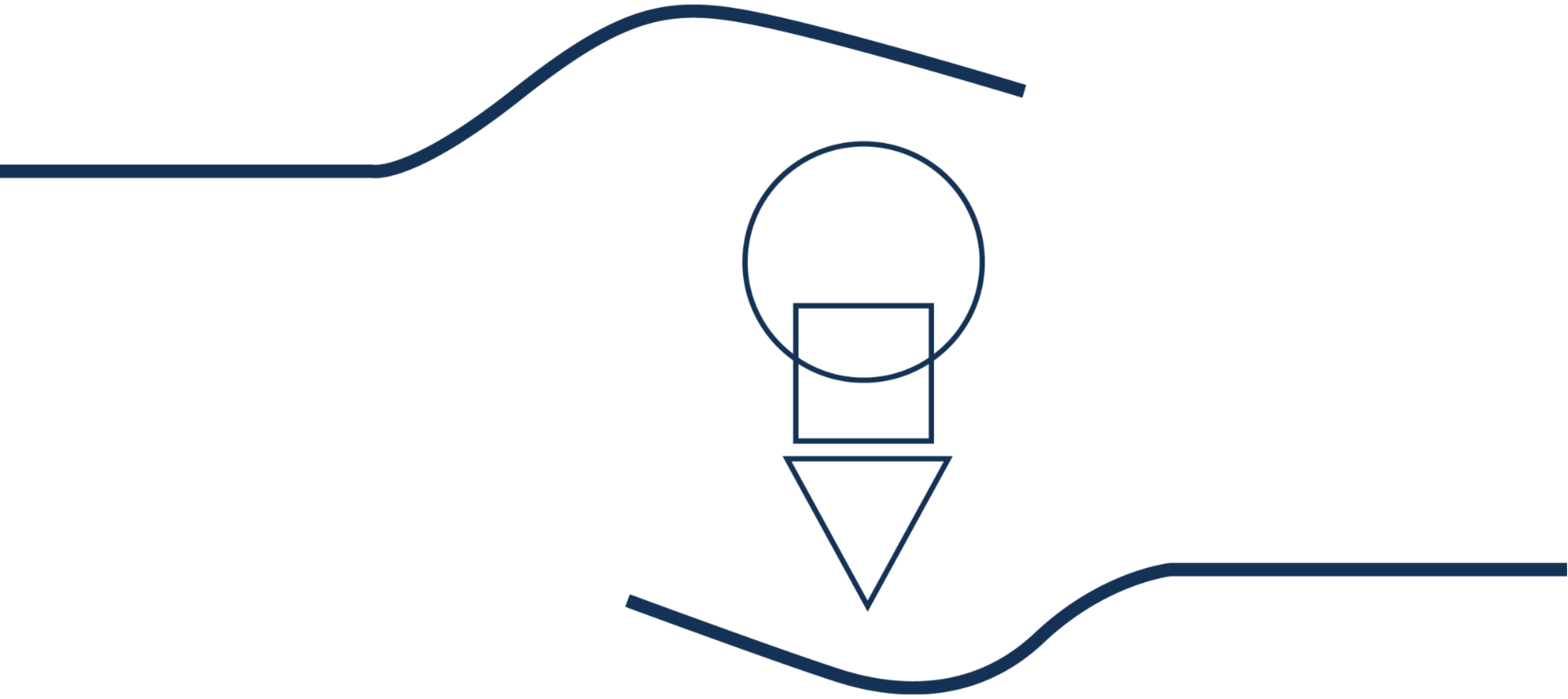

MOTIVATING GIRLS IN COMPUTATIONAL THINKING

INSIGHTS FROM PRIMARY EDUCATION RESEARCH

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Abstract

This conference paper explores the research methods and preliminary findings of research focused on understanding primary school girls' motivation in Computational Thinking (CT). By analysing current literature, the scope of the research, and emerging data, the research sheds light on strategies to bridge persistent gender gaps in Computer Science (CS) and CT education.

The literature highlights the ongoing underrepresentation of females in CS and CT fields, advocating for early interventions that frame computing as enjoyable, hands-on and supported by relatable role models. Addressing these gaps, this research employs a three-phase Design-Based Research methodology within a New Zealand primary school. Data collection includes focus groups with both teachers and female students, observations and Likert scale surveys to examine motivational factors during CT activities.

The research methods and initial findings from the research are shared, revealing how teachers' pedagogical choices, including authentic Technology practice and collaboration activities impact girls' motivation. These insights contribute to a broader understanding of how to foster gender equity in STEM education by creating more inclusive and motivating environments for younger learners.

Target Audience (style Abstract)

ECE, Primary, Intermediate, Secondary, Tertiary

Keywords

Computational thinking, motivation, Design-Based research, gender equity

Introduction and Background

Digital Technology (DT) has undergone significant transformation over the past few decades, becoming deeply embedded in education, workplaces and daily life. As societies embrace the digital age, DT has become a fundamental component of curricula worldwide. The early 21st Century saw reports from Europe and the United States emphasising the need to equip students with a deeper understanding of DT, advocating for an overhaul of education systems to better integrate DT (Gander et al., 2013; Koh, 2015; Prensky, 2001; Reigeluth & Joseph, 2002; Su, 2009; Tapscott, 2009; Voogt et al., 2015).

As part of DT education, Computer Science (CS) and Computational Thinking (CT) have evolved considerably, shaping the way students engage with DT. CS, developed as an academic discipline in the United States during the 1940s, branched out from engineering (Tedre et al., 2018). Initially focused on developing new computing devices, the field later shifted toward preparing specialists for the workforce. By the 1960s, CS had been introduced into American high schools, marking a significant step in integrating computing education into formal curricula (Tedre et al., 2018). More recently, CT, alongside CS, has gained recognition as a fundamental component of education (Grover, 2021). Despite this growth, the participation of female students in CS and CT remains disproportionately low compared to male students. This highlights persistent gender disparities in digital technologies education and in digitally based careers (Cebr, 2020; Cheryan et al., 2017; Kuppler, 2022; UNESCO, 2018). This is despite evidence showing that diversity fosters innovation and creativity, drives strong organisational performance, and contributes to the development of new knowledge (DuBow, 2013; Hofstra, 2019; Page, 2019; Tiwari, 2022). The question is why?

Though distinct in meaning, terms such as computing, coding, CS and CT are often used interchangeably. Computing typically refers to the use and operation of computers, while CS encompasses the study of algorithms, network design and artificial intelligence (Encyclopaedia Britannica, n.d.). Similarly, although related, coding and CT are not synonymous. Coding (often viewed as a subset of programming) is frequently promoted through platforms like Code.org, which has contributed to its widespread use in education. This has led to semantic shifts in how the term 'coding' is understood, sometimes obscuring key distinctions between concepts. While proficiency in one area can support learning in another, treating these terms as synonymous can cause confusion in both teaching and curriculum development (Akiba, 2022; International Society for Technology in Education, 2022; Sun et al., 2022).

The lack of clarity in terminology and understanding is part of a broader set of challenges within the field. In this paper, Digital Technologies Education (DTE) is used as a generalised term to encompass studies that focus on the teaching and learning of CT, CS, programming, coding and robotics, despite variation in terminology across sources.

This research explores the factors influencing primary school girls' motivation for working in digital technologies computational thinking. It begins by outlining the concept of CT and its place within the New Zealand Curriculum [NZC], followed by a review of literature on existing gender disparities in the field of DT. Adopting a design-based research [DBR] approach and drawing on qualitative data collection methods, the research investigates the central research question: How can adapting learning approaches support and increase 10- and 11-year-old girls' motivation in CT? The paper presents initial findings in response to the sub-question: What pedagogies best enhance girls' motivation in CT? The paper highlights two main findings: the importance of authentic technology practices and the value of collaborative activities in fostering girls' motivation.

Computational Thinking

Once limited to secondary schools and higher education, CT is now embedded in primary school curricula across several countries, including Australia (Papadopoulos, 2017), the United Kingdom (Cebr, 2020), New Zealand (Ministry of Education [MoE], 2017), and the United States (Stephenson et al., 2012). Adding CT to curricula aims to transform students from passive users of DT into creators with essential digital skills for the 21st century (Cebr, 2020; MoE, 2017; Papadopoulos, 2017). Many curricula introduce CT concepts as early as age five, incorporating both digital and unplugged (off-device) activities. In an increasingly DT-driven world, early exposure to CT fosters creativity and digital literacy, preparing students to think critically about digital systems (Caeli & Yadav, 2020). Furthermore, the growing demand for a workforce skilled in digital industries, including computer programming, underscores the importance of these educational advancements.

CT is a cognitive process used to solve problems through logical reasoning and algorithmic thinking that is rooted in CS principles (Curzon et al., 2014). Wing (2006) likens CT to literacy and numeracy, asserting its importance in everyday life. It serves as the foundation of CS, occurring both before and after the use of digital devices. At its core, CT involves formulating problems in a way that enables computational solutions, whether executed by humans or machines (Wing, 2018).

The benefits of teaching DTE extend beyond computing, supporting learning in mathematics, literacy, and STEM (science, technology, engineering and mathematics) subjects more broadly (El-Hamamsy et al., 2023; Li et al., 2020; Wing, 2006). Furthermore, early exposure to DTE can help challenge the social and institutional barriers that discourage girls from pursuing computing-related fields (El-Hamamsy et al., 2023).

Computational Thinking Within the New Zealand Curriculum

In New Zealand, Computational Thinking is situated within the Technology Education learning area of the NZC where technology is defined as:

> …intervention by design. It uses intellectual and practical resources to create technological outcomes, which expand human possibilities by addressing needs and realising opportunities. Design is characterised by innovation and adaptation and is at the heart of technological practice (MoE, 2017, p. 1).

In 2017 Technology within the NZC was revised. As part of the revision, two new digitally related technological areas were added. The rationale for adding these digital technological areas was to ensure all learners become digitally capable individuals, placing greater emphasis on developing skills to become innovative creators of digital solutions, rather than being users and consumers of DT (MoE, 2024). The two new areas were Computational Thinking for Digital Technologies (CTDT) and Designing and Developing Digital Outcomes (DDDO). Within CTDT three new Progress Outcomes for Primary education (at curriculum Levels 1-4 for children ages 5 to 12) were included. These Progress Outcomes highlight the progressions students make as they expand their knowledge in CT. In CTDT students undertake activities on-and off-devices:

> Computational thinking enables students to express problems and formulate solutions in ways that mean a computer (an information processing agent) can be used to solve them.
>
> In this area, students develop algorithmic thinking skills and an understanding of the computer science principles that underpin all digital technologies. They become aware of what is and isn't possible with computing, allowing them to make judgements and informed decisions as citizens of the digital world. (MoE, 2017, p. 4)

All CTDT progress outcomes also focus on "authentic context and taking account of end-users" (MoE, 2017, p.11).

Authentic Contexts

Snape and Fox-Turnbull (2013) highlight that authentic Technology practice supports students in engaging with real-world collaborative learning. They emphasise that Technology Education is one of the most effective curriculum areas for fostering authentic practice. Authentic technological practice connects students' learning to real-world situations using genuine tools and processes, helping them develop deeper understanding and relate to future workplace scenarios (Fox-Turnbull, 2007). Hennessy and Murphy (1999) also emphasise that such practice enhances engagement by making learning relevant to students' lives and careers.

However, despite the introduction of new DT curricula and authentic technological practice engaging students, gender disparities persist in the DT sector, at high school and beyond, both within New Zealand and worldwide, raising concerns about inclusivity and equal opportunities in these fields (Cebr, 2020; Cheryan et al., 2017; Digital Skills Forum, 2021; National Science Foundation, 2017; Wang et al., 2021).

Gender Disparities in Digital Technology

Beyond education, there are gender disparities in the DT sector, with women underrepresented compared to men (Cebr, 2020; Cheryan et al., 2017; Digital Skills Forum, 2021; National Science Foundation, 2017; Wang et al., 2021). This imbalance is particularly concerning as DT continues to shape various aspects of modern life. Within CS, gender bias is further exacerbated by a lack of diverse representation, with male-dominated teams contributing to an industry-wide issue of inclusivity (Breidenbach et al., 2021; Kuppler, 2022; UNESCO, 2018).

One consequence of this underrepresentation is the inadvertent gender bias embedded in algorithmic design. Many algorithms are created by homogenous groups; thus, they reflect the perspectives and assumptions of their developers, reinforcing existing inequalities (Perez, 2019;). Studies highlight that the absence of diverse voices in CS contributes to systemic bias, as the technologies being developed fail to account for broader societal perspectives (Hofstra et al., 2019; Noble, 2018).

Research also indicates that gender gaps in STEM fields, including DTE, begin to emerge in primary school (Master et al., 2017; Wang & Degol, 2017). However, early exposure can help to reduce gender differences in engagement and self-efficacy (Master et al., 2017). Early exposure to DTE, social expectations, and stereotypes surrounding problem-solving abilities influence students' engagement in these subjects. Encouraging DTE at the primary level has been recognised as a key strategy for addressing gender disparities early on (El-Hamamsy et al., 2023; Sullivan, 2021), thus providing young learners, particularly girls, with opportunities to participate in DTE can enhance motivation and foster long-term interest in the field (Master et al., 2017).

Due to the persistent gender gaps in DTE, it is crucial to encourage girls to develop their skills from an early stage. Research highlights that boys are generally more motivated to engage in DTE than girls, making it important to understand and emphasise the factors that foster girls' interest in the field (Kong et al., 2018). Studies suggest that early exposure, role models, real-life applications, combining both unplugged (off device) and plugged-in (on device) approaches, gaming and interdisciplinary connections can support and sustain girls' engagement in DTE (El-Hamamsy et al., 2023; Fagerlund, 2022; Gursch, 2022; Luo et al., 2020; Master et al., 2017). For instance, an Accenture and Girls Who Code (2016) report from the USA suggests a three-stage approach: sparking interest in junior high (11–13-year-olds), sustaining engagement in high school, and inspiring careers in college, demonstrating consistent exposure can significantly increase women's participation in subsequent computing careers.

The Australian Council for Educational Research (ACER) (2023) further emphasises the need to build confidence among educators and students, relate DTE to real-world contexts and challenge stereotypes that may hinder female participation. One approach to building confidence is through working collaboratively with peers and other interested parties.

Collaboration has been identified as a key factor in increasing girls' motivation and self-efficacy in STEM and DTE. Master et al., (2017) highlight how cooperative learning environments, where students support one another, fosters a sense of belonging and interest in STEM. Working collaboratively can take several forms, including when students are working together on the same project. However, another refers to students sitting side by side, working on their own projects while supporting each other. This is the approach taken in my research. Such an environment enhances engagement, as it allows for social interaction and mutual encouragement, both of which are essential in sustaining girls' participation in DTE (Pudjiarti et al., 2023). Furthermore, interdisciplinary approaches, such as integrating DTE with biology or art, have been found to boost interest among female students (Corinna & Sabitzer, 2023; Kori & Luik, 2020). However, results vary depending on the specific elements of DTE offered, highlighting the need for continued exploration of effective engagement strategies.

Research Focus

With the introduction of CTDT in the Technology learning area of the NZC (MoE, 2017) and considering the persistent gender imbalance in education and the DT workforce, early engagement in DTE offers a valuable opportunity to begin shifting patterns of participation (Sullivan, 2021). Mills et al. (2021) argue that girls often lack access to the necessary resources and learning opportunities to develop their DTE skills, reinforcing gendered marginalisation within the field. They emphasise the need for all educators, across subjects and grade levels, to integrate DTE into learning experiences:

> If we are to equip every student in the next generation with the skill set to participate in our technological society, all educators, across disciplines and grade bands, need to provide opportunities for students to engage in computational skills and practices (Mills et al., 2021, p. 7).

To address the challenges and contribute to DTE and specifically CT as a field of research, this research explores the factors influencing girls' motivation in CT within upper primary school classrooms (ages 10 to 12) in New Zealand. Understanding what drives girls' motivation at this age could contribute to greater female participation in computing, reducing gender stereotypes and encouraging more equitable representation in secondary education, tertiary research and the DT workforce.

Methodology

The research adopted a Design-Based Research [DBR) methodology with a qualitative approach to explore factors that motivate primary school girls in CT. DBR was chosen for its strong alignment with practical educational interventions and its collaborative nature, involving both teachers and students in the design and refinement of learning experiences. Guided by a pragmatic paradigm, the research was structured through a three-phase iterative research design and aims to answer the question 'How can adapting learning approaches support and increase 10- and 11-year-old girls' motivation in Computational Thinking?' with a focus on initial findings to the sub-question 'What pedagogies best enhance girls' motivation in CT?'

The research was conducted in a primary school setting, involving three classrooms. Each class contributed six female participants, resulting in a total of 18 students (n=18). In each phase, teachers and researcher collaborated to refine CT unit plans based on student feedback, ensuring continuous improvement of the interventions.

A pragmatic paradigm serves as a lens through which this research was conducted, prioritising practical solutions and innovation (Cohen et al., 2011; Tashakkori & Teddlie, 1998). It is grounded in a bounded relativist ontology, which acknowledges that reality is shaped by individuals within a social context (Moon & Blackman, 2014). Additionally, the research is informed by sociocultural epistemology, which holds that knowledge is co-constructed through shared experiences.

ARCS Model of Motivation

The ARCS Model of Motivational Design (Attention, Relevance, Confidence, and Satisfaction) is used to frame the concept of motivation in this research. The ARCS Model of Motivation (Keller, 2009) is a well-established and validated approach in educational research (Hung et al., 2023; Li & Keller, 2018). Motivation is a complex issue, and literature is rife with multiple definitions and theories. However, the ARCS model is derived from an extensive analysis and integration of motivational theories and research findings (Keller, 2009). The premise of the ARCS model is that learners' motivation is influenced by instructional design; and by teachers focusing on specific aspects of the ARCS model, in instructional design, learners' subsequent motivation and engagement can increase.

This research utilised the ARCS model of Motivation to situate motivation (Hung et al., 2023; Keller, 2009; Li & Keller, 2018; Maiti et al., 2023). Within the ARCS model: 'A' refers to attention strategies that capture and sustain learners' interest, such as using engaging tasks or novel approaches; 'R' the relevance ensures that the learning experience connects to students' prior knowledge, experiences, and future goals; 'C' confidence involves fostering learners' belief in their ability to succeed through scaffolding and achievable challenges; Finally, 'S' satisfaction reinforces motivation by providing opportunities for meaningful application, feedback and a sense of accomplishment. The ARCS framework is used to design educational experiences that enhance engagement and persistence in learning (Keller, 2009).

The ARCS model is rooted in expectancy-value theory (Li & Keller, 2018). In this research, the ARCS model serves a dual purpose: first, to define motivation within the context of research; and second, to structure the questioning for data collection in the focus groups and Likert scale questionnaires. This approach was used to ensure the research had conceptual clarity, aligned the research with a strong theoretical foundation and supported comparability with existing and future research.

Methods

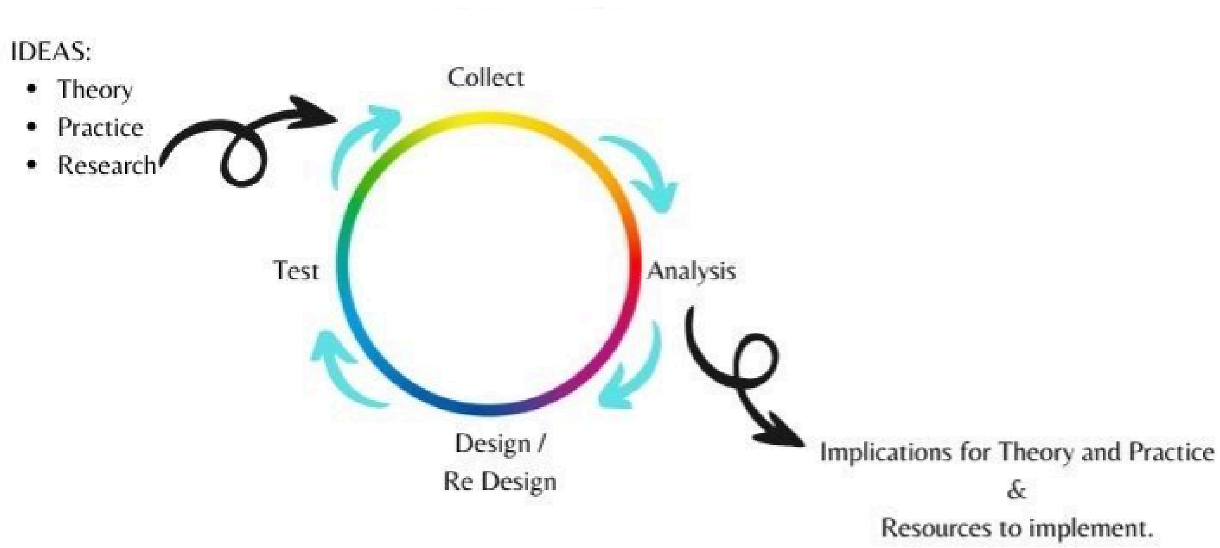
This research employed a qualitative research design supported by multiple data collection methods. A combination of separate focus groups with students and teachers, classroom observations and Likert-scale questionnaires administered to students was used to gather data. These methods were selected to capture perceptions of participants, as well as observable behaviours over the course of the research.

The Reduced Instructional Materials Motivation Survey (RIMMS), a reduced version of the Instructional Materials Motivation Survey (IMMS) (Keller, 2009, p. 289), was utilised as a guide to frame questions for the focus groups and Likert scale questions. The IMMS and RIMMS were both designed specifically for the ARCS model and provided a key framework for the questioning to ensure questions related to the well-established ARCS framing of motivation (Keller, 2009).

Below the iterative process for this project is identified first in Figure 2 as an overview of the process that the research followed. Figure 2 shows the continuous cycle of data collection, analysis, design (an intervention) and then collection. This process is continuous, however for the purpose of this research there needs to be a beginning and end point as shown in Figure 1.

Figure 1

Research Start Point, Phases Cycles and End Point of the DBR Iterative Cycle

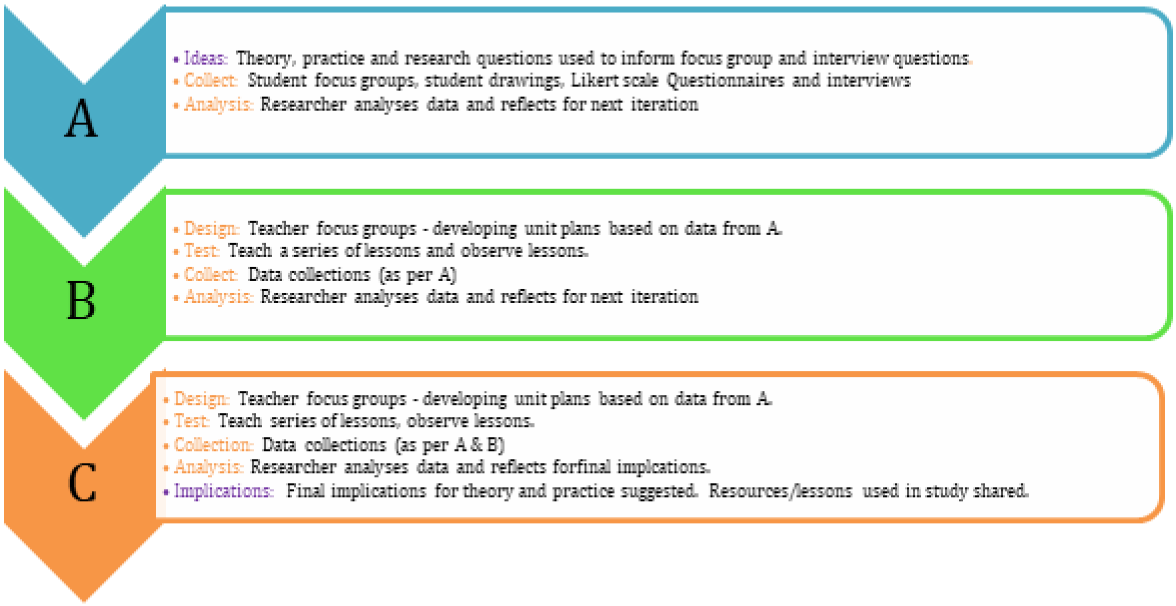


Note: Adapted from Fraefel, 2014 . DBR's continuative cycle of collect, analysis, design/re-design and test with entry (start) and exit (finish) points.

Each of the three specific phases of research (A, B and C) is unpacked in Figure 3. Each phase of the research includes collect, analyse, design and test) and these are expanded below in Figure 2.

Figure 2

Phase A, B and C of this Proposed Research DBR Cycle



Data Analysis

The selected methodology made it possible to gather anecdotal evidence, including opinions, beliefs and informal knowledge. This research's systematic, ongoing, and reflective cycle of data review supported this process. Braun and Clarke's (2024) six phases of thematic analysis, employed in the data analysis, are listed below.

1. Familiarising yourself with the dataset
2. Coding
3. Generating initial themes
4. Developing and reviewing themes
5. Refining, defining and naming themes
6. Writing up (Braun & Clarke, 2024, p. 7191).

Analysing the data starts with familiarisation. After that, patterns and recurrent themes are found and coded (Braun & Clarke, 2024; Cohen et al., 2011). These themes are actively constructed by the researcher through ongoing, interpretive engagement with the data (Morriss, 2024). Instead of having a single, sizable data collection point, data collection is continuous in DBR. As a result, new themes are identified as the research progresses and in situ (Braun & Clarke, 2024; Cohen et al., 2011).

Findings

This paper reports on the main theme identified in the initial analysis. Several sub-themes relating to the theme of teachers' pedagogical choices emerged as especially interesting. Two are of particular interest in addressing the sub-question: What pedagogies best enhance girls' motivation in Computational Thinking (CT)? These are: i) Situating Computational Thinking in Authenticity Technology education and ii) Collaboration. These are presented and discussed in the following sections as they offer insight into effective pedagogical strategies that girls identified help foster motivation in their CT learning experiences.

Situating Computational Thinking in Authentic Technology Education

The data suggests that situating CT in authentic Technology Education contexts was important in the girls' motivation. When students were designing digital solutions for an end-user, students identified this as a key motivator for them within their CT tasks. The students identified that having an end-user to design for, an audience beyond their teachers, allowed them to see the purpose and value of their learning and they took greater ownership of their learning process.

> *Student M: I felt like I worked harder when you do it for a buddy because you feel like you have to get it done and then they don't feel sad. But if you do it for yourself, you can just take your time and don't really do it properly because you don't really need to get it done by any time.*
>
> *Student P: For Scratch you had to do it for your buddy, and you had the responsibility to get it done in time too and make it good quality.*
>
> *Student T: It made you want to keep doing it (CT) because they're expecting good from you. You don't want to disappoint [them].*

Additionally, through designing for an end-user students enjoyed the process of designing within constraints, as it allowed them to maintain creativity whilst finding a solution to interpret and meet the end-user's brief.

Student T: If you ever become a game designer, you need to know how to make them move and think. But buddies as well, you need to have ideas from the public if you want to make a game.

Student H: The fact that it came from someone else's brain, it's quite cool. Because we couldn't think of what we wanted to do. It was more like we had to do what they [their buddy) wanted to do, so it's a little bit easier. Cause they'd say I want the beach background, and I want the dog, and I want it to go into the water and swim. It was good having someone to design something for. And then we can just program it to do what they wanted it to do.

Furthermore, students felt designing for an end-user gave them an increased sense of social connection and collaboration.

Student K: Well, I like working with friends and [I] like talking to my buddy (end-user) about what they like and stuff.

Student P: I like making the game for them on Scratch and [I] like talking to them. What do they like? And making a plan.

This finding highlights the powerful role that authentic technology practice, including engagement with end-users, plays in enhancing girls' motivation in CT learning environments. The collaborative impact identified above was also found to be a key driver in their motivation and is unpacked as a second sub-theme below.

Collaboration

The next sub-theme explored in this findings section focuses on the importance of collaboration in female students' motivation. Students highlighted how working with and alongside peers was a driver in their motivation.

Collaboration fosters a sense of community and shared responsibility, making learning more interactive and enjoyable. Collaborative practice is also identified in STEM education as an important aspect (Master et al., 2017). Within this research, the students worked on their own individual projects, however, they sat in pairs or groups and supported one another. The following quotes highlight the students' preferences for support and collaboration in the classroom.

Student T: There was quite a lot of help too... if we didn't know something, then we wouldn't just sit there for hours, looking at it, what do we do? There's a lot of help around the class.

Student M: If you're stuck on something. Your friends can always help you get through. They might say "you can do this, you can do this" and it motivates you to get it done.

Student T: We could ask another group next to you and if you don't really know what you're supposed to be doing, if you didn't listen quite well, it helps.

Here students identify that they enjoyed the shared experience of learning alongside their peers and teachers, as the teachers also identified they were not experts in CT:

Researcher: So, you liked that there was help?

Student M: Everyone was really new, even 'the teacher' was new.

Student A: It was all the same ...We're in the same place (on Scratch) learning new things.

Student C: I have support from peers as well.

The girls also highlighted that they liked to be a support person for their peers as well as asking for help from others, fostering a sense of reciprocity in the collaboration:

Student T: I like how people were asking me for help.

Student C: You could maybe listen to another group and maybe they could help you and you could help them.

These comments emphasise the importance of mutual peer support and collaboration in creating an effective and motivating classroom environment for females. The students valued the opportunity to collaborate, share knowledge and help each other, which not only aids in solving problems but also fosters a sense of community. This highlights that learning for girls should not be a solitary pursuit but a reciprocal collaboration.

Discussion

The data analysis conducted in this research has identified findings into participants' perspectives of the implemented interventions and the impact on participants motivation, as represented in the constructed themes. This first key finding emphasised the importance of integrating CT tasks within authentic Technology practice. This included designing for end-users, such as younger 'buddies,' which fostered a sense of purpose and ownership among the students. This approach enabled learners to view their work as meaningful, inspiring greater commitment and creativity. For instance, students highlighted the motivational aspect of designing for others, expressing a desire to meet the expectations of their end-user. This responsibility spurred commitment to their tasks, as indicated by Student M, who felt a strong drive to complete work efficiently and effectively to ensure their end-user's needs were met and they were not disappointed. This finding is echoed in Snape and Fox-Turnbull (2013), Turnbull (2002), Hennessy and Murphy (1999) and ACER's (2023) work, albeit with an emphasis on Technology Education rather than specifically girl's motivation in CT.

Additionally, the interaction with end-users created opportunities for social connection and collaboration, deepening students' engagement with CT concepts. The relational aspect of the design process was particularly significant, as students enjoyed exchanging ideas and crafting solutions tailored to the preferences of their end-users. In addition to end-user interaction, peer and teacher collaboration was also found to be important. In the review of literature, no existing literature was found that currently identifies this aspect in relation to CT.

Collaboration emerged as another sub-theme, underscoring its importance in fostering a reciprocal, supportive and interactive learning environment. The research identified that students felt motivated when shared problem-solving was encouraged. Peer support not only helped students overcome challenges but also cultivated a sense of community and shared responsibility. Such an approach aligns with Master et al's (2017) STEM-focused research, highlighting the importance of cooperative environments and studies documenting the benefits of collaboration (Osman et al., 2011; Pudjiarti et al., 2023). In this research, however, collaboration was optional, making it the students' choice to engage with their peers.

Students appreciated the availability of help from peers and teachers, which appeared to alleviate frustration and motivated them to persist in their tasks, aligning with Masters et al's. (2017) research in STEM and Pudjiarti et al's., (2023) research in DTE. Collaborative interactions were also identified as reciprocal, with students not only seeking assistance but also contributing to their peers' learning experiences, creating reciprocity in support, which aligns with the concept of ako (Bishop & Berryman, 2009). This reciprocity, whilst working on their own projects (rather than a combined project), does not appear to be explicitly identified in relation to girls' motivation in CT.

Moreover, the non-hierarchical learning atmosphere, where students and teachers learned alongside each other, further motivated the students. This shared learning experience fostered an inclusive environment where students identified that they felt comfortable experimenting, asking questions and contributing to a sense of ako (Bishop & Berryman, 2009).

Conclusion

This research offers insights into how motivation among New Zealand primary school girls in CT can be fostered through thoughtful pedagogical design. By applying a DBR methodology and using Keller's ARCS model as a framework, the study highlights the role that teacher decisions, particularly around authenticity and collaboration, play in shaping CT experiences.

The findings have several key implications for classroom practice. Teachers should consider integrating authentic, end-user-focused design tasks that connect with learners' interests and real-world contexts. Purposeful collaboration, where learners are not only working together but also contributing meaningfully to one another's thinking, can further enhance motivation.

Further work is now needed to dig deeper into the data collected in this study and expand on the identified aspects of motivation, authenticity and collaboration. These insights contribute to ongoing efforts to bridge gender gaps in Computer Science and Computational Thinking by ensuring that learning environments actively support and motivate girls at the primary level, before critical subject selection decisions are made in high school.

Acknowledgements

I would like to acknowledge TENZ for their support through a postgraduate scholarship. This funding enabled the release of participating teachers from their classrooms, allowing them to actively engage in and contribute to the mahi of this project. Their involvement was essential to the research and deeply valued.

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