The Relationships between Efficacy Beliefs (Self, Teacher, and Collective) and the Planning and Teaching of Computational Thinking.

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Abstract

Computational thinking is recognised as a vital skill to adequately prepare students for future jobs in contemporary society. Students need to develop advanced computational skills, and teachers need the knowledge and skills to integrate CT into their classroom instruction. This multiple case study aimed to understand the relationships between self, teacher, and collective efficacy beliefs and how primary/ elementary level school leaders and teachers plan and teach computational thinking (CT). Drawing upon Bandura's self-efficacy theory, the research identifies how various contextual and domain-specific factors shape self, teacher, and collective efficacy beliefs. Self-efficacy beliefs refer to an individual's confidence in their own ability to successfully execute the actions required to achieve specific goals or handle particular situations. Teacher efficacy beliefs are a specific application of the broader concept of self-efficacy in the context of teaching. Teacher efficacy beliefs refer to a teacher's confidence in their ability to foster student learning, manage classrooms, and overcome challenges related to teaching. Collective efficacy is the shared belief among a group of people in their combined ability to achieve goals or address challenges and extends the concept of self-efficacy from the individual to the group level.

In particular, a focus of the study was how the sources of efficacy judgements were either supported or undermined by various factors, contributing to self, teacher, and collective efficacy of the participants. This research is important because there is less research focused on the assessment of all four sources of self-efficacy, and limited research on how teachers describe teaching experiences that impact their efficacy beliefs.

From two New Zealand based cases, and one case in the United States (US), findings confirm the multifaceted nature of efficacy beliefs, and highlights the significance of factors such as

professional development (PD), resource availability, time constraints, collaboration, and leadership support on teachers and school leaders' efficacy judgements. Enactive mastery experiences were the most commonly described source of efficacy judgement in relation to these factors.

This research offers valuable insights into the complex interplay of factors shaping efficacy beliefs in CT education, thereby informing strategies for increasing teacher support, refining professional development practices, and creating effective educational policies for CT integration in schools/school districts.

Chapter One: Introduction

Technology has increasingly permeated every aspect of life (Coffin & MacIntyre, 1999; Hepp et al., 2004; Ketelhut et al., 2020; Madsen et al., 2018). In modern society, everyone can benefit from understanding how, when and where digital technologies can assist in solving our problems, or at the very least how to communicate with others who can help us with computer-supported solutions (Barr et al., 2011; Kukul & Karatas, 2019). This technological evolution raises the need for individuals to understand how the digital world works and what opportunities and risks it brings (Hepp et al., 2004; Nouri et al., 2019).

In 2017, the technology learning area of the New Zealand curriculum underwent major consultation and review (Fox-Turnbull, 2018; Ministry of Education, 2017). A draft version was released in 2018 with the view that by 2020 all schools would implement the new curriculum requirements. Specifically, these requirements were introduced via two new strands, namely computational thinking (CT) and designing and developing digital outcomes, with their main goal being for students in years 1-10 to develop foundational digital skills and capabilities (Ministry of Education, 2017) before any specialisation occurs in years 11-13 (Kellow, 2018). CT equips students to articulate problems and devise solutions so, if needed, a computer can solve them. Although often thought of when using a device, CT does not always involve machinery; it can be performed on a simpler scale and without a digital device (Wing, 2017). The New Zealand curriculum envisages that as student's progress through the CT strand to year 10, they will increasingly develop more complex algorithmic thinking skills and an awareness of the principles that underpin computer science in general (Te Kete Ipurangi, 2019). The designing and developing digital outcomes strand focuses on students' understanding and skills development related to designing and producing quality, fit-for-purpose digital outcomes. Students learn about the technologies people need to locate, analyse, and present digital information effectively and efficiently keeping the end-user in mind (Te Kete Ipurangi, 2019).

The main justification behind these additions to the curriculum is the belief that all students need digital technology capabilities to fully participate in modern society and these skills are integral to a range of occupations where people are creators of digital artefacts (Brown et al., 2014; Falkner et al., 2014; White, 2015). Additionally, the introduction of the new strands are to encourage students to develop skills with technology to overcome the workforce shortage in the technology sector and benefit the economy (Bell & Roberts, 2016; Bocconi et al., 2016; Fox-Turnbull, 2018; Gander et al., 2013). With computational thinking becoming more recognised as an important skill to adequately prepare students for future jobs in modern society, teachers need the knowledge and skills to integrate CT into their classroom instruction.

Furthermore, researching self, teacher, and collective efficacy beliefs in education is important because these beliefs significantly impact teaching effectiveness, student outcomes, and overall school climate. Teachers with high self-efficacy are more likely to engage in innovative teaching practices, persist through challenges, and create positive learning environments, which may lead to increased student achievement and motivation. Conversely, low teacher efficacy can result in increased stress, and reduced student performance (Bandura, 1997; Hattie, 2016). Therefore, it is likely that efficacy beliefs influence how teachers and school leaders plan and teach CT.

Considering the lack of research investigating the relatively recent adoption of CT in primary schools in New Zealand, and elementary schools in the US, this study adopts a multiple case study design to explore the relationship between teachers and school leaders' efficacy beliefs and the planning and teaching of CT. Understanding and addressing efficacy beliefs can inform professional development programs, improve classroom management, and develop a more supportive school culture, ultimately contributing to better educational outcomes and a more effective learning experience for students. Overall, this study aims to contribute to the broader goal of enhancing students' preparation for future jobs and their understanding of how to problem-solve by improving the integration of CT skills in education.

1.1 Research Aims of the Study

In this research, the focus is on understanding how efficacy beliefs relate to the planning and teaching of CT concepts, so strategies can be developed and utilised (Askar & Davenport, 2009; Mannila et al., 2018) as supportive frameworks to encourage positive uptake of CT planning and teaching in schools in New Zealand, and in the United States (from here on, the US). The research seeks to provide valuable insights that can benefit various stakeholders: educators, who can use this understanding to enhance professional development efforts and refine instructional strategies for integrating CT into primary/elementary classroom practices; researchers, who may use the findings to fill the existing research gap on CT education in specific educational contexts; and policy makers, who can use the findings to inform decisions on curriculum development and teacher training initiatives aimed at improving CT skills among teachers.

This study intends to explore the relationships between efficacy beliefs (self, teacher and collective) and the planning and teaching of CT in New Zealand primary schools, and US elementary schools. Self-efficacy theory provides a theoretical framework to examine how beliefs about one's capabilities influence behaviours and outcomes in the specific context of CT integration in educational settings. Efficacy beliefs influence individuals' choices, efforts, and perseverance in various tasks (Bandura, 1997). In the context of integrating CT into education, teachers' and school leaders' beliefs about their ability to plan and teach CT effectively can influence their willingness to adopt new instructional strategies and their persistence in overcoming challenges (Tschannen-Moran, et al., 1998; Hoy & Spero, 2005). Furthermore, teachers' efficacy beliefs for teaching CT can also influence student outcomes. Higher teacher efficacy is associated with greater student engagement, motivation, and ultimately, better learning outcomes (Rich et al., 2020; Rich et al., 2017). In addition, collective efficacy refers to a group's shared belief in their collective capability to achieve specific goals or outcomes (Goddard et al., 2004; Tschannen-Moran, & Barr, 2004; Zhou, 2019). In educational settings, particularly when introducing new concepts like CT, collective efficacy beliefs among teachers and school leaders are important. When educators collectively believe in their ability to effectively integrate CT into curriculum and classroom instruction, they are more likely to collaborate, share resources, and support each other in overcoming challenges (Loughland, & Nguyen, 2020).

From 2020, all New Zealand schools were required to implement the CT from years 1-10 (student ages 5-15). In the US, there is variation across states as to whether CT is compulsory or not. In particular, the US state where Case Study Three was situated, does not currently have a compulsory state plan for K-12 computer science (which includes CT), however, the state adopted the K-12 Computer Science Standards (Department of Education, 2019) in 2019 as a framework for teachers to implement if they so choose (Yadav et al., 2022). The justification behind including a US-based case is that educational practices and beliefs about teaching and learning, including CT, differ between countries due to contextual influences. Comparing New Zealand and the US can reveal how contextual factors may influence beliefs about self, teacher, and collective efficacy, and how these beliefs shape the planning and teaching of CT. Additionally, each country's educational policies and curriculum frameworks affect how CT is integrated into primary/elementary education. Analysing these frameworks can offer insights into how different contexts support or undermine teachers' sources of efficacy judgements when implementing CT.

Two schools in New Zealand, and one school district in Michigan, US provided the context for this study. Within the New Zealand schools, the teachers completed 100 hours of government funded professional development. The teachers from the school district in the US completed both asynchronous online coursework, and an in-person professional development course over their summer break in 2022, amounting to 20-30 hours.

1.2 The Rationale for the Study

A gap has been identified where more work is needed in developing theoretical and practical understanding of how best to design and implement CT teaching and learning to achieve the desired outcomes at primary and elementary level (Grover & Pea, 2013). There is far less information on digital technology learning areas, including relevant pedagogy and assessment practices within conventional primary/elementary classroom settings than at secondary and tertiary levels (Bell et al., 2014; Falkner et al., 2014; Mannila et al., 2018). Alongside this, self, and teacher efficacy are important concepts to measure due to evidence of how it affects learner success (Moore & Esselman, 1994; Thoonen et al., 2011). Specifically, research has shown that teachers' beliefs in their own efficacy influence their instructional practices, classroom management strategies, and the level of support they provide to students. Teachers with high efficacy are more likely to persist in their efforts to help students succeed, employ effective teaching strategies, and create a positive learning environment conducive to student engagement and achievement (Bandura, 1997; Tschannen-Moran, & Woolfolk Hoy, 2001). In addition, teacher efficacy impacts the quality of instruction delivered, with teachers who believe in their ability to make a difference in student learning outcomes more likely to use diverse instructional methods, provide timely feedback, and adjust their teaching approaches to meet students' needs (Gibson & Dembo, 1984; Ashton & Webb, 1986). This enhances teaching effectiveness and may increase the likelihood of positive learning outcomes for students.

Even though self, and teacher efficacy beliefs associated with CT are likely to greatly influence the development of CT teaching practices, the relationship between these concepts remains under-researched (Ertmer et al., 2012; Kukul & Karatas, 2019; Mannila et al., 2018). With CT beginning to be taught in New Zealand, and US schools, it is important to understand the current situation, through measurement procedures and tools to understand how teachers are incorporating CT skills in their teaching and learning practices (Kukul & Karatas, 2019). Understanding teacher efficacy, especially for CT planning and teaching, is important as CT skills become integrated into education in New Zealand and the US. Teacher beliefs strongly influence whether content is adopted and taught (Bandura, 1997), impacting professional development engagement and in class student support (Tschannen-Moran & Woolfolk Hoy, 2001). Research has connected teacher efficacy to improved student outcomes (Ashton & Webb, 1986), and therefore highlights the need to increase educators' efficacy in CT instruction.

In addition, reliable measurement tools are needed to assess teacher efficacy (Hoy & Woolfolk Hoy, 2003), guiding evidence-based decisions in educational policy and curriculum development. Strengthening teacher efficacy in CT will help to prepare students for future digital challenges (Mannila et al., 2018).

In sum, this research aims to contribute to a deeper understanding of the complex interplay of factors that influence efficacy beliefs when planning and teaching CT, providing valuable insights for improving teacher support, professional development practices, and educational policies related to CT integration in schools.

1.3 Researcher Positionality

In conducting research, it is neither possible nor desirable to separate what you (as the researcher) believe, value, your past experiences, and who you are as a person (Bogdan & Biklen, 2007). Because there is no separation between the two, it is important to include my position as the researcher, as this has influenced data collection, analysis, and the interpretation of findings throughout the study.

I began my career teaching biology and general science at two secondary schools in the North Island of New Zealand, and while teaching, I decided to undertake a master's in education degree with an endorsement in digital education. I was motivated to complete this degree via distance, over three years, because I witnessed both teachers and students becoming less confident about utilising digital technology in their classrooms. In addition, I wanted to upskill on the changes to the technology learning area as I intended to provide professional development to teachers. Once my master's degree was completed, I moved into a facilitation role for a professional development provider. This experience contributed to my understanding of CT in the New Zealand curriculum and provided me with a raft of opportunities to speak to and educate primary and secondary teachers on how to understand, teach, and integrate CT into their classrooms. While in this role, I learnt more about how CT could be implemented within schools which led me to enrol in a PhD. I wanted to understand how CT was being implemented in other educational contexts. I had learnt that the US was doing interesting work in this area, so I applied for, and was granted a Fulbright General Graduate Award to complete research in the US as a visiting researcher at Michigan State University in 2022. During my time in the US, I worked with leaders in the field of CT, engaged with state-wide curriculum standards which differed slightly to those in New Zealand, and worked with a variety of teachers. After several years of working with teachers in New Zealand and the US, and after collecting and analysing data as part of my doctoral thesis, I recognised there are many factors at play in relation to their efficacy beliefs and how they plan and teach CT.

1.4 Thesis Overview

The thesis is organised into eight chapters. Chapter one provides the aim and rationale for the study and provides a background for the research. Chapter two reviews literature on CT and efficacy theory (self, teacher, and collective) to provide information and support the aims of the study. Chapter three discusses the case study methodology underpinning the study and identifies the methods used to collect and analyse data. Chapter four, five and six present the findings for Case study one (CS1), Case study two (CS2), and Case study three (CS3). Chapter seven focuses on the cross-case analysis and discussion of the three cases, supported by relevant literature. Chapter eight is the final chapter and presents the conclusion and implications for this study and provides recommendations for future research.

Chapter Two: Literature Review and Theoretical Framing

This review considers relevant literature on the history of computing in schools, before moving onto the history of digital technologies in the New Zealand curriculum, and the definition of CT, followed by an exploration of the technology learning areas with a focus on CT. Furthermore, the state of CT curricula within an American educational context is compared and contrasted. There is also a brief explanation of what is happening with CT in worldwide education. The review informs the current study and helps identify the research gap. The chapter then introduces the social cognitive theory, of which self-efficacy theory is the key framework for this study, outlining both self and teacher efficacy as well as collective efficacy. The literature review also describes key studies which have used self-efficacy theory as a framework, in mathematics, science, and more specifically, CT. The purpose is to outline the theoretical framing of this research, which focuses on understanding the relationships between efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT.

2.1 A History of Computing in Education

The need for bringing computing principles into education has been around for decades. In 1960, computer science professor Alan Perlis argued that students need to understand computers and general tools for problem-solving rather than as a specific tool to solve a particular problem (Katz, 1960). Similarly, MIT professor Peter Elias stated that humans should be taught to understand algorithms, not necessarily involving a computer, arguing that it is a matter of being able to discuss and solve the interesting problems being discovered (Greenberger, 1962). Naur also argued that young students should learn datalogy (Danish translation of computer science) as part of generalised education. He invented the term datalogy to clarify that computer science encompasses all types of data and data processes - moving the central focus away from computers (Naur, 1966). Naur posited that all of us learn languages and mathematics at school, without becoming linguists or mathematicians in adulthood. In the same way, educators must bring computer science into schooling to prepare students for life in the era of computers, just as reading and writing are viewed as necessities for life in a printed world. Naur viewed datalogy as a cross-curricular problem-solving skill and argued that while it may take many years to implement the changes necessary within the education system, key stakeholders would eventually value the need for such a subject (Naur, 1966).

Specifically, Naur (1966) viewed programming as a way to influence students' thinking to see problems and possible solutions based on a tool's perspective, and what the tool is capable of, and he argued that there is a need for a deep understanding of programming before developing formal programming skills. In contrast, as computing progressed, Malmberg (1970) stated that the most interesting part of the problem-solving process was designing and expressing algorithms, as opposed to actual programming. Malmberg also stressed the importance of the design and expression of algorithms in a way that a machine could understand. Similarly, Knuth (1974) described computer science concepts as mental tools that can be used to support a deeper understanding of core content learning within other curriculum areas. Knuth argued that expressing something as an algorithm and understanding and manipulating algorithms prepares a person for more than the formal act of programming.

With regards to the history of computing in New Zealand in particular, it was one of the first English-speaking countries to formally introduce computer science into the high school education system as part of the National Certificate of Educational Achievement (NCEA) achievement standards in 2011 (Bell & Roberts, 2016). However, computer science (CS) as a stand-alone discipline has had an ambiguous start in the New Zealand education system and, until recently, had rarely been taught in schools (Bell et al., 2010). At best, short-term courses on programming ran successfully, and at worst, computing education focused on general information and communication skills (typing and using presentation software), which gave some students the impression that computer science must be an extension of more general topics (Bell et al., 2010). Although it is important for students to learn how to use computers effectively, solely focusing on digital skills may come at a cost for those wanting to learn computing as a discipline. For example, Bell et al. (2010) highlighted that computer science is often mistaken as covering three different areas: (1) using computers as a tool for teaching (e-learning), (2) using computers as a tool for general purpose applications (sometimes called ICT), and (3) computing as a discipline (including programming and computer science). Bell et al. (2010) argued that school leaders and teachers may confuse these three areas causing the discipline of computer science to become misconstrued.

More recently, researchers have called for digital literacies to be embedded within the school curriculum to ensure the development of skills that 21st century learners will need, particularly understanding how to use, create, and solve problems with technology (Bell et al., 2014; Falkner et al., 2014). More specifically, for CT principles to be included in primary school curricula (Armoni, 2016; Qualls & Sherrell, 2010; Webb et al., 2017) so that students can develop these skills over time and clarify any misunderstandings early on. Bell (2014) claims that the introduction of computer science content to lower levels of schooling (years 1-10) has proven valuable, subsequently making it easier for students to confront the more difficult curriculum content in NCEA qualification years. Bell argued that when CT is introduced earlier, students are more likely to enjoy and explore computer science as a subject instead of focusing solely on assessment. This is in line with Lu and Fletcher (2009) who stated:

> Just as proficiency in basic language arts helps us to effectively communicate and proficiency in basic math helps us to

> successfully quantitate, proficiency in CT helps us systematically
> and efficiently process information and tasks (p. 23).

In addition, according to Caeli and Yadav (2020) it is vital for young people to understand how digital technologies work, regardless of the plethora of intuitive interfaces. These researchers stated that understanding how data is collected and used by companies to deliver and manipulate our online experiences is more important than ever, particularly from a young age: *"we must teach kids to learn to think computationally in creative and open-ended ways and not just to follow closed-ended instructions"* (Caeli & Yadav, 2020, p. 33).

2.2 What is Computational Thinking (CT)?

The addition of CT to the existing technology learning area in the New Zealand curriculum and understanding CT in the US context is the focus of this study. For students to be successful in a world where digital skills are essential, CT can provide a structure to support educators to prepare students to develop computational literacies (Kafai & Proctor, 2022; Shute et al., 2017). CT has gained popularity as the name for the conceptual and practiced elements of computer science in education (Bocconi et al. 2016; Denning, 2017; Wing, 2008). Papert (1980) first introduced CT from a constructionist perspective, emphasising that children develop CT skills by creating and interpreting computational artifacts. More recently, Wing states that CT is about, *"the thought process involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent"* (Wing, 2017, p. 8).

The CT community has attempted to define what constitutes CT and although the community is yet to agree on a single definition, the general consensus is that CT involves computing concepts (abstraction and algorithms) alongside computing practices (decomposition and debugging) (Grover & Pea, 2013; Shute et al. 2017; Yadav et al., 2016). Denning (2017) describes CT as *"habits of mind developed from designing programs, software packages, and computations performed by machines"* (p. 33). Most authors seem to agree that CT involves higher-order thinking processes enabling learners to express problems and formulate solutions in such a way that a computer can solve them (Denning, 2017; Wing, 2017; Yadav et al. 2016), but CT does not always involve technology (Armoni, 2016; Bell & Roberts, 2016). Rather, it represents key computer science principles which can be applied to many different tasks across curriculum areas. For example, upon a review of the literature, Duncan et al. (2017) considered the definition of CT as a separate entity from computer science and computing. This was based on their view of CT as *a "form of problem-solving that is widely applicable and is not unique to computing subjects"* (p.2). In the US, according to the Computer Science Teachers Association (CSTA) and the International Society for Technology in Education (ISTE), CT allows students the opportunity to utilise computing to develop critical thinking and problem-solving skills with this mindset encouraging students to create, design and develop technology or tools to perhaps advance a field of interest. When CT is applied to high-level thinking skills such as problem-solving and critical thinking, opportunities for innovation are likely to increase (Kukul & Karatas, 2019).

Previous research has also indicated that a CT definition can be used as a map for solving the issues around how to teach CT to students (Ismail et al., 2022). The authors believe that a framework identifying CT elements may assist teachers in recognising and incorporating CT in their curriculum as well as help students understand CT. CT is increasingly valued in education, however because there is an inconsistent definition for CT, it may cause confusion among educators and how it can be put into practice. With the argument that a clear outline of what constitutes CT may assist teachers in their planning and teaching of CT, the CT definition used in this study is from Yadav et al. (2016) who defined CT as breaking down complicated problems into more manageable sub-problems (decomposition), using a sequence of steps to solve those problems (algorithmic thinking), reviewing how the solution can be transferred to similar problems (abstraction), and finding and fixing errors (debugging). This definition was perceived as the best fit for the context of this study as it was most relatable and accessible for primary/elementary teachers. Furthermore, this CT definition aligned with the Progress Outcomes from the New Zealand Curriculum (New Zealand Curriculum, 2020) and the Michigan Standards (Department of Education, 2019). For example, in addition to decomposition, algorithmic thinking, and debugging, Progress Outcome 1 in the New Zealand Curriculum requires students to break down (decomposition) simple tasks into step-by-step instructions (algorithmic thinking). This process requires them to filter out unnecessary details, focusing only on the essential steps needed for a task, an early form of abstraction. Students also identify errors (debugging) in step-by-step instructions, which involves recognising patterns in mistakes (e.g., repeated steps, missing instructions). In Progress Outcome 2, students need to follow and debug simple algorithms. To do this, students also need to recognise patterns in algorithms, helping them create structured programs with outputs and sequencing. In Progress Outcome 3, as students work with algorithms (digital and non-digital) they start recognising generalisable steps that apply across different problems. By predicting program behaviour, they engage in higher-level thinking, abstracting key elements of how a program functions.

The Michigan CS standards aligned with the CT definition used as they require students to complete standards 1A-AP-08 ‘Model daily processes by creating and following algorithms’, 1A-AP-11 ‘Decompose (break down) the steps needed to solve a problem’, 1A-AP-14 ‘Debug (identify and fix) errors in an algorithm’, and 1B-AP-08 ‘Compare and refine multiple algorithms’ using abstraction and pattern recognition.

2.2.1 Current state of CT in the New Zealand Curriculum

The primary reason for the inclusion of CT in the technology learning area in the New Zealand Curriculum (NZC) was the view that all learners need to develop the confidence and ability to not only use digital technologies, but to design and create digital systems using CT skills (New Zealand Ministry of Education, 2018). Advocates have argued that CT can be used to connect computing and a variety of curriculum areas (Wing, 2006; Ketelhut et al., 2020; Rich et al., 2020) and CT allows for inquiry-based approaches to computer science, because it offers students the opportunity to recognise problems and test an array of solutions (Goode et al., 2012). Furthermore, there is the understanding that learning with digital technologies is more than merely understanding how to use devices and includes students thinking critically and developing digital artefacts and technology in ethically acceptable ways (Bell & Roberts, 2016; Starkey, 2016). Almost 20 years ago, Wing (2006) argued that technological advances in computing facilitated new problem-solving strategies and the ability to test new solutions in virtual and real worlds. These advances would drive the need for educated people who can engage with the power of computer-supported problem-solving across a wide range of disciplines (Barr & Stephenson, 2011). Importantly, CT does not always solely equate to programming but rather, it represents key computer science principles which can be applied to many different tasks (Yadav et al. 2017), particularly those with an overarching theme in digital education.

The other reason for CT's introduction into the technology learning area in New Zealand is related to socio-economic development. Fostering a deeper understanding of computer science is essential for 21st century learners to develop skills and knowledge as creators of software, therefore assisting economic activity and independence (Bell & Roberts, 2016). Technology is the number two export sector in New Zealand, and it is argued that in-demand digitally skilled people will better position New Zealand in the global market (Fox-Turnbull, 2018). Nevertheless, there are continuing industry concerns that businesses are forced to look overseas to fill job vacancies, due to the struggle in finding New Zealand graduates with the right skills (Gander et al., 2013). The lack of qualified personnel is a concern for New Zealand's technology industry and is something the Ministry of Education aimed to address with the introduction of CT into the technology learning area (Ministry of Education, 2017).

2.2.2 Current State of CT in the United States Education System

In the US, the number of students who major in computer science lags far behind those in practically perceived disciplines such as business and education (Lu & Fletcher, 2009) even though it is predicted that job opportunities in computing will increase 13% in ten years (Bureau of Labor Statistics, 2018a, 2018b). To encourage more students into the field of computer science, educators need to raise awareness of the subject at an earlier stage and widen the perception away from computer science being solely programming (Brown et al., 2014; Denning & McGettrick, 2005). In acknowledgement, the National Education Technology Plan (NETP) was developed as the flagship educational policy document for the US, designed to articulate a vision of equity and active use of technology for learning (Office of Educational Technology, 2017). The NETP aimed to broaden digital technologies across the entire education system to improve student learning and increase the adoption of effective practice with technology (Thomas, 2016). In addition, in 2016, Barack Obama initiated the 'Computer Science for All' policy aimed to educate students as technological developers and citizens of the technological world they live in (Smith, 2016).

With regards to schools, there have also been educational reforms to include CT for K-12 students (Gretter & Yadav, 2016) including the Next Generation Science Standards (NGSS) which includes using CT tools to model complex systems with simulations in a science classroom environment (Yadav et al. 2017). The idea is for K-12 students to not only learn about key CT practices but also understand other curriculum content through those practices (Dwyer et al., 2013). For example, Bell, (2016) argues that teaching and learning computer science concepts crosses over to a number of mathematics concepts. Similarly, Rich et al. (2019) explored how in mathematics, students can use problem-solving approaches performed through evaluating and analysing computational artifacts (Rich et al., 2019). According to the NGSS Lead States (2013) document, implementing these standards requires elementary teachers to actively engage students in CT in their classrooms. Furthermore, various state governments have increasingly adopted policies that require learning CT (Rich & Hodges, 2017) with seven states already using K-12 CS standards before 2017 and by 2019, 31 states had adopted CS standards (Code.org, 2019). State policy change has been supported by a national CT framework which covers five concepts: (a) computing systems, (b) networks and the internet, (c) data and analysis, (d) algorithms and programming, and (e) impacts of computing (K–12 Computer Science Framework, 2016). In 2017, the computer science teachers' association (CSTA) and the international society for technology in education (ISTE) rewrote their CT standards to demonstrate how CT should be integrated across curriculum areas, so students become computational learners, collaborators, and designers (ISTE, 2017).

Although compulsory in New Zealand, but not compulsory in the US state that is the context for Case Study three, the previously described situations from both New Zealand and the US indicate the importance of trained teachers with sufficient knowledge and skills for teaching CT (Webb et al., 2017). This key factor will be explored further throughout the thesis.

2.2.3 CT Worldwide

There has been rapid growth in the advancement of CT in educational contexts internationally with arguments that the concepts and skills involved with CT are vital for success in an increasingly digital world (Weintrop et al., 2021). This growth has resulted in policy changes where technology and engineering practices are now required to be taught at schools from the first years of schooling in some countries. For example, in 2014, England included computing as a core competency from kindergarten (Rich et al., 2017). In Finland, all teachers must have computing integrated across the curriculum areas from the students' first year of school (Opetushallitus, 2014). Programming and CT as cross-curricular elements from the first year of primary education also became compulsory in Finland in 2016 (Toikkanen & Leinonen, 2016). In Singapore, in 2017, the Ministry of Education integrated STEM education into the Applied Learning Program where students can apply knowledge and skills in STEM subjects to real world problems. The content of this program includes scientific inquiry, reasoning and problem solving, design and computational thinking as well as data analysis (Ng, 2017). Similarly, in 2020, the Indonesian Ministry of Education and Culture stated that it was their priority to add CT as a core competence of the national curriculum (Budiansyah, 2020).

Many countries have expressed concerns about the difficulty involved in ensuring teachers have the technical, content, and pedagogical knowledge, skills, and capabilities for teaching CS, and that the knowledge is also continually upgraded (Gal-Ezer et al., 1995). In Finland, teachers are expected to learn how to integrate CT into their own classroom practice as their own professional learning and development (PD). This is an important aspect of their PD, entitled teacher participation and ownership (Toikkanen & Leinonen, 2016). In France, according to Hubwieser et al. (2015), CS teacher training ranges from 0-120 hours per year, but increases to 240 hours depending on the district and the teachers who have completed these courses are eligible for tenure. Similarly, in Israel, teachers must complete in-service courses which are provided by a dedicated centre that funds and is responsible for these workshops. These workshops are designed to ensure teachers are coping with ongoing curriculum updates and to also build a strong community of practice (Hubwieser et al., 2015). In Korea, teachers graduate from teachers' college and then complete an evaluation for teacher qualification and are only provided with a teaching certificate for each school level that they teach. If Korean teachers want to teach CS, they must complete the educational course in the department of computer education, and then obtain a certification for the 'informatics-computer' subject (Hubwieser et al., 2015).

The review of the international research literature suggests that there has also been a sharp rise in resources available that assist teaching of computing and engineering. For example, Code.org has become a hub for teaching young students to code via visual language, text-based language, and block-based languages for many English-speaking teachers worldwide. While policy change and resources for teaching computing have increased, teacher training is severely lacking in many places around the globe, such as the US (Gal-Ezer & Stephenson, 2010; Sentance & Csizmadia, 2016; Yadav et al., 2019), the United Kingdom (Sentance et al., 2014), India (Garcia et al., 2023), and New Zealand (Duncan et al., 2017; Irons & Hartnett, 2020).

With governments requiring teachers to integrate computing from a very early age, many teachers need support to learn how to do this (Rich et al., 2017). Many international studies portray primary and elementary school teachers as subject generalists, and although they have had years of training in content and pedagogy of the core curriculum, the teachers generally lack training specifically in computing (Ng, 2017; Rich et al., 2019; Stanton et al., 2017; Yadav et al., 2019). This raises concerns about how teachers will gain the necessary computing (and CT) knowledge to confidently include it into their own teaching practice (Nordén et al., 2017; Toikkanen & Leinonen, 2016). Nordén et al. (2017) continue by stating how new digital methods and tools arise at such a fast rate that teachers need the confidence to explore what is relevant to them and how to plan learning activities that include digital tools, and the thought processes involved in teaching with these tools. Overall, it is evident that across the world, education systems need teachers who are independent and confident with lifelong learning skills to foster learning within the area of computing.

2.3 How do Educators Teach CT?

If New Zealand and US educators are to implement CT skills successfully, they first need to understand how learners develop these skills, why these skills are important, and how they may use computers for gathering data, breaking down, and analysing patterns (Bell & Roberts, 2016; Fox-Turnbull, 2018). According to Yadav et al. (2020) there is a need to educate teachers about fundamental CT ideas and how they relate to their classrooms on a daily basis. Yadav et al. (2020) argue that there is less attention in bringing CT into elementary classrooms, compared to the current research at a high school level.

In recent years, there has been a significant movement towards integrating practices of CT into other curriculum domains, so CT is not isolated or under the computer science umbrella (Basu et al., 2014; Bortz et al., 2019; Dong et al., 2019; Hambrusch et al., 2009; Pollock et al., 2019). The pragmatic reasons behind CT integration into the curriculum include a lack of time and space in an already overcrowded curriculum, the importance of CT in many different areas, and the value of providing students with CT exposure who may be unable to take a dedicated class on computing (Gautam et al., 2020). Other studies (Barr & Stephenson, 2011; Israel et al., 2015; Yadav et al., 2018) also found that primary and elementary teachers are under pressure to teach the current curriculum and cannot devote hours per week to CT. Although this may be the case, the teachers from these studies were willing to implement CT when CT supported another subject area.

There is a natural alignment of CT integration across curriculum areas in mathematics and science subject areas (Common Core State Standards Initiative [CCSSI], 2021; Next Generation Science Standards [NGSS], 2013). By using CT, students can develop computational models to make predictions, and this may parallel the science and engineering practice of developing and using models (Rich et al., 2019). Similarly, in research conducted by Duncan et al. (2017), where professional development was provided to a group of New Zealand primary school teachers, the authors identified ways teachers were able to integrate CT into their teaching practice, engage students with key concepts, as well as analyse teacher confidence when delivering the learning material. Duncan et al. (2017) used a series of adapted, themed, contextualised, and age-appropriate activities designed using tools from CS unplugged, bee bots (small robots), and Scratch (online block-based programming). The topics covered the use of algorithms, programming, and data representation as computing fundamentals: including devices storage and process information (data representation and algorithms) and the mechanisms which connect an algorithm to data. In their pilot study, Duncan et al. (2017) found that 'typical' primary school teachers were capable of delivering CT material to engage students when they receive adequate support. The authors also found that the teacher participants reflected that they were able to deliver a large amount of curriculum topics through CT material, enabling new topics to take less time, yet still able to maintain their own place (as opposed to full integration). The teachers in the study commented on their students exercising social skills and teamwork in surprising ways.

In addition, CT also has an informal presence through computing camps, library CT programs and a variety of educational toys that can engage young people in CT (Weintrop et al., 2021), although these out of school programs are not the focus of this study.

2.3.1 Using Non-Digital Tools to Teach CT

Non-digital tools (without the use of technology) for CT learning do not involve a technological device and consist of CT taught using pen and paper, physical items, or the students themselves. These approaches provide students the opportunity to experience CT in contexts via non-digital activities before they experience them on a digital device, which has been shown to be beneficial

(Hermans & Aivaloglou, 2017). Research that compares non-digital and digital activities with young students (Brackmann et al., 2017; Hermans & Aivaloglou, 2017), identified that non-digital approaches are considered easier to engage young students in the ideas of decomposition, pattern recognition and algorithmic thinking (Huang & Looi, 2020). Although non-digital approaches are viewed as useful initially, when people need to solve large-scale problems, there are often large amounts of complex data that computers need to process to solve the problem efficiently (Caeli & Yadav, 2020). However, there is a need to teach students non-digital CT activities first, to develop a deeper understanding of data processing, and to teach students that humans have an important role in the problem-solving process, before moving into digital computational activities. Students are required to learn how to decompose problems, design the necessary steps to solve the problem, and then represent solutions as code that can be used by a computer – with the argument that it is humans that solve problems, and computers are the tools at our disposal (Caeli & Yadav, 2020).

With regards to teachers, there are many initiatives and resources available to support teaching of non-digital activities (CS unplugged, 2019; Code.org, 2020), yet if CT concepts are taught as a stand-alone subject, it may not transfer across to real-life situations and help in authentic problem-solving (Caeli & Yadav, 2020). Yadav et al. (2020) stated that using a non-digital approach lessens the cognitive load and elementary teachers can embed CT into their curriculum; perhaps by integrating it into core subject areas, such as mathematics and science. The authors continue by arguing that once teachers get more comfortable with CT concepts and recognise the links in their lessons, teachers can then scaffold learning from non-digital activities to CT activities supported by devices. Furthermore, research by Rich et al. (2019) focused on introducing CT in a non-digital context within existing mathematics and science lessons. The authors found that teachers could a) use CT to guide their own planning; b) use CT to structure lessons; and c) present CT to students as problem-solving strategies. For example, one teacher who used CT to guide their planning chose not to discuss the ideas of 'abstraction' with the students - her planning reflected her own understanding of abstraction, but this was not explicitly discussed with the students. Two other teachers, however, chose a CT concept and structured their lessons around it - in this case, debugging. This was apparent in lesson planning, but also when engaging students in using debugging strategies. Finally, CT ideas were made clear to students by three teachers who introduced particular tasks and then discussed the CT ideas as strategies that could be used to solve the problems. There is much previous work indicating that non-digital activities have proven beneficial for non-specialist teachers for CT integration (Huang & Looi, 2020; Yadav et al., 2017), and are therefore often included as part of teacher professional learning and development for CT integration (Araujo et al., 2019).

2.3.2 Using Digital Tools to Teach CT

Most modern learning environments have a range of resources such as laptops, tablets, and projectors (Hepp et al., 2004; Turel, 2014), yet even with an increase in technology access (An & Reigeluth, 2012) there is still a limited amount of effective technology integration in classrooms due to a variety of factors (Ertmer, 1999; Ertmer & Ottenbreit-Leftwich, 2010; Higgins et al., 2012; Howard & Mozejko, 2015; Perrotta, 2013).

Research indicates that teachers understand CT as logical thinking and problem-solving by using computers/technology in the classroom, or programming (Sands et al., 2018). Programming involves a list of rules instructing a computer how to function, and learners need to understand how to complete these instructions in a sequence, repeat that sequence and debug whether the sequence was completed correctly (Freeman et al., 2017). Programming is by far the most popular way to develop CT skills, and software such as Scratch can reinforce CT concepts and is often used to demonstrate how abstract concepts can come to life (Wing, 2008). Scratch involves block-based programming where the code is dragged and dropped into a stage area where the blocks click into place to form instructions for the character (or sprite). If taught consistently, programming can help students engage in CT elements, however, recent research has warned that in block-based programming environments, students can create programs without fully understanding the programming concepts themselves (Grover et al., 2019; Salac & Franklin, 2020) or engaging in CT with purpose (Grover, 2021). Grover et al. (2015) caution that overemphasising programming and syntax can hinder deeper engagement in CT and result in shallow programming experiences. However, when CT is ingrained into the curriculum in well-designed tasks, learners understand programming concepts more deeply, have the ability to create better examples, and can transfer that understanding to new programming and problem-solving contexts (Grover, 2021; Hutchins et al., 2020). Therefore, educators must ensure that children not only learn how to use the program, but also build skills toward an understanding of complex CT concepts.

While authors (Yadav et al., 2020) argue that relating CT to programming is accurate, it limits the power of CT ideas and how they may be integrated across other discipline areas. While there have been efforts to support teachers' understanding and capabilities when teaching CT through programming (Hsu et al., 2018) using tools such as Scratch (Rich et al., 2022), teachers still have difficulties designing activities and delivering lessons with the use of programming tools (Bers et al., 2013; Manches & Plowman, 2017). Evidence indicates a teacher's belief in their own ability to work effectively and successfully with computer technology is a significant factor in patterns of computer use in the classroom (Albion, 1999; Mannila et al., 2018; Paraskeva et al., 2008; Ropp, 1999). Although a professional may use a digital application without training, the ways of thinking about computing must be explicitly taught to students and teachers (Guzdial, 2008).

There are arguments towards both non-digital and digital activities to integrate CT yet, developing CT concepts which are embedded across curriculum areas with and without a technological context, will benefit a larger variety of students (Yadav et al., 2017). As educators gain a better understanding about CT, a key question then is how to best incorporate CT into mainstream teaching and learning practices – when and how should students learn these skills?

2.3.3 Professional Development and CT

Professional development (PD) provides a way for teachers to understand CT themselves, as well as learn how to teach CT. In a study by Yadav et al. (2018), the authors found that PD can increase teacher understanding of CT and how it may be helpful in their classes.

There have been studies on the short-term effects of CT PD for pre-service, and in-service teachers. Recent research on how to integrate CT into teaching practice for pre-service teachers as modules in teacher education programs (Araujo et al., 2019; Jaipal-Jamani, & Angeli, 2016; Kaya et al., 2020) and in-service teachers (Macann, & Carvalho, 2021; Rich et al., 2019) has involved working with teachers on short professional development courses to embed CT. With regards to preservice teachers, in the pilot study by Ng (2017) a small group of pre-service teachers completed three workshops. Results suggested that the pre-service teachers were able to master programming skills and design programming activities for young children after receiving training. In addition, findings from a study by Yadav et al. (2017) showed that after PD, most preservice teachers defined CT as a problem-solving approach and closely related it with logical thinking. In terms of integration, the study found that preservice teachers would use technology to embed their conception of CT in the classroom and most preservice teachers could embed CT by teaching their students how to use step-by-step instructions to solve problems. The preservice teachers in this study could also see the link between CT and mathematics because of the problem-solving aspects of mathematics. The researchers (Yadav et al., 2017) argued that these results indicate that even when preservice teachers understand CT, it is important there are enough opportunities and time to contextualise CT into their teaching grade level and the subject area. Although various studies show promising results, simply supporting teachers' understanding of CT may not be enough to support their understanding of how to integrate CT across curriculum areas in meaningful ways (Yadav et al., 2017).

Research focused on in-service teachers and their understanding and integration of CT following professional development has also been undertaken. In a study by Rich et al. (2019) the authors explored how elementary teachers integrated CT into mathematics and science lessons focusing on initial ideas about CT and how CT may already be happening in their practice. These ideas and lessons were then leveraged throughout professional learning and development for other teachers. Similarly, in research by Blum and Cortina (2007), the authors found that after weekend workshops introducing teachers to CT and how it relates to other curriculum areas, the PD influenced the teachers' perceptions of CT. The results showed that instead of solely focusing on computer science as programming, the teachers changed their ideas and saw how CT can be applicable across curriculum areas and relevant to students' daily lives. In the Rich et al. (2019) study most teachers made specific connections (17 connections) between CT and the Standards for Mathematical Practice (CCSSI, 2010), yet very few teachers made specific connections (3 connections) between CT and the Science and Engineering Practices (NGSS, 2013). The connection between algorithmic thinking and mathematics was explicit for more than half of the teachers involved in the because of the word algorithm referring to traditional methods for performing arithmetic. The authors suggest the fewer connections made between science and CT may reflect teachers' lower content knowledge of science than for mathematics, and that this result may be due to the heavy focus on mathematics and literacy for elementary schools. The Rich et al. (2019) findings suggest that bringing CT into elementary mathematics teaching is a tenable approach for exposing students to CT, although more research is still needed to find effective ways to support teachers in the classroom to make these connections. In terms of science teaching and CT, the results from this study show that curriculum materials and professional learning and development are necessary to increase both teachers' CT knowledge and their understanding of how to integrate CT into science.

Another research study followed teachers' PD for an extended period (Duncan & Bell, 2015) at a New Zealand intermediate school (students aged 11-13 years). One teacher was asked to teach a 'computing' class once per week with each class in the school, and twice weekly for one extension class. Classes had on average 20 lessons focusing on CS and programming with over 600 students taught, and 559 participating in the end of year survey assessing the study. Although the teacher had no prior experience teaching programming or CT, they were very motivated to learn and teach the concepts. The authors worked alongside the teacher providing learning resources for programming, activities, and challenges as well as one-on-one professional development (for planning and to assist with knowledge gaps) every three weeks. At the end of the study, the teacher described being more confident teaching binary and Scratch - mainly due to teaching the same topic to three different classes, they became familiar with the activity and began having their own insights into how to teach it to the students. The teacher noted that teaching the CT and programming lessons would not have been possible without the additional support from the researchers as it was all new learning. The teacher also stated that not only was learning the content demanding, but learning to present the content to students required a lot of work. Regardless of this, the teacher reported the experience as a positive one. Similarly, Yadav et al. (2018) explored how elementary teachers' understanding progressed over a year following professional development opportunities. The results of this study showed that teachers were initially more familiar with CT than expected, however their understanding of CT became more nuanced, moving from saying that CT involved logical thinking, to CT involving conditional logic.

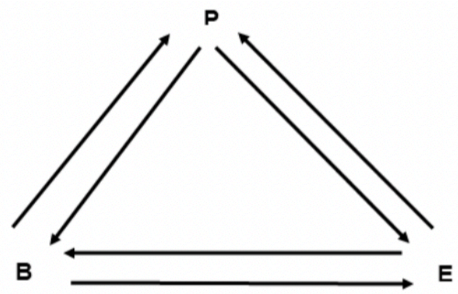
While current efforts in training teachers in CT integration have mainly involved in-service teachers and short-term professional learning and development opportunities (Yadav et al., 2017), the authors argue that this is a temporary solution, and it is important to train future teachers early in their programs and long-term for them to not only understand CT, but also how to embed it into their curriculum content.

After having defined CT, introduced previous research in how CT has been taught in New Zealand, and the US, I now turn to the supportive framework used for the basis of this study; social cognitive theory, and in particular, self-efficacy theory. The social cognitive theory is valuable as a framework in education because it helps highlight the complex interactions and processes involved in teaching and learning and may support practical guidance for teachers to enhance their effectiveness and students' learning experiences (Bandura, 1997). Within social cognitive theory is self-efficacy theory where a teachers' self-efficacy beliefs shape their instructional practices, classroom management, and support for students with high efficacy leading to persistent effort to use effective teaching strategies, and create engaging learning environments (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2001). Self-efficacy theory offers a powerful lens to understand educational outcomes addressing motivation, performance, learning strategies, and the instructional practices of teachers (Bandura, 1997), and in this case, when teachers plan and teach CT.

2.4 Social Cognitive Theory

This study is framed by Bandura's social cognitive theory. Social cognitive theory explains the processes behind how people learn and the enactment of agency over their behaviour (Bandura, 1997) proposing a multifaceted causal structure that addresses both competency development and the regulation of action (Bandura, 1986). Social cognitive theory explains human learning and behaviour through what Bandura (1978) calls triadic reciprocal causation (see Figure 1) where personal, behavioural, and environmental factors interact.

Figure 1
Triadic Reciprocal Causation (Bandura, 1978, p. 22)



P – personal, B – behavioural, E – environmental.

Reciprocal causation is a multi-directional model suggesting a person's agency is influenced by environmental factors, behaviour, and internal personal factors such as cognitive, affective, and biological events (Henson, 2001). Bandura (1997) explains that although the causal factors are reciprocal, all three have various strength during different situations and take time to exert their influence. According to Henson (2001), reciprocity determines what we believe about ourselves, affecting the choices we make and actions we take. We are products of the continuous interplay between external and internal factors and our current and past behaviour (Henson, 2001). Social cognitive theory (Bandura, 1997) focuses on the dynamic interaction between individuals, their behaviours, and their environments which is necessary to form an understanding about the interactions between teachers and students when planning and teaching CT. A key aspect to social cognitive theory is that of agency where to be agentic is to make things occur intentionally through one's actions, and where agentic individuals are involved in their own self- development and adapt with changing situations (Bandura, 2001). In the context of teaching CT, the triadic reciprocal causation model highlights how a teacher's self-efficacy (personal factor) influences their instructional methods (behavioural factor), which in turn impacts students' learning outcomes and classroom environment (environmental factor). For example, a teacher with high self-efficacy in CT is more likely to implement effective teaching strategies, engage students, and create a positive learning environment. This, in turn, enhances students' abilities and confidence in CT, and may reinforce the teacher's own efficacy contributing to a cyclical process of growth and improvement in both teaching and learning. This means that social cognitive theory can provide insights into how behaviours are learned, maintained, and modified over time, particularly helpful when understanding how teachers plan and teach CT.

2.4.1 Self-Efficacy Theory

Self-efficacy theory is a component of social cognitive theory, and underscores how teachers' beliefs in their ability to impact student learning influence their instructional methods, classroom management, and student support. For example, teachers with high self-efficacy demonstrate persistent efforts to employ effective teaching strategies and foster engaging learning environments (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2001). Because of the importance of efficacy beliefs on student achievement (Donohoo et al., 2018; Mannila et al., 2018; Moore & Esselman, 1994; Thoonen et al., 2011), self, teacher, and collective efficacy are the focus for the current research, which involves exploring the relationships between efficacy beliefs and the planning and teaching of CT in New Zealand primary schools and US elementary schools.

Self-efficacy is one of three efficacy constructs within this study. Self-efficacy beliefs are context and domain specific (Bandura, 1986) functioning as determinants for human motivation and action (Bandura, 2001) and can influence our effort, choices made, our persistence when facing adverse situations and the level of stress experienced in response to adversity (Usher & Pajares, 2008). Yeşilyurt et al. (2016) also described self-efficacy as the regulation of cognitive, social, emotional, and behavioural skills necessary to perform a task within a situation, and efficacy is a future-oriented judgement of perceptions of competence, rather than actual competence, and consequently, people often overestimate or underestimate their ability, with these estimations impacting future courses of action (Bandura, 1997). Therefore, understanding teachers' self-efficacy in relation to CT may support strategies for how to assist teachers in their approach when learning and teaching CT. In addition, self-efficacy beliefs can influence teachers' persistence in overcoming challenges related to teaching CT which is important as CT is new to many teachers. The stronger the self-efficacy beliefs, the higher the goals people set and the firmer a commitment to those goals (Locke et al., 1984; Mannila et al., 2018; Pajares, 1992; Taylor et al., 1984).

According to self-efficacy theory, behavioural change operates through the alteration of the person's expectations of personal mastery and success (Bandura, 1977). Bandura (2001) stated that efficacy beliefs are the foundation of human agency: "Unless people believe they can produce desired results and forestall detrimental ones by their actions, they have little incentive to act or to persevere in the face of difficulties" (p.10). Furthermore, self-efficacy is task- and domain-specific, meaning a person's beliefs in their ability to succeed vary depending on the task (Bandura, 1977; Pajares, 1996). This means people have varying levels of confidence across different skills; for instance, a person may believe they are more proficient in mathematics but less so in writing (Zimmerman, 2000). Self-efficacy beliefs are also influenced by past experiences, feedback received, perceived task difficulty, and available resources (Bandura, 1997). In addition, Bandura described that it is partly due to efficacy beliefs that people decide what challenges to tackle, how much effort to expend, how long to persevere when failures occur, and whether those failures are motivating or demoralising. Those with high self-efficacy visualise success which provides a positive guide for performance, whereas those who judge themselves with lower self-efficacy are more inclined to envisage a failure scenario; undermining performance because they are focused on what can go wrong (Bandura, 1989). Those with higher self-efficacy beliefs typically means they increase effort, persistence, and resilience when tackling challenges within specific domains, while lower self-efficacy may lead to avoidance or reduced effort (Bandura, 1986; Lent et al., 1994). Recognising this specificity is important in education to develop interventions that may support a person's efficacy and performance in specific areas of learning, in this case, planning and teaching CT.

Self-efficacy beliefs are derived from four main types of experiences. The most influential is enactive mastery (successfully practicing a skill or behaviour), followed by vicarious experiences (where one observes behaviour from a valued role model), then verbal persuasion (encouragement from others who are of value) (Bandura, 1997) and physiological states such as stress and excitement (Albion, 1999) which is also referred to as affective states (Goddard et al., 2004). All four sources are critical components that determine individual efficacy, as well as in the development of collective efficacy beliefs (Goddard et al., 2004).

Mastery experiences refer to situations where action is taken to create a desired outcome contributing to the person's expectation that their performance will be successful again in the future (Goddard et al., 2004). Furthermore, the context in which the mastery experience occurs is of the most importance (Bandura, 1977). Conversely, an unsuccessful mastery experience (failure) affects self-efficacy more powerfully than when a situation is successful and occurs if a person thinks their course of action has been a failure, lowering self-efficacy beliefs and increasing the expectation that their future actions will continue to fail. Sherer et al. (1982) point out that successful or failed experiences from the past may influence expectations that an individual carries with them into new situations, affecting their self-efficacy beliefs about their level of mastery. Furthermore, in research by Gale et al. (2021), where 179 middle, and high school teachers were surveyed and ten were interviewed, the authors found that enactive mastery experiences were the most cited source of self-efficacy. For example, 67% of the teachers described successful enactive mastery experiences increasing their self-efficacy, and 50% described unsuccessful enactive mastery experiences decreasing their self-efficacy.

Vicarious experiences also influence self-efficacy beliefs and are the most significant source of information after mastery experiences. When skills are modelled by someone else whom the observer identifies as competent and as having similar ability levels as themselves, the self-efficacy beliefs of the observer are likely enhanced (Bandura, 1997). Alternatively, if the model performs the action poorly, a decrease of efficacy beliefs may result for the observer (Goddard et al., 2004).

In addition, Goddard et al. (2004) explain that verbal persuasion experienced as both encouragement and performance feedback also influence self-efficacy beliefs. Although verbal persuasion may not create a long-term change in efficacy beliefs, it can counter setbacks which may interrupt persistence due to self-doubt. How persuasion affects self-efficacy beliefs depends on the perceived credibility and expertise of the persuader, alongside their level of trustworthiness (Bandura, 1986).

The final source of information acting upon self-efficacy beliefs is that of physiological states. A person's belief in their abilities affects the level of stress or positive anticipation they experience in difficult situations, as well as their level of motivation (Bandura, 1993). According to D'Mello and Graesser, (2011) negative emotions (for example, confusion and frustration) are often associated with failure, mistakes, and revising plans. On the contrary, positive emotions (for example, excitement and joy) are felt when an activity is completed, challenges overcome, and discoveries are made. Goddard et al. (2004) proposed that positive and negative emotions add to an individual's perceived capability or incompetence during a situation. Moderate levels of stress can energise highly efficacious people (Bandura, 1997) with those in control of negative experiences not imagining worsening scenarios (Bandura, 1993). Conversely, individuals who believe they cannot control negative experiences face high anxiety and inefficacious thinking, leading to distress that impairs their level of functioning (Bandura, 1993). The physiological states associated with low self-efficacy may also affect motivation and engagement with content often interfering with learning (Lehman et al., 2008).

Previous research has shown that enactive mastery and vicarious experiences are consistently found to be the most powerful sources of efficacy, whereas verbal persuasion and physiological states have been less researched (de Carvalho et al., 2023). In addition, Morris et al. (2017) stated that there is less research outside of enactive mastery experiences, and few studies have focused on the assessment of all four sources of self-efficacy. With teachers specifically, there is limited research on how teachers describe teaching experiences affecting their self-efficacy beliefs (Gale et al., 2021). In addition, self-efficacy beliefs are formed by integrating multiple sources at the same time, and the teacher participants in research by Gale et al. (2021) described experiences that reflected several sources of efficacy. For example, of 179 middle, and high school teachers surveyed, 27% discussed multiple sources when explaining how particular experiences had increased their self-efficacy, and 16% commented on multiple sources with regards to experiences that decreased their self-efficacy beliefs. However, there is evidence that in combination with enactive mastery experiences, verbal persuasion can have a powerful effect on self-efficacy, with participants quoting both sources of efficacy judgements during their experiences, leading to an increase in self-efficacy (Gale et al., 2021). Moreover, Morris and

Usher, (2011) found that enactive mastery experiences and verbal persuasion are intertwined: because there are few clear markers of teaching mastery, teachers often perceive they are reaching their teaching goals when confirmed by the verbal persuasion of others.

In the same study, physiological states were also discussed as increasing self-efficacy beliefs, however 17% of teachers described physiological states in particular situations that decreased their self-efficacy (Gale et al., 2021). Thus, it can be presumed that when designing PD, it is important to understand that people tend to avoid situations where they think their skills are exceeded, whereas they will get involved in tasks they think they are capable of handling (de Carvalho et al., 2023). The PD provided by de Carvalho et al. (2023) was broken down into manageable sections to manage cognitive load, and learning occurred in environments of *"encouragement, support, and growth, rather than criticism or judgment"* (p. 11) which minimised negative physiological states.

While self-efficacy theory was most appropriate for this study, other theories were considered; Activity theory, TPACK, and the Arena framework. For example, the activity theory framework focuses on analysing and understanding complex systems of activities within social and cultural contexts, including the dynamics between individuals, tools, communities, and societal structures (Engeström, 1999). Whereas self-efficacy theory focuses on individuals' beliefs in their own capabilities to perform specific tasks and achieve goals (Bandura, 1997) and was best suited for this study which focused on individual teacher and school leader/coach participants.

In addition, Koehler and Mishra (2009) discuss how the TPACK framework functions to develop techniques for describing how technology-related professional knowledge is put into practice. By explicitly describing what type of knowledge teachers need, they are in a stronger position to understand the variance in digital technology integration happening within their classrooms, and schools. It is the layered structure of the TPACK model (alongside Bronfenbrenner's ecological approach) as to why it was not deemed suitable for this research. There are also aspects for CT integration that do not require digital technology, and TPACK concentrates on the technological aspect.

The Arena framework was developed to better understand how digital technologies are employed throughout education systems. This knowledge assists in deciding what changes are needed to better lead and support the use of digital technologies in various learning environments (Davis, 2017). In this framework, Davis has aligned key terms in ecology with the process involved in managing change when educational institutions utilise digital technologies. While the Arena framework supports many parts of this research, the concept of the *ecosphere* is where this framework does not suit this particular study. This is because this research primarily focuses on the relationship between teachers and school leaders' experiences with the planning and teaching CT at school, not the wider ecosystem. The Arena framework describes ecospheres, which in this case, means families, community and the nation, and this was not suitable for this research.

2.4.2 Teacher Efficacy

Teacher efficacy is also a focus of this study. Teacher efficacy is a teacher's belief in their capability to organise and execute courses of action to successfully accomplish a particular teaching task within a specific context (Tschannen-Moran et al., 1998). Teacher efficacy is defined as a teachers' beliefs in their own ability to plan, organise, and carry out lessons and activities required (Skaalvik & Skaalvik, 2010) affecting positive change in learning (Moore & Esselman, 1994; Ross et al., 2001). These beliefs relate to a teacher's sense of competence rather than an objective measure of actual competence (Protheroe, 2008) with strong indicators these beliefs also affect teaching and learning (Mannila et al., 2018; Moore & Esselman, 1994; Thoonen et al., 2011). Furthermore, Pajares (1992) found a positive relationship between personal educational beliefs, how a teacher plans, and their professional practice. Pajares argued that teacher efficacy beliefs are more influential than how an individual organises and defines tasks with these beliefs a strong predictor of teaching behaviour.

Teacher efficacy is task or domain specific: teachers may hold different efficacy beliefs according to the behavioural domain (Bandura, 1997). For example, a person may have varying teacher efficacy beliefs with regards to classroom management, student engagement, their instructional practices, or content areas (Tschannen-Moran & Woolfolk Hoy, 2001). Furthermore, the context is important, because self-efficacy beliefs are context-specific to an individual, who may have high self-efficacy in one area where they have prior experience and accomplishments, and low self-efficacy in a different context which is not previously known to them. Therefore, understanding efficacy for teaching CT is important, as teacher efficacy in other contexts or subject areas may have developed differently, and may not transfer to a CT context (Yadav et al., 2021). In addition, teachers' efficacy beliefs can greatly impact student achievement (Moore & Esselman, 1994; Thoonen et al., 2011) underpinning the important contribution efficacy can have on teachers as they engage with computing and digital technologies curricula (Mannila et al., 2018). Research over more than 40 years shows a positive relationship between teacher efficacy and teaching environment, student motivation and achievement (Nordén et al., 2017) and according to the authors, high teacher efficacy has also shown to contribute to an increase in teacher well-being.

In addition, teachers with a sense of high efficacy are more likely to overcome hurdles and persist with their students and practice (Goddard et al., 2004; Mannila et al., 2018) and are more open to new ideas and willing to experiment with methods offering students new and different learning experiences (Allinder, 1994; Tschannen-Moran & Hoy, 2001). What is more, is that teachers with high levels of efficacy spend more time teaching subject content where their efficacy is higher (Riggs & Enochs, 1990), whereas teachers may avoid teaching content when their efficacy for that topic is lower (Riggs, 1995). Previous research has examined the relationships between teacher efficacy and mathematics achievement among middle school students and found that teacher efficacy beliefs in mathematics teaching are significantly correlated with student achievement outcomes (Gibson & Dembo, 1984; Henson et al., 2001). In addition, prior research has investigated teacher efficacy beliefs and science teaching. Findings have shown similar results to that of mathematics in that high levels of science teacher efficacy were associated with more innovative teaching practices and greater student engagement in science classes (Riggs & Enoch, 1990). In addition, there have been studies focusing on efficacy beliefs and STEM (see section 2.5.4).

With regards to teaching with digital devices, teachers with lower teacher efficacy are less likely to use technology than confident teachers (Holden & Rada, 2011; Vannatta & Fordham, 2004). Furthermore, Tschannen-Moran et al. (1998) suggest a valid measurement of teacher efficacy requires teachers' perceived competence, alongside analysis of teaching-related tasks including resources and constraints within the context. These authors argue for the importance of such a measure, so schools view teacher efficacy as malleable, and specific to context which may assist in understanding how competence beliefs are shaped by different settings, and groups of students. In other words, a teachers' efficacy beliefs in their ability may change from year to year with different students.

There are also supports and barriers impacting teacher efficacy beliefs when integrating technology (and CT) into their classrooms (Ertmer, 1999). Barriers that teachers face when planning and teaching CT may be a lack of computers or internet access, and institutional barriers (e.g., unsupportive school leaders who do not want to implement technology) (Mason & Rich, 2019). Armistead (2016) adds that major barriers also include a lack of professional development opportunities, financial constraints, and pressure from parents. There are also barriers in how teachers' beliefs, established classroom practice, and reluctance to change affect technology integration (Ertmer, 1999). Teachers must understand the content, the technology they are using, and the pedagogy behind the content, technology, and students in order to successfully teach with technology (Mishra & Koehler, 2006). Furthermore, relevant educational experiences designed to increase CT content understanding, alongside experiences of how CT is integrated within their existing practice, are needed for teachers to teach CT successfully (Rich et al., 2019). The current research focuses on a variety of supports and barriers, and these are discussed as part of each case study (see Chapters 4, 5, and 6).

2.4.3 Collective Efficacy

Finally, collective efficacy is also a construct within this study. Bandura (1997) acknowledged that people do not work in isolation, and therefore form beliefs about the collective capability of groups to which they belong. He defined this behaviour as collective efficacy where a shared belief amongst group members to organise and execute a course of action is required to achieve a specified outcome. There is greater creativity and productivity when members possess positive beliefs about their capabilities as a team (Bandura, 1977; Donohoo et al., 2018; Kim & Shin, 2015) and this is an important factor in education. Collective efficacy uses the same sources of information to make efficacy judgements including enactive mastery, vicarious experiences, verbal persuasion and physiological states (Bandura, 1997; Goddard et al., 2004).

According to Klassen et al. (2010), collective efficacy within education typically reflects teachers' beliefs in the attributes of the group. Individual teachers judge the capabilities of the group, and collective efficacy is the perception that their cooperative efforts will affect students positively (Goddard, 2002). Collective efficacy is also an important contributor to a school's culture, and when teachers and school leaders share their sense of high collective efficacy, the culture tends to be characterised by a high expectation for student success (Donohoo et al., 2018). Research has illustrated that the collective efficacy of a school is significantly related to student achievement (Goddard et al., 2004), even after controlling for previous student achievement and socioeconomic status (Bandura, 1993; Klassen et al., 2008). Hattie (2016) argues that collective efficacy is the top factor when determining what influences student achievement. Through his research, Hattie (2016) found collective efficacy three times more predictive of student achievement than socio-economic status and had twice the predictive power of prior achievement of students. In addition, there is a connection between a teacher's perception of whether the school leaders are supportive of technology, and higher teacher perception of beneficial technology use (Perrotta, 2013). The converse is also true, and when collective efficacy is lacking and educators do not follow certain courses of action, it resulted in a belief that the students are unable to achieve positive outcomes (Donohoo et al., 2018).

2.4.4 Previous Research on Self-Efficacy Theory in STEM

Teachers have various efficacy beliefs when planning and teaching across curriculum areas, and CT is no different. Research on specific subject teaching experience, overall teaching experience, and motivation to experiment with teaching, report on a number of factors that may or may not have an impact on teachers' efficacy beliefs. For example, Rich et al. (2017) found that teachers with previous experience in STEM (Science, Technology, Engineering, and Mathematics) had shown higher self-efficacy for computing as well as a higher willingness to teach computing in their classes. The teachers with higher self-efficacy participated actively in PD and often had prior experience in STEM. Not only did those teachers participate in the training, but they also implemented their new knowledge through full classroom lessons and by integrating the activities into core content. The teachers with higher self-efficacy reported that although some activities initially seemed unattainable for their teaching practice; through the training days, implementing the activities, and from previous experience in STEM, they were able to increase their efficacy for teaching computing. The researchers commented that it was likely the combination of training, teacher background in STEM, alongside a willingness to experiment that influenced their reported increases in self-efficacy. However, in contrast, Yadav et al. (2021) found that although academic background was significantly related to self-efficacy when teaching computer science, teachers with a STEM background indicated the lowest level of self-efficacy related to teaching computer science. Further research has indicated that overall teaching experience may not impact efficacy beliefs when integrating CT specifically (Yadav et al., 2021), which may suggest that teachers perceive CT teaching quite differently from their prior experience, and that all teachers believe they are a novice in this context, regardless of overall experience level. Within the same research, the authors also found that there was no difference in self-efficacy beliefs relating to teachers' own level of experience with computer science. Overall, these studies present differing views on the influence of STEM background and teaching experience on teachers' self-efficacy in teaching CT/computer science. While Rich et al. (2017) indicate a positive relationship between high self-efficacy and previous STEM background, Yadav et al. (2021) suggest that a STEM background may not guarantee higher self-efficacy in the context of CT. These contrasting perspectives highlight the complexity of factors influencing teachers' efficacy beliefs in integrating new disciplines like CT into their teaching practices.

2.4.5 Efficacy Scales

Self-efficacy scales are instruments designed to measure self-efficacy, which is the belief in one's ability to succeed in specific situations or accomplish tasks (Bandura, 1997). Self-efficacy scales can be used by teachers tracking their progress, employers, and policy makers to map out the need for development in certain areas (Nordén et al., 2017). It has only been recently that the number of studies on CT have increased, resulting in various self-efficacy measurement tools (Kukul & Karatas, 2019). Self-efficacy scales are made up of several statements (items) that identify a personal position according to different skills and competencies on a particular subject. Participants are asked to identify from the statement what they believe they can do based on their current level of knowledge. Statements often include the words “I can/could do…” rather than “I know how to…” (Nordén et al., 2017). It is important to investigate the type of support necessary to assist teachers and how to empower them to begin teaching CT (Duncan et al., 2017).

To understand whether efforts to prepare teachers to teach CT have been successful Rich et al. (2020) argued that we need measures to assess teachers' CT knowledge, self-efficacy, and value beliefs on the importance of teaching these concepts to young children. The authors state that although there are instruments to assess CT for students (Roman-Gonzalez et al., 2017), and teaching self-efficacy (Tschannen-Moran & Hoy, 2001), at the time of data collection, there was no validated instrument to assess teachers’ beliefs when planning and teaching CT. The most relevant for this study was a survey by Rich et al. (2020) where the researchers developed and validated an instrument to effectively measure teachers’ value, self-efficacy, and teaching beliefs about programming. The author’s justification was to then use this instrument to measure the effectiveness of teacher training to change their beliefs about programming in the classroom.

According to Rich et al. (2020) CT is a difficult construct to measure because there is disagreement amongst experts as to what actually constitutes CT. The authors sought to better understand how to assess primary and elementary teachers’ self-efficacy for understanding and teaching CT and reviewed ten scales that assess programming or computer self-efficacy. For the current study, it seemed logical to review many of the same scales and justify their relevance in answering the research questions.

Investigation into the literature on efficacy scales resulted in incorporation of several scales for the teacher/school leader survey in the current study. The decision behind choosing scales created by others is that they have been tested for reliability and validity. Three scales analysed assessed general computing self-efficacy (Norden et al., 2017; Quade, 2003; Torkzadeh & Koufteros, 1994). Two scales focused specifically on programming self-efficacy (Kukul et al., 2017; Tsai et al., 2019), however the scale created by Tsai et al. (2019) also focused on CT as do the three scales constructed by Bean et al. (2015), Korkmaz et al. (2017), and Weese and Feldhausen, (2017). The review by Rich et al. (2020) found that the existing scales typically measured the CT constructs of decomposition, pattern recognition, abstraction/algorithms, problem-solving and collaboration. The authors discovered that no tool measured all three types of beliefs they were interested in measuring: teachers' value, self-efficacy and teaching efficacy for CT and programming. Therefore, Rich et al. (2020) created their own scale to measure these items, grounding efficacy statements in the language and activity of CT that they had observed alongside CT/programming activities from the literature. The authors formed positive and negative statements teachers could respond to on a 6-point Likert-type scale indicating their level of agreement with that statement.

All previously mentioned scales assessed self-efficacy across a variety of CT practices, however only the scale developed by Bean et al. (2015) assessed teachers' self-efficacy when teaching CT. Although the Bean et al. (2015) scale had many valid items for the current study, it was not chosen because many of the items were specifically focused on programming. Therefore, the scale created by Rich et al. (2020) was chosen for inclusion in the survey for the current study. The justification is because the scale by Rich et al. (2020) has items that assessed teachers' value beliefs, self-efficacy beliefs *as well* as teaching efficacy for CT and programming. These items were seen as more closely related to the current research questions.

There were several collective efficacy scales also reviewed for potential inclusion in the current study. The collective efficacy scales reviewed had items worded to include 'my group' rather than 'I can' to assess the participant's beliefs on how the collective group was perceived to perform (Fuller et al., 2006; Goddard, 2002; Tschannen-Moran & Barr, 2004; Wang & Lin, 2007). The scale created by Tschannen-Moran and Barr (2004) has items which specifically focus on "How much can teachers in your school do to produce meaningful student learning?" and "How much can teachers in your school do to help students master complex content?" The context for the items of this scale were student achievement and behaviour which is not relevant for the current study. The scale by Goddard (2002) focused on group competence (GC) involving teaching methods, skills, training and expertise and task analysis (TA) which is the perceptions of constraints and opportunities inherent to the task at hand. These are valuable constructs, but not in the context of collective efficacy when learning and teaching computational thinking skills. The scale created by Wang and Lin (2007) had very few examples and the article was used as an analysis of how to construct and validate a collective efficacy scale.

For the current study, the scale created by Fuller et al. (2006) was used. This scale assesses many factors: 'Group potency' is used to assess the team's belief in its general effectiveness across various tasks and situations. 'Computer collective efficacy' is used to assess the team's belief in its ability to perform more advanced computer tasks. 'Virtual team efficacy' is used to assess the team's belief in their ability to work together in a technological environment. 'Effort' is assessing the team's perception of their effort toward completing the task, and 'Group outcome perceptions' is used to assess the perception of outcome and team satisfaction. The combination of these factors are most relevant when assessing collective efficacy beliefs of primary/elementary teachers when planning and teaching CT.

2.5 Chapter Summary

This chapter reviewed background research identifying the critical need for everyone to understand how, when, and where digital tools can be leveraged to solve problems effectively, highlighting the growing importance of CT skills. The increased awareness of CT's significance has prompted changes in educational frameworks. As educators and policymakers recognise that digital literacy and problem-solving skills are essential in the modern world, there has been a push to integrate CT into curricula across various educational levels. Consequently, educational policies are evolving to include CT as a foundational skill, reflecting a broader recognition of its importance in preparing students for future challenges and opportunities. For example, the technology learning area of the New Zealand curriculum underwent major consultation and review to add CT into years 1-10 curricula (Fox-Turnbull, 2018; Ministry of Education, 2017). In the US, CT standards have also been introduced and implemented in some states.

As a result, research is needed to understand how teachers understand CT themselves, and how to teach CT to their students. The chapter also introduced the theoretical lens of self-efficacy theory, which supported the exploration of the relationship between teachers and school leaders' self, teacher, and collective efficacy beliefs and how they plan and teach CT.

Understanding teachers' efficacy beliefs when planning and teaching CT is important because it affects their ability to effectively deliver instruction and engage students. Teachers with high efficacy beliefs are more likely to use innovative teaching methods and persist through challenges, which enhances student learning and interest in CT. In contrast, teachers with low efficacy beliefs may struggle with implementing effective planning and teaching strategies, therefore impacting student outcomes negatively. By understanding how to improve teachers' efficacy, we can better support their professional development and ensure that students gain necessary skills for a technology-driven future.

In the following chapter, the research methods and procedures used to address the research questions are outlined. Included within this chapter are the explanation of the research design, data collection techniques, and data analysis strategies. By detailing the methodology, the following chapter aims to ensure the transparency, validity, and reliability of the study.

Chapter Three: Methodology

This study sought to understand the relationships between self, teacher, and collective efficacy beliefs and the planning and teaching of CT in primary/elementary schools. To understand this relationship, the study investigated the perspectives of both primary teachers and school leaders across New Zealand and to further explore such relationships, the study also included insights from elementary teachers and school leaders (coaches) from the US. Educational practices and beliefs about teaching and learning, including CT can vary between countries due to cultural differences. This investigation used a multiple case study methodology and utilised Albert Bandura's self-efficacy theory (described in 2.4.1) as the theoretical framework that guided the research questions, the collection of the data, and interpretation of the data gathered.

This chapter is divided into two parts. The first part outlines the research paradigm, research design, and research questions that guide the study. This includes implications from the paradigm worldview, multiple case study methodology, along with limitations that might arise from using this approach. The contexts for the study are also briefly described.

The second half of the chapter describes the implementation of the methodology including a detailed account of the ethical processes guiding data collection, case selection procedures, and the data generation instruments. The procedures used for coding and analysing the data are also explained. Finally, the mechanisms by which quality was maintained are described.

3.1 Paradigm

Morgan (2007) defined a paradigm as a way of perceiving and experiencing the world around us, and ontological and epistemological views sit within paradigms. The term ontology is described as our understanding of reality, how we view the world, what is real and what is changeable, and where we fit among it, whereas epistemology is the process of how we come to understand the world around us (Bazeley, 2017). Furthermore, Feilzer (2010) described a paradigm as a deeper philosophical position which structures the nature of social phenomena. This study used a constructivist paradigm, which is a philosophy or paradigm used in multiple-case research and is a way to view theory and practice (knowledge) from multiple viewpoints, perspectives, and positions, including quantitative and qualitative standpoints (Johnson et al., 2007).

A constructivist paradigm means that individuals construct their understanding and knowledge of the world through personal experiences and reflection on those experiences (Honebein, 1996). A constructivist approach recognises that there are no universal "truths" or fixed categories for human experience. Instead, knowledge is understood as the outcome of social and personal processes of meaning-making (Pilarska, 2021). In understanding others and conducting research into their attitudes, thoughts, feelings, perceptions, and meanings, it is impossible to directly access another person's mind or measure their inner experiences. However, through a constructivist approach, we can indirectly gain insights into people's sense of reality or their 'lifeworld' (Alvesson & Sköldberg, 2009). A constructivist paradigm proves particularly relevant for this study because the participants' external reality is perceived through their senses, influenced by their previous experiences, and each individual's constructed reality continuously evolves and adapts (Denicolo et al., 2016). This perspective aligns with efficacy theory, which states that individuals' beliefs about their own capabilities are influenced by their interpretations of personal experiences and external feedback (Bandura, 1997). Just as constructivism overviews the subjective nature of reality and continuous adaptation, efficacy theory highlights how these

personal and contextual factors impact judgements about one's efficacy. Thus, understanding how participants construct their realities can provide valuable insights into how their efficacy beliefs are formed and adjusted, ultimately informing the planning and teaching of CT.
By gathering and interpreting data through surveys, interviews, observation and strategy documents, this study delves into the behaviours and actions the teachers take when planning and teaching CT. Given that the current research aims to understand the relationships between teachers' and school leaders' efficacy beliefs and how these impact the planning and teaching of CT, a constructivist paradigm was the philosophical position that guided the chosen research design – multiple case studies underlies the analysis and reporting of the current study.

3.2 Research Design

A case study is defined by Yin (1981) as "an empirical inquiry about a contemporary phenomenon (for example, a 'case') set within its real-world context when the boundaries between phenomenon and context are not clearly evident" (p. 98). Case study research assumes that examining the context and other complicated related conditions is vital to understanding the case and produces a broader range of topics covered, where data are likely from multiple sources of evidence (Yin, 2011). A case study requires extensive data collection to form an understanding of the entity under investigation and is the preferred strategy when open-ended questions are being asked, or when the research focus is on a phenomenon within a real-life context (Burns, 2000). The current research used a multiple-case design which was appropriate due to the same phenomenon existing in various situations (Yin, 1981) and used the main techniques for a case study; surveys, interviews (semi-structured), observation, and document analysis (Burns, 2000).

According to Bromley (1986), a case begins with deriving an in-depth understanding of one or a small number of cases, set in a real-world context. By focusing in-depth, case studies aim to produce a more complex understanding of what is occurring, in turn, resulting in new learning about the behaviour (Yin, 2012). In addition, case studies do not occur as snapshots in time - there is repetition of similar (but not exact) behaviour that happens at different points in time and may be an essential part of understanding the case (Yin, 2012). Context is a third set of conditions outside of the case and is viewed as a strength to case study research because it allows for relevant contextual conditions to be examined (Yin, 2012).

Within case study research, a boundary defines the limits of the study. Boundaries specify what will be included and excluded from the investigation; mainly the phenomenon being investigated, the context in which it is examined, and the time frame of the study. Boundaries help researchers maintain a clear and manageable scope, allowing for in-depth exploration of a particular instance or phenomenon, in this case, the planning and teaching of CT. However, these boundaries also mean that findings are specific to the defined case and may not be easily generalisable beyond it (Stake, 1995; Yin, 2018).

Multiple case design is a qualitative research method used to explore and analyse multiple cases within a single study to gain a deeper understanding of a phenomenon. In the present study, the approach involved examining three cases to identify patterns, similarities, and differences, to provide a deeper and more nuanced view of the planning and teaching of CT. Unlike single case designs, which focus on a single case to generate insights, multiple case design enabled comparisons and more generalised conclusions based on a broader range of data (Yin, 2018). In addition, employing a multiple case research design enhanced the validity and reliability of the findings by allowing for cross-case analysis and triangulation of data (Creswell & Poth, 2017). This approach facilitated the comparison and contrast of different cases, helping to identify consistent patterns and variations, which strengthened the robustness of the conclusions drawn from the study.

Furthermore, multiple case studies offer a collection of situated case activities occurring in relation to the research questions. For this study, descriptive questions aimed to detail the characteristics of each case, while comparative questions focused on identifying similarities and differences between cases (Yin, 2018). Process-oriented questions investigated the mechanisms at work within and across cases, and contextual questions explored how the specific context influences outcomes (Stake, 1995). Outcome-oriented questions examined the effects related to each case, and theoretical questions sought to understand how each case contributes to broader theoretical frameworks (Creswell & Poth, 2017).

In addition, multiple case study research, framed by the constructivist paradigm, highlights understanding the complex, subjective realities of participants within their specific contexts (Creswell, 2013). Constructivism aligns well with multiple case studies as it allows for the deep exploration of participants' perspectives on phenomena like efficacy beliefs when planning and teaching CT. Within each case, quantitative methods, such as surveys, can be used to capture broader patterns and relationships (Plano-Clark & Ivankova, 2016). In each case, qualitative data was also collected to uncover how individuals' beliefs and experiences shape their planning and teaching practices and the integration of CT. Qualitative research within a case focuses on deep exploration of a central phenomenon rather than generalising to a population (Creswell & Guetterman, 2019) and might include descriptive studies, observations and interviews (Newman et al., 1998). By integrating these approaches, multiple case study research provides a comprehensive understanding of how efficacy beliefs influence CT practices, ensuring individual experiences are considered (Bazeley, 2017). Rigorous data analysis is important to ensure that findings are valid and reflective of the complex, constructed realities of the participants (Newman et al., 1998).

A multiple case study research design was deemed suitable for this study, as it can be used for exploring complex, context-dependent research questions. This approach provided detailed insights that help reveal underlying patterns often missed by other research methods (Stake, 2013; Yin, 2012). The objective was to show how various components and constraints interact, including how common and unusual factors are portrayed - all situated in complex interactions within each case (Stake, 2013).

3.3 Research Questions

The focus of this project is to understand the relationships between efficacy beliefs and teachers' and school leaders' experiences associated with the planning and teaching of computational thinking (CT). The research is guided by the following questions:

1. What are the relationships between teachers' efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT?
2. What are the relationships between senior leader's efficacy beliefs (self, and collective) and the planning of CT?
3. What factors support or undermine sources of efficacy judgements when planning and teaching CT?

3.4 Method

Methods in research refer to the strategies or techniques employed to collect data (Crotty, 1998). In this study, a multiple case study approach was used to identify and explore the relationships between teachers' and school leaders' efficacy beliefs when planning and teaching CT.

3.4.1 Case Studies

Two New Zealand schools and one US school district were the contexts for this research investigation. The New Zealand schools were a year one to eight primary school (students aged 5-13) in the North Island and the other was an intermediate school in the South Island (years seven and eight, students aged 11-13). The participants involved in these case studies had all participated in PD specifically on the two new strands of the technology learning area of the New Zealand curriculum (of which CT is included). In addition to the New Zealand schools, one school district in the mid-west of the US was also a case. The teachers and school leaders involved had completed an online PD course on CT as well as two in-person days in their summer break in 2022, which involved learning about CT overall, and how to integrate CT into their current teaching programs.

In defining the boundaries of each case for this study, several criteria were established to ensure a clear focus. Each case involved primary or elementary teachers working with students aged 5 to 13, and the participants were interested in planning and teaching CT. To maintain consistency and relevance across cases, the teachers in each setting had completed PD specifically designed for CT. Data collections remained consistent across each case, and involved surveys, interviews, and classroom observations. This approach aligns with the principles of case study research, which emphasise the importance of clearly delineated contexts and consistent data collection methods to allow for meaningful comparisons and insights (Yin, 2018). By focusing on these common elements—age group, PD participation, and data collection methods—the study effectively defines the boundaries of each case, ensuring that the research findings were both specific to the context of planning and teaching CT and comparable across different settings.

The boundaries also encompassed similar contextual factors, such as variables for the individual schools and the school district (e.g., leadership support, teacher collaboration, resource allocation, and school strategies/policies) (Stake, 1995). In addition, the cases were differentiated by their level of analysis: the individual schools provide a micro-level perspective, while the school district offers a meso-level view (Creswell, 2013). These boundaries ensured a focused and comparative analysis of the planning and teaching practices across different educational settings (Bazeley, 2017).

Selecting two New Zealand schools as cases and a school district in the US as another case provided valuable contrasts and insights into how primary/elementary teachers and school leaders plan and teach CT. The choice to have two single schools as cases allowed for an in-depth examination of their implementation of CT and offered detailed insight into the specific challenges and successes encountered within their individual contexts. While the individual schools offered focused perspectives on CT within their settings, the selection of a school district in the US as another case provided a broader perspective on how CT was adopted across multiple schools within a larger organisational framework. This diversity enriched the analysis by revealing both common patterns and context-specific differences in teacher practices (Yin, 2018). The comparative approach helped to understand how different scales of educational settings influenced CT implementation, offering a comprehensive view of the phenomenon across varying contexts (Creswell & Poth, 2017).

3.4.2 Data Gathering

For this study, quantitative data was gathered via survey, and qualitative data was gathered using semi-structured interviews, classroom observations, and analysis of school/state strategy documents within the context of CT (see Table 1).

Table 1
Research Questions and Data Collection Methods

	Research Questions	Data Collection Methods
1.	What are the relationships between teachers' efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT?	Survey Interview Observation

2.	What are the relationships between senior leader's efficacy beliefs (self, and collective) and the planning of CT?	Survey Interview School Strategy documents
3.	What factors support or undermine sources of efficacy judgements when planning and teaching CT?	Interview Observation School Strategy documents

The aim of collecting several types of data was to strengthen the robustness of the study, using various data sources for data triangulation. These methods allow researchers to investigate events and processes by examining dependencies and relationships between factors, aiming to understand what is happening and how things unfold (Denicolo et al., 2016). Quantitative data, such as survey results or statistical measures, can reveal patterns and relationships that provide a broader context for understanding the phenomena under investigation (Creswell & Creswell, 2017). With regards to qualitative research within a case, according to Creswell and Guetterman (2019), qualitative research is not used to generalise a population, instead it is used to develop a deeper exploration of a central phenomenon. Therefore, the researcher purposefully selected individuals and sites for data collection to best understand the central phenomenon. Through developing a detailed understanding of the participants and/or site, not only does the researcher gain an understanding, but it may also lead to participants learning about the phenomenon more themselves and provides a voice for those people.

Survey. There are strengths and weaknesses when using a survey within research. A strength is that survey research is efficient for collecting data from a wide range of individuals and educational settings: many variables can be measured without a large increase in time or cost (Check & Schutt, 2011). Specifically, a cross-sectional survey involves collecting data at a single point in time, allowing researchers to quickly examine current attitudes, beliefs, opinions, or practices. Cross-sectional surveys can capture how people

think about various issues and their actual behaviours, providing insights that inform decision-makers about programme effectiveness or differences between groups (Creswell & Guetterman, 2019). However, surveys also have weaknesses. Surveys rely on self-reported data, which can be prone to biases such as social desirability or inaccurate responses (Dillman et al., 2014). In addition, the structured nature of surveys may limit the depth of understanding and fail to capture the complexities of respondents' experiences (Groves et al., 2018). Furthermore, poorly designed surveys may lead to ambiguous results and low response rates, potentially impacting the validity and reliability of the findings (Fink, 2017).
For measuring self, teacher, and collective efficacy beliefs within cases, a way of ensuring relevant questions are asked is to use established instruments that have already demonstrated validity and reliability. By employing an already validated survey, researchers can ensure that their measurements are consistent and comparable across different cases, which enhances the reliability of the findings (Yin, 2018). In addition, using validated instruments allows for a more systematic analysis of efficacy beliefs, helping to triangulate qualitative insights with quantitative data (Creswell & Creswell, 2017). The integration of established measurement tools within a multiple case study research design ensures that the research findings are grounded in empirical evidence and that the conclusions drawn about efficacy beliefs are well-supported within the context of the study (Stake, 1995; Plano-Clark & Ivankova, 2016).
It is important to ensure that these survey instruments accurately measure the relevant concepts (Check & Schutt, 2012) and that survey questions are directly related to the research questions. Therefore, a survey was created for the current study using a scale from Rich et al. (2020) for self, and teacher efficacy, and a collective efficacy scale from Fuller et al. (2006). For self, and teacher efficacy, the scales created by Rich et al. (2020) were chosen for inclusion in the survey because the scales had items that assess teachers' self-efficacy beliefs as well as teaching efficacy beliefs for computational thinking and programming. The researcher viewed the items within this

scale as more closely related in addressing the research questions. Prior to sending the survey to voluntary participants, it was piloted by some teacher education faculty, both in New Zealand and the US.

The cross-sectional survey was collected from the participants at one point in time and the survey protocol mostly used multiple choice, close-ended questions to form an understanding about demographics, alongside self, teacher, and collective efficacy scales (Check & Schutt, 2012). Sections of the survey protocol were adapted for practising teachers and for school leaders with school leaders able to state 'not applicable' for the teaching sections. The survey took around 20 minutes to complete.

Interviews. In this research, the interviews were semi-structured with the questions flexibly worded, and the interview protocol contained a mix of more and less structured questions. Interviews were conducted to better understand experiences from both teacher and school leader participants in all cases. An interview is usually a person-to-person discussion where one person (in this case, the researcher) asks questions to elicit information from another person (the participant) (Merriam, 1998). Interviews are a helpful tool when the researcher cannot observe behaviours, feelings or how their participants interpret the world around them, or when there is a particular interest in past events (Merriam, 1998). Interviews can be helpful for 'how' and 'why' explanations alongside insights into the participant's perspective (Yin, 2018).

In semi-structured interviews, specific information is desirable from the participants which is gained during a structured section of the interview. This structure allows the researcher to respond accordingly to whatever situation and form an understanding of the emerging worldview of the participant as well as new ideas on the topic which may arise (Merriam, 1998). Furthermore, semi-structured interviews provide a flexible framework that allows researchers to delve deeply into emerging issues as they arise. Unlike highly structured interviews, semi-structured interviews enable a more fluid conversation that can uncover unexpected insights and nuances (Denicolo et al., 2016).

However, despite their advantages in depth and flexibility, semi-structured interviews are not suitable for large-scale studies due to the time and resources required for conducting and analysing each interview. While this was noted, it was not a factor in this study's data collection as the sample sizes were small. Additionally, semi-structured interviews are susceptible to researcher bias, where the interviewer's preconceptions may influence the direction of the interview or interpretation of responses. Moreover, participants may still filter their answers to conform to social norms or expectations (Denicolo et al., 2016).

Observations. A classroom observation of each teacher participant was conducted to gather data, provide a deeper insight to develop a more comprehensive understanding of the phenomena under study, and increase the validity of the study. Multiple case studies often use a variety of observation and interview methods focusing on a classroom, teacher, or pupil/s. By picking a focus during the observation, the researcher breaks off a piece of the whole so the study is manageable, however, this must be considered. For this study, the focus was the classroom teacher, as school leaders and coaches were not observed. The distortion was perceived as reduced by choosing a naturally existing focus which has a distinct identity of its own (Burns, 2000). Distortion refers to any potential biases or inaccuracies that could affect the study's results (Patton, 2015). By focusing on a naturally existing role (classroom teachers), the study aimed to minimise these distortions.

In addition, the researcher needs to have as close to neutral effect on the behaviour observed as possible, so participants do not respond with behaviour they believe the observer wants to record or behave in ways that deliberately mislead the observer (the Hawthorne effect).

During classroom observation, Merriam (1998) states that assumptions can be made that because the participant has been chosen, they have something to contribute, have had an experience worth discussing and an opinion of interest to the researcher. Therefore, researchers need to assume neutrality toward the participants' knowledge and avoid arguing, debating, or otherwise letting personal views be known (Merriam, 1998). They should be respectful, non-judgmental, and non-threatening.

Observations can add new dimensions for understanding the situation and any problems encountered (Yin, 2018). An opportunity that arises during observation is the ability to perceive reality from someone 'inside' the case. Researchers argue that this is invaluable for creating an accurate portrayal of what is happening (Yin, 2018). Furthermore, observation of people's actions and behaviours in specific circumstances can provide more insightful data than relying solely on their self-reported accounts, which may be filtered or edited consciously or unconsciously (Denicolo et al., 2016).

In addition, observations are often used to triangulate data, and in this research, they were used in conjunction with interviews and document analysis to substantiate findings. Observations involve the researcher observing the behaviour first-hand and using their knowledge to interpret what is observed, rather than relying on second-hand interview accounts (Merriam, 1998). Although an advantage in that respect, there are also challenges during observations. According to Yin (2018), the researcher has less ability to work externally and may have to assume positions (for example, become a supporter of the group) which is contrary to good observation practice. During the case studies, the researcher observed the CT lesson and the teacher and students knew why the researcher was there conducting an observation, however the researcher did not interact with the teacher/students during the observation.

Strategy Documents. The use of school/state strategy documentation as evidence allowed the researcher to corroborate and supplement evidence from other sources. Although a researcher can make inferences from documents, these inferences should be treated as clues for further investigation (Yin, 2018). School strategy documents can provide a formal and detailed account of the school's strategic goals, policies, and planned initiatives, offering valuable insights into the institution's priorities and approaches (Yin, 2018). They serve as a foundational reference for understanding the context and rationale behind various educational practices and decisions, helping researchers interpret how these align with observed outcomes and behaviours. In addition, school/statewide strategy documents can offer a clear picture of the intended objectives of the school's programs, including initiatives related to professional development, curriculum changes, or pedagogical innovations (Creswell & Creswell, 2017). For example, if a school has a documented strategy for integrating CT into the curriculum, examining this document helps assess whether the observed implementation matches the planned approach.

School/statewide strategy documents can also provide a baseline for evaluating the impact of educational interventions and policies. By comparing documented strategies with the actual practices observed in each case study, researchers can identify discrepancies, assess implementation, and understand the supporting or undermining factors affecting the execution of strategies (Stake, 1995). This comparison is essential for evaluating the success of the initiatives and providing recommendations for improvement.

Lastly, the justification behind using school/statewide strategy documents is their contribution to the triangulation of data. The documents offer an additional source of evidence to corroborate findings from other data collection methods such as interviews, observations, or surveys, therefore strengthening the credibility and dependability of the case study conclusions (Plano-Clark & Ivankova, 2016).

3.5 Context of the Study

By comparing New Zealand and US contexts, the study explored how cultural factors influenced the relationships between self, teacher, and collective efficacy beliefs, and the planning and teaching of CT. This offered insights into how cultural contexts shape educational practices and perceptions. In addition, each country had its own educational policies and curriculum frameworks. Understanding how these frameworks supported or undermined the integration of CT into primary/elementary education provided valuable understanding. For instance, New Zealand and the US may have different priorities, standards, or approaches to planning and teaching integrated CT, which can impact teachers' and leaders' efficacy beliefs and practices. Furthermore, the structure and organisation of educational systems differed across countries. Differences in PD opportunities, school leadership practices, and support structures can affect how CT is implemented by teachers and school leaders/coaches. Comparing these systems can highlight effective strategies or challenges that influence the planning and teaching of CT. Through a more diverse range of perspectives from both New Zealand and the US, this research provided a richer understanding of the factors influencing CT education. It may lead to researchers developing more nuanced recommendations for policy makers, curriculum developers, school leaders, and teachers in each country, as well as identify potential cross-country lessons or strategies that could benefit both contexts.

For the current study, each case involved primary or elementary teachers working with students aged 5 to 13 (years 1-8 in New Zealand, or grades 1-6 in the US) and the cases had participants who were interested in planning and teaching CT. To maintain consistency and relevance across cases, the teachers in each setting had completed PD specifically designed for CT. Data collections remained consistent across each case, and involved surveys, interviews, and classroom observations. The intention behind collecting data by case studies was to collect specific quantitative data via survey, interview and observe teachers, interview school leaders, and analyse the influence of policy and strategy documents associated with the planning and teaching of computational thinking (please see Table 2). Data collection also involved semi-structured interviews with teachers and 1-2 school leaders (number of school leaders/teachers involved depended on the size of the school) at each New Zealand school. Teachers and school leaders (called coaches in the US) were interviewed and teachers only were observed from the school district in America. Both interviews and observations allowed an in-depth exploration of experiences within each case and how those experiences affected various efficacy beliefs (self, teacher and collective) when planning and teaching computational thinking.

Table 2

Overview of the Study

Research focus	• Explore the relationships between teachers' efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT. • Explore the relationships between senior leaders' efficacy beliefs (self, and collective) and the planning of CT. • Identify the factors that support or undermine sources of efficacy judgements when planning and teaching CT.		
Methodology	Multiple Case Study		
	Case study One	Case Study Two	Case Study Three
Research Context	Full state primary school in a rural area, in the North Island of New Zealand	State Intermediate school in an urban area in the South Island of New Zealand	Teachers from the same school district in Michigan, United States of America.
Dates	Early March – early September, 2021	Early May – late November, 2021	Early June – late October, 2022
Boundaries of each case	• Each case involved primary or elementary teachers working with students aged 5 to 13. • The focus of each case was on planning and teaching computational thinking (CT). • All teachers across cases completed professional development specifically designed for CT. • Data collection methods were consistent and included surveys, interviews, and classroom observations.		
Participants	Teachers=6 School leaders=2 F=6 M=2	Teachers=5 School leaders=1 F=3 M=3	Teachers=10 School leaders =2 F=10 M=2
Methods	• Surveys (teachers and school leaders/coaches) • Semi-structured interviews with teachers and school leaders/coaches • Observation of teacher participants • Analysis of School strategy and policy documents (NZ)/state-wide curriculum documents (US)		
Sequence of research	1. Survey (all participants) 2. Interviews (all participants) 3. Observation (teachers only) 4. School/State strategy and policy documents shared.		

F=female M=male

3.6 Research Ethics

A number of ethical principles were adopted to ensure the rights of the participants involved in the study were respected. Ethical principles included; privacy and anonymity, voluntary participation and informed consent, the potential benefit of the study outweighed the potential harm, and important findings shared from the study (Berg, 2001). Informed consent is fundamental in ethical research as it ensures an individual's right to voluntarily participate – the decision must be of free choice (Berg, 2001). To ensure informed consent for this study, the researcher adhered to the principles of full information given to the participants, the comprehension of the information by the participant, and that participation was voluntary (Frankfort-Nachmias & Nachmias, 1996). For participants to make an informed decision, the researcher took responsibility to make sure the participants were provided with all the information about the study, which they could clearly understand. This was in the form of an information sheet, detailing the study, what was involved for the participants, and the opportunity to discuss the project with the researcher if questions arose. In addition, for the New Zealand participants, a short explanation video and information sheet was provided for parents (see Appendix 6 & 7) whose children were present in the class while the teacher observations were taking place. This was because the ethics required parental consent for their children to be observed in their classes. In the US, the same ethical considerations were upheld. In addition, in the US the ethics requirement was an 'opt-out' system where parents could choose not to have their children participate in a classroom observation.

The participants must be assured that data collected from them is kept confidential (Merriam, 1998). Complete anonymity was not possible because the participants of each case were in schools where all staff may have known they were partipating in the research. However, the researcher ensured that the participants were confident in the researcher avoiding potential harm, to the best of her ability. All names used to reporting findings were pseudonyms (gender preserved), and the researcher removed any identifying names (such as schools/school district) (Burns, 2000). The information linking the participant to their pseudonym was kept separate, and was only available to the researcher. Data was also only available to the researcher (and supervisors). There was no transcriber used in this study, the researcher completed transcriptions herself. In addition, teacher participants observed were reassured that the focus of the study was their self, teacher, and collective efficacy beliefs, and no judgement was made on their teaching capabilities. The right to withdraw was important to ensure that minimisation of harm was paramount.

As part of ethical practice, participants had the right to withdraw from the study (Burns, 2000) up until the data was analysed. All participants were aware of their right to withdraw during the survey, interviews, and classroom observation. Although somewhat of a time demand for the teacher and school leader participants, none withdrew from the study and all participants completed the survey, interview, and observation (teachers only). School leader participants in New Zealand also spent time with the researcher discussing the school strategy and policy documents. The school leaders in the US did not discuss the state-wide curriculum documents with the researcher because these documents were found online, and each school differed in their utilisation of the documents.

Before starting the research in New Zealand, an ethics application was reviewed and approved in April 2021 by the Massey University Human Ethics Committee: Southern A, Application 20/62. After approval, case studies were selected and permission was then sought from the principals (see Appendix 1) to gain access into the school so the researcher could introduce the project to potential participants, explain participant's involvement, provide them with more information and answer any questions they may have (see Appendix 2 & 3). Teachers and school leaders who were interested requested the survey link via email. After completing the online survey, results were stored confidentially, and the survey data was deleted from the software. Consent was implied by completing the survey, but participants could opt into interviews (school leaders and teachers) and classroom observations (teachers). If they agreed, they provided their contact details for scheduling an interview. Consent forms were also provided for participants in an email prior to any interview and observation (see Appendix 4). For classroom observation, parents of the students were also contacted via the teacher. They were emailed an information sheet (Appendix 5), an introductory video from the researcher (Appendix 6), and consent forms (Appendix 7) for them and their children to sign, allowing them to be present in class during the observation.

Another ethics application for the US case study was reviewed and approved in November 2021 by the Massey University Human Ethics Committee: Southern B, Application SOB 21/53. The ethics at Michigan State University was approved by the Human Research Protection Program, which approves all research with human subjects. Participants from one school district signed up for the CT professional learning and development program. After completing the PD (asynchronous content learning, and two in-person days) the teachers and coaches were emailed a link to complete the survey. Once the survey was completed, the participants were asked for their details so the researcher could contact them for an interview (teachers and coaches), and observation (teachers only). Consent forms were provided for participants in the email (see Appendix 4).

3.7 Data Collection in Action

In this study, multiple data were collected via surveys, interviews, observation, and reviewing school strategy (or state-wide in the US) documents. This data ensures that participants' experiences can be used to gain insights into their beliefs about self-efficacy, teacher efficacy, and collective efficacy beliefs when planning and teaching CT.

Prior to data collection, New Zealand cases were chosen using purposive sampling. One school was selected because the researcher had previously worked there in a professional capacity, although they were no longer active in that setting. The researcher had developed a trusting relationship with the school leaders and teachers and arranged to discuss the project with the school leaders in person.

Another school was chosen through a colleague of the researcher, who had previously worked there. The researcher approached the colleague to inquire if they could provide a contact at the school. The colleague agreed to pass on the invitation letter and information sheet to the principal and ask if they would be open to a discussion with the researcher. When the principal expressed interest, the researcher then contacted them via email to provide further details.

The US case was selected through a colleague at Michigan State University. The colleague had previously worked with the school district, and believed the teachers and school leaders would express interest in participating as a case. The colleague agreed to pass on the invitation letter and information sheet to one school leader/coach and ask if they would be open to a discussion with the researcher. When the school leader/coach expressed interest, the researcher then contacted them via email to provide further details.

A summary of the research procedure is in Table 3. In addition, Table 4 describes the data generation methods and audit trail for the study.

Table 3

Summary of the Research Procedure

Timeframe	Stage	Procedure
April – September 2021	First case study identified and data collected.	1. Ethics approval from Massey University (Application 20/62) 2. Schools identified as suitable case studies. 3. Request letter sent to principal, or school leader (see Appendix 1). 4. Permission granted by principal or school leader. 5. Initial staff meeting conducted to introduce the project. 6. Survey link emailed to participants who volunteered. Completion implied consent. 7. Information and consent forms sent to participants for the interview and observation (see Appendices 2, 3 & 4). 8. Signed consent forms recieved from participants. 9. Video introduction and information sheets sent to participants to disseminate to parents for observation (see Appendices 5 & 6). 10. Consent forms sent to teachers to desiminate to parents/students (see Appendix 7) 11. Signed student consent forms received.
April - November 2021	Second case study identified and data collected.	12. Request letter sent to principal, or school leader (See Appendix 1). 13. Permission granted by principal or school leader. 14. Initial staff meeting conducted to introduce the project. 15. Survey link emailed to participants who volunteered. Completion implied consent. 16. Information and consent forms sent to participants for the interview and observation (see Appendices 2, 3 & 4). 17. Signed consent forms recieved from participants. 18. Video introduction and information sheets sent to participants to desiminate to parents (see Appendices 5 & 6). 19. Consent forms sent to teachers to desiminate to parents/students (see Appendix 7) 20. Signed student consent forms received.
February 2022	American case study ethics requested.	21. Ethics approval from Michigan State University.

Timeframe	Stage	Procedure
April – August 2022	Third case study identified	22. School district identified and teacher participants opt into professional learning and development summer course. 23. Participants complete online CT course, one 2 hour online session with reseacher, and two face-to-face full day sessions. 24. Survey link emailed to participants. Completion implied consent. 25. Information and consent forms sent to participants for interview and observation (see Appendices 2, 3 & 4). 26. Signed consent forms recieved from participants. 27. Video introduction and information sheets sent to participants to desiminate to parents (See Appendices 5 & 6). 28. Consent forms sent to teachers to desiminate to parents/students (see Appendix 7) 29. No parent opted out for their child to not be in class during the teacher observation.

Table 4

Summary of the Data Generation Methods

Data collection method	Details	Rationale	Identifier
Participant survey (teachers and school leaders)	Online participant survey. This survey was the same for all participants in each case study.	- Collect demographic information about research participants. - Measure participants self-efficacy and teacher efficacy beliefs using appropriate sections of the Rich et al., 2020 scale. - Measure participants collective efficacy beliefs using appropriate sections of the Fuller et al. (2006) scale. - Gain an initial understanding of self, teacher and collective efficacy beliefs of the participants.	Pseudonym – Survey CSxPyQz (where x is the (C)ase (S)tudy number, y is the (P)articipant number, and z is the (Q)uestion number) Example: Rachel – Survey CS1P6Q7
Participant interviews (teachers and school leaders)	Semi-structured interviews with the participants in the identified case studies.	- To investigate, in-depth, participants self-efficacy, teacher efficacy and collective efficacy beliefs when planning and teaching CT.	Pseudonym – Interview CSxPyQz Example: Jennifer – Interview CS1P5Q4

Data collection method	Details	Rationale	Identifier
Observation (teachers only)	In class observation of the teachers in the identified case studies.	- To investigate, in-depth, participants self-efficacy, teacher efficacy, and collective efficacy beliefs when planning and teaching CT.	Pseudonym – Observation CSxPy (where x is the (C)ase (S)tudy number, y is the (P)articipant number) Example: Rachel – Observation CS1P4
Strategy and policy documents (school leaders only)	School strategy and policy documents with CT embedded.	- To explore the relationships between CT within school strategy and policy and the efficacy beliefs of the teachers and school leaders.	Each case has their own strategy documents with sections highlighted pertaining to planning and teaching CT.

3.7.1 Survey

Data gathering firstly involved the collection of predominantly quantitative data from two schools in New Zealand. One school was in the central North Island and was a full primary (years 1-8). The other school was in the South Island and was an intermediate school (years 7 & 8). Both New Zealand case study schools had teachers and school leaders who had participated in 100 hours of government funded CT PD. From the selected schools, full-time, currently registered teachers of students in years 1-8 were invited to complete the survey. Teachers from the selected schools in school leadership positions (principals, deputy principals, and assistant principals) were also invited to participate in the survey. In case study one: six teachers and two school leaders participated in the survey. In case study two: five teachers and one school leader participated in the survey. In addition, in the US, teachers from one school district[1] who completed PD on CT during the summer of 2022 were invited to complete the self, teacher, and collective efficacy survey. In case study three: 10 teachers and two school leaders (coaches) participated in the survey.

The survey consisted of five sections. The first section contained demographic questions including age range, and number of years in the teaching profession. The second section had one open-ended question asking participants to explain their ideas of what computational thinking entails. This was followed by 12 questions using a 0–100-point Likert scale relating to the participants' self-efficacy beliefs, 10 questions using a 0-100-point Likert scale related to the teachers' teacher efficacy beliefs (school leaders were not applicable), and finally, 22 questions using a 0–100-point Likert scale related to participants collective efficacy beliefs. Please see Appendix 8. The survey employed for assessing self and teacher efficacy concentrated on programming and technical aspects of computing. While this was

[1] A school district is a geographical unit for the local administration of elementary or secondary schools.

appropriate at the time of data collection, a more recent survey specifically targeting efficacy beliefs related to CT has since become available (see Kaya et al., 2020). This newer survey may have been more relevant to the context of this study.

3.7.2 Interviews

One interview per participant was conducted to gain a deeper understanding of participants' self, teacher, and collective efficacy beliefs. The interviews lasted no longer than one hour. Participants in Case study 1 chose to either interview in person, or via Zoom. Participants in Case study 2 all chose to interview in person. The participants in Case study 3 all chose to interview via Zoom. All interviews were conducted in a relaxed atmosphere, where the participants (and researcher) were free to discuss their thoughts. At the beginning of each interview, the participants were reminded that their identity would remain confidential in the reporting of findings, and this reminder encouraged the participants to express their opinions freely. Due to the semi-structured nature of the interview, the interview protocol was a guide for the researcher, so the interview could be somewhat flexible if the participant had the need to discuss one question more than another.

The interview was also used to collect information about what the teachers and school leaders had previously done in relation to the planning and teaching of CT. The interview also had questions pertaining to the factors which supported or undermined their efficacy beliefs when planning and teaching CT (see Appendix 9). The interview questions were designed after a thorough review of the literature on both self-efficacy theory, and CT (see chapter two) and included topics on: participant understanding of CT, how CT was introduced to them, CT activities they had taught their students, how successful they thought they were when teaching CT, whether they had modelled CT to other teachers or students, factors they believed supported or undermined their planning and teaching of CT, and how the school strategy and policies supported their planning and teaching of CT.

3.7.3 Observations

One classroom observation per teacher participant was another data collection approach used in this study. Case studies involving observations are used to probe more deeply with a view of establishing a more general understanding of the wider population to which the unit is part of. Formal observations often use instruments to assess the occurrence of behaviours during the time period, and this was the case for the current study. While the research focused on teachers, since the research involved students in class who were not yet 16, it was necessary to secure parental consent to ensure that the rights and welfare of the minors were protected. Parental consent was a fundamental ethical requirement, ensuring that guardians were informed about the research and could make decisions regarding their child's participation (Creswell & Poth, 2017).

During the observation, the researcher noted:

1. The physical setting (a classroom – either an open learning environment or a more traditional single-celled classroom. In some observations, there were also resources in use (chromebooks, iPads, robotics).
2. The participants involved. The participant was the teacher, although students were also present. When the student had parental consent, and the teacher interacted with them, this data was noted down from the teachers' point of view.
3. The activities and interactions during the observation. This included what happened in the activity, the sequence of the activity, how the teacher and students interacted with each other, what rules structured the activity, the duration of the activity, and whether this task seemed like a usual task or a one-off.

4. Anything subtle that happened during the observation. In particular, if something did not happen when it may have been supposed to.
5. Any observer comments and how my presence may have affected the observation.

The field notes contained verbal descriptions of the classroom setting, the people involved, and the activities being completed. Notes also contained direct quotes of what the teacher said in relation to computational thinking. During the observations the researcher looked for these key identifiers in comments/questions from the teachers. These key identifiers have been modified from (Yadav et al., 2021). Please see Appendix 10

3.7.4 Strategy and Policy Documents

Case study one shared their overarching school strategy document. The school's localised curriculum was a document available to all staff. Developed through consultation with staff, students, whānau (family), and iwi (local tribes), it served as a 'live working document' outlining the curriculum, implementation strategies, and strategic priorities. This evolving resource included the school's vision and values, key competencies, NZC principles, effective pedagogy, assessment for learning, and contextualized curriculum implementation to enhance student learning. For CT in particular, the document shared information on the revision of the Technology learning area in The New Zealand Curriculum which aims to enhance digital technology education for all students from years 1–13 (ages 5-18). This change aims to develop students into innovative creators of digital solutions rather than just users of technology. The case study one school had received professional development support, created progressions for learning outcomes, and established teacher workshops, while continuing to adapt its digital technologies curriculum tailored to students' needs.

Case study two shared a document called "Digital Technology Curriculum plan" which stated their goal to advance students from digital literacy to digital fluency, enabling them to become effective digital citizens. Netsafe (2021) defines a digital citizen as someone who integrates digital skills, knowledge, and attitudes to engage as an active, lifelong learner in society. By the end of their two-year program, students should view themselves as capable digital learners, participate effectively in digital environments, understand computer science as a viable career, and consider ethical practices and stakeholder impacts. They should be aware of safety issues, gain hands-on experience with technology, understand its evolution and societal impact, and develop skills in creating and debugging algorithms. The focus is on equipping students with critical thinking and problem-solving abilities to use computational thinking for creating digital solutions and confidently navigating the digital world. The document covered the New Zealand Curriculum Progress Outcomes for Computational Thinking and outlined what stages the students would be working on throughout their two years at the school. The document also outlined the achievement objectives for each Progress Outcome so teachers could see what each looked like for student learning outcomes.

For case study three, state-wide documents were sourced online by the researcher about the planning and teaching of CT for the state in the US. Entitled Michigan K-12 Computer Science Standards, the document discusses the collaborative effort among educators, government, and private sector partners which shaped the direction of K-12 education in Michigan. The goal was to ensure all students and teachers across the state had equitable access to high-quality educational opportunities. The roadmap, Michigan's educational technology plan, was developed to guide resources and create new learning models where students used technology strategically, engaged in research and reasoning, communicated effectively, and solved problems. The document goal is to integrate computer science standards (which includes CT) into existing content areas for Kindergarten through Grade 5, with middle school students exploring courses that build skills for early high school and specialisation in Grades 11 and 12. K–12 computing education includes computer literacy, educational technology, digital citizenship, information technology, and computer science, which delves deeper into algorithmic processes, hardware and software designs, and their societal impact (Tucker et al., 2006). The Computer Science Standards document outlines clear expectations for students, specifying the knowledge, practices, and skills required at each educational level. Designed to support a sustainable computer science education program, these standards serve as reference points for planning and teaching. The CS Standards work group recommended adopting grade bands that align with developmentally appropriate standards from the computer science teachers association (CSTA) K-12 Standards document. These bands are Level 1A for Lower Elementary (Grades K-2), Level 1B for Upper Elementary (Grades 3-5), Level 2 for Middle School (Grades 6-8), Level 3A for High School (Grades 9-10), and Level 3B for High School - Specialising (Grades 11-12). The document continued with details for each 'band' and what the learning outcomes are for students.

3.8 Data Analysis

A strength of case study data collection is the ability to utilise many different sources of evidence for an in-depth study of phenomena in real-world contexts, therefore strengthening the construct validity of the case (Yin, 2018). This section describes the analysis techniques employed for the collected data. These techniques were used for each case study. Survey data was briefly analysed prior to interviews and observations being undertaken, however survey data was again analysed in more depth alongside the interview and observation data. For this section, quantitative data analysis will be explained first, followed by a description of the qualitative data analysis.

Based on the PD as a bridge between teacher competencies and CT integration, as outlined in the figure from Caskurlu et al. (2021), data analysis was separated into sections (see Figure 2) which described the CT teacher competencies used to support the findings for self, teacher, and collective efficacy beliefs.

1) Conceptual foundations of CT were used to structure teacher and school leaders' definitions of CT, in particular the five CT concepts of decomposition, abstraction, pattern recognition, algorithmic thinking, and debugging. The teacher and school leaders' understanding of these five concepts was used to understand their self-efficacy beliefs.

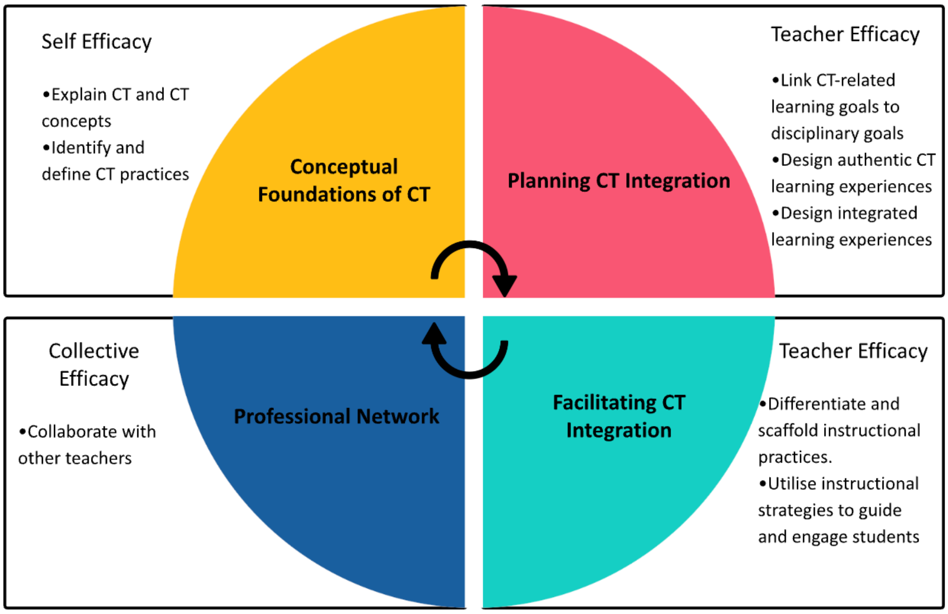
2) Planning CT integration is the planning and design of CT activities and CT integrated activities. Planning CT integration is used to understand the teachers' teacher self-efficacy beliefs (school leaders are omitted because they do not plan CT integrated activities).

3) Facilitating CT integration is the teaching of CT activities integrated across discipline areas and is used as a structure to further understand teacher self-efficacy beliefs. This section is also only for teachers because the school leaders do not teach the activities themselves.

4) Finally, professional network describes the collaboration between teachers and school leaders and is used as a structure for understanding collective efficacy beliefs of the school.

Figure 2

CT Teacher Competencies (Caskurlu et al., 2022 p. 139).



3.8.1 Quantitative Data Analysis

Survey data was analysed in this way, separated into the five foundational CT concepts (and general problem-solving) and presented in tabular form. The medians of all participants per case were also calculated under each section (for example, group median for decomposition). Finally, the overall group median for each of the conceptual foundations of CT (and general problem-solving) contributing to self-efficacy is presented. The rest of the survey data (for teacher efficacy and collective efficacy) was also calculated this way.

Table 5 shows examples of how the survey questions relating to self-efficacy were separated into the five CT concepts; decomposition, abstraction, pattern recognition, algorithmic thinking, and debugging. There were also two survey questions which fitted into 'general problem-solving'. The five CT concepts followed the definition used for this study (Yadav et al., 2019). The decomposition questions in the survey were categorised because they are part of 'breaking a problem into smaller subsections'. The abstraction questions were categorised because they are part of 'focusing on the important information and ignoring irrelevant information'. Pattern recognition focuses on finding patterns in information/data. Algorithmic thinking is understanding how to read full sets of information and apply logic to a problem. Debugging is finding and fixing a problem. General problem-solving had two questions relating to more holistic ways for problem-solving, and not in the context of CT.

Table 5

Self-Efficacy Survey Questions Related to the Five CT Concepts & General Problem-Solving

Decomposition	Abstraction	Pattern Recognition	Algorithmic Thinking	Debugging	General Problem-Solving
When I am presented with a problem, I can break it down into smaller steps.	I can identify where and how to use variables in the solution of a problem.	I can find patterns in data	I can apply Boolean logic (e.g., IF, AND, NOT, OR) to solve problems with multiple conditions.	I can correct mistakes in the coding of a computer program on my own.	I am good at solving puzzles.
I can look at a computer program and explain the purpose of each command.	I can suggest different solutions in order to solve coding problems.		I can read a formula (e.g., algorithm, equation, input/output process) and explain what it should do.		I can describe fundamental computing concepts (e.g., loops, variables, algorithms, conditional logic).
	I can generalise solutions that can be applied to many different problems.		I can plan out the logic for a computer program even if I don't know the specific programming language.		

The teacher efficacy survey questions (Table 6) were categorised according to concepts relating to the teaching of CT. These are: understanding CT concepts, planning, and designing CT lessons, sourcing CT learning resources, and CT integration. The third section had 10 questions using the same Likert scale described previously relating to the participants' teacher self-efficacy beliefs (see Appendix 8). School leaders did not complete this section and were given the option of 'not applicable' because they do not teach CT themselves.

Table 6

Aggregate Teacher Efficacy Survey Questions

Understanding CT concepts	Planning, designing, and sourcing CT lessons	CT Integration
I can help students debug their computer programs.	I can create computing activities at the appropriate level for my students.	I can integrate computer programming into my current curriculum.
I can explain basic computing concepts to children (e.g., algorithms, loops, conditionals, functions, variables, debugging, pattern-finding).	I can develop and plan effective computing lessons.	I can use my computer programming skills to integrate computing content into my class lessons.
	I can find uses for computer programming that are relevant for students.	I can recognise and appreciate computing concepts in all subject areas.
	I can find the resources to help students learn to code.	I can explain how computing concepts are connected to daily life.

All collective efficacy scales reviewed had items worded to include ‘my group’ rather than ‘I can’ to assess the participant’s beliefs on how the collective group was perceived to perform (Fuller et al., 2006; Goddard, 2002; Tschannen-Moran & Barr, 2004; Wang & Lin, 2007). For collective efficacy, the scale used was created by Fuller et al. (2006). For the context of this study, the survey questions for computer collective efficacy, group potency, virtual team efficacy, effort, and group outcome perception were used. ‘Computer collective efficacy’ was used to assess the team’s belief in its ability to perform more advanced computer tasks. ‘Group potency’ was used to assess the team’s belief in its general effectiveness across various tasks and situations. ‘Virtual team efficacy’ was used to assess the team’s belief in their ability to work together in a technological environment. ‘Effort’ was assessing the team’s perception of their effort toward completing the task, and ‘Group outcome perceptions’ was used to assess the perception of outcome and team satisfaction. The combination of these factors is most relevant when assessing collective efficacy beliefs of primary/elementary teachers when planning and teaching computational thinking.

Table 7 illustrates survey questions relating to collective efficacy separated into the six collective efficacy concepts for analysis purposes; group computing concepts, knowledge, and skills; group technology collaboration and communication; group capability; group effort; group quality of outcomes; and general group satisfaction.

Table 7

Aggregate Collective Efficacy Survey Questions

Group computing concepts knowledge and skills	Group technology collaboration and communication	Group capability	Group effort	Group quality of outcomes	General group satisfaction
I believe my group has the ability to understand terms/words relating to computer software.	I believe my group has the ability to use communications software to collaborate with remote group members.	I believe my group has confidence in itself.	My group worked hard on the project.	I am satisfied with the project outcome produced by my team.	I was satisfied with my group members.
I believe my group has the ability to troubleshoot computer problems.	I believe my group has the ability to do teamwork in a distributed environment if we have access to appropriate technology.	I believe my group expects to be known as a high-performing team.	My group exerted substantial effort on the project.	I am pleased with the quality of work we did in my team.	I was pleased with the way my teammates and I worked together.
I believe my group has the ability to explain why a program (software) will or will not run on a given computer.	I believe my group has the ability to share information using technology with remote group members.	I believe my group can get a lot done when it works hard.	My group did a significant amount of work on the project.	I am satisfied with the final project submitted by my team.	I was very satisfied working with this team.
	I believe my group has the ability to use communication technology to do work with people who cannot physically get together to meet.			The work produced by my team was high quality.	
				The project outcome produced by my team was excellent.	
				The deliverables of my team were outstanding.	

For this study, a measure of central tendency (namely, median) was used as a way to represent continuous variables as a single value (Fallon, 2016) collected from the survey data. The justification to use median was that it offers advantages in cases where there are small sample sizes, the data exhibit skewness, contain outliers, or are not suitable for parametric assumptions (Hoaglin et al., 2000). In addition, the survey data was analysed using the non-parametric Kruskal-Wallis test (Kruskal & Wallis, 1952) to evaluate variations among three or more independently sampled groups based on a single continuous variable.

For self, and teacher efficacy beliefs, the 0-100 Likert-scale was interpreted as follows: 0 indicated 'cannot do at all', 50 indicated 'moderately can do', and 100 indicated 'totally can do'. Although not explicit on the Likert-scale, 25 was interpreted as 'somewhat can do' and 75 was viewed as 'mostly can do'. During analysis, 0-20 was interpreted as cannot do at all, 21-40 was interpreted as somewhat can do, 41-60 was interpreted as moderately can do, 61-80 was interpreted mostly can do, and 81-100 was interpreted as totally can do. The fourth and fifth sections (10 questions, and 12 questions, respectively) had 0–100-point Likert scale relating to the participants' collective-efficacy beliefs. 0 indicated 'not confident', 50 indicated 'moderately confident', and 100 indicated 'totally confident'. Although not explicit on the Likert-scale, 25 was viewed as 'somewhat confident' and 75 was viewed as 'mostly confident'. Again, during analysis, 0-20 was interpreted as totally not confident, 21-40 was interpreted as somewhat confident, 41-60 was interpreted as moderately confident, 61-80 was interpreted as mostly confident, and 81-100 was interpreted as totally confident (please see Appendix 8).

From here, the median was calculated for each participant for each of the competencies discussed above. The medians were rounded to whole numbers. For example, for two decomposition questions, Ashley reported 92 (*totally can do*) for 'when I am presented with a problem, I can break it down into smaller steps' and 19 (*cannot do at all*) for 'I can look at a computer program and explain the purpose of each command'. Therefore, Ashley's overall median for the decomposition questions was 56 and interpreted as *moderately can do*. Table 8 provides an example of how the survey data was analysed.

Table 8

Example Analysis of Self-Efficacy Survey Data - Ashley CS1

Survey Question	CT concept	Median	Median for each CT concept	Total median for SE
1	Decomposition	92	56	**53**
2	Decomposition	19		
3	Abstraction	50	50	
4	Abstraction	59		
5	Abstraction	50		
6	Pattern Recognition	39	39	
7	Algorithmic Thinking	50	50	
8	Algorithmic Thinking	60		
9	Algorithmic Thinking	47		
10	Debugging	70	70	
11	General Problem-Solving	50	61	
12	General Problem-Solving	71		

The cross-case analysis focused on the overall group medians for each efficacy (self, teacher, and collective) for each case. The purpose of an overall group median was to compare the medians to identify patterns or differences between cases. The interpretation of the overall group medians provided insights to whether certain outcomes or characteristics were consistently observed across cases or if there were significant variations. The overall group medians were analysed in IBM SPSS Statistics (Version 27) using the non-parametric, Kruskall-Wallis test (Kruskal & Wallis, 1952) to assess the differences between three or more independently sampled groups across one continuous variable. The justification behind using a Kruskal-Wallis test is that there were three groups to test using medians (McKight & Najab, 2010). To use a Kruskal-Wallis test, four assumptions had to be met. Firstly, the dependent variable should be measured at ordinal or continuous level. For this study, the survey data was continuous. Secondly, the independent variable should have two or more independent groups. For this study, there were three independent cases. Thirdly, there must be no relationship between participants of the groups themselves. In this study, the participants are from three different schools/school districts, and no participant was in more than one case. Finally, the distributions of each case had to be similar. Although the Kruskal-Wallis test does not require the assumption of normality, it assumes that the distributions of the different groups have similar shapes. This means that the data in each group should come from populations with similar distribution shapes, even if those shapes are not normal (Tukey, 1977). Once these four assumptions were met, the Kruskal-Wallis test (p value .05) was carried out using the overall medians for self, teacher, and collective efficacy, for each case. The findings are discussed in chapter seven.

3.8.2 Qualitative Data Analysis

The qualitative data in this study were organised and analysed using Nvivo 14. Nvivo is a qualitative data analysis package, and was used to manage the large amounts of qualitative data for this research project. Nvivo projects were set up for each case study, and the partipants had profiles within their respective cases. The interview transcripts and observation sheets were imported into Nvivo within each participants' folder. The interview responses were analysed first – this was done by creating nodes/codes (see Appendix 11). "Topic coding is used to identify all material on a topic for later retrieval and description, categorization, or reflection" (Richards & Morse, 2012, p. 156). By using deductive coding pre-existing theories or frameworks helped to categorise data, ensuring that the analysis is guided by established concepts and hypotheses (Miles et al., 2014). This approach was used for testing specific theories and provided a structured way to analyse data in alignment with existing knowledge. In addition, inductive coding was also utilised as a more exploratory approach where codes and categories emerged from the data itself and allowed for the identification of patterns and themes (Braun & Clarke, 2006). This method facilitated a deeper understanding of the data by revealing new insights and generating theories grounded in the participants' perspectives. Both approaches were important for the study during qualitative analysis, with deductive coding providing theoretical rigour and inductive coding offering flexibility and depth (Saldaña, 2016).

Specifically, each theme was assigned a ‘code’ and each section of interview/observation text could be assigned to that as a ‘node’. The purpose of coding is to allow the researcher to simplify specific characteristics of the data (Richards & Morse, 2012). Each node was named to identify the key idea of the sections of text (see Appendix 12). Sections of text could therefore be stored together, under the same node. Occasionally, there were sections of text that could be coded at several nodes – these longer sections were chunked into smaller sections and coded to the appropriate nodes. As the coding process continued, the interview/observation text was reviewed and it was clear that some of the nodes were too broad. For example, text coded at “PD - professional development” was separated into subnodes which included “government funded facilitator”, “internal school PD” or “online courses”. This iterative process was used to clarify the researcher’s understanding of key themes within the qualitative data set (Patton, 2002).

After an initial review of the interview data, it became apparent that many of the nodes were capable of fitting under many themes. A theme is a common thread running through the data and may emerge when coding the data (Richards & Morse, 2012). A ‘clean’ project was created for Case study one. This was to help the researcher see the themes and connect the nodes to each theme in a more consistent manner. Nvivo was able to transpose them into the nodes used for the interview/observation text. Analysis of the interview data was completed first because this data provided a broader picture of emergent themes. The same process was also done for the observation data, using the same codes developed from analysing the interviews. All data related to case study one was analysed first.

While Nvivo enabled the researcher to code the qualitative data, the four sources from which of self-efficacy judgements are made (Bandura, 1986), namely enactive mastery, vicarious experiences, verbal/social persuasion, and physiological states were at the forefront when analysing the data. Self-efficacy theory was used as an organising framework for the developing themes identified during the coding process and therefore revealed the social, behavioural and contextual influences within each case study. For example, when coding participants' data with regards to enactive mastery experiences, the evidence involved teachers' direct successes or failures in planning and teaching CT. Positive experiences were analysed as those where teachers effectively implement CT lessons and achieve desired outcomes, which may have led to a boost in their confidence. Conversely, negative experiences were analysed when lessons did not go as planned, leading to challenges and potential decreases in participant efficacy beliefs. Participants can have vicarious experiences by observing others' successes or failures. Analysis of the data involved positive vicarious experiences when teachers observed a professional development facilitator or one of their peers succeed, potentially leading to an influence on their own CT planning and teaching practices. In contrast, negative vicarious experiences involved participants' observing others' failures, potentially leading to reduced efficacy for planning and teaching CT. When coding participant data regarding verbal persuasion and dissuasion, analysis focused on the impact of others' verbal feedback on teachers and school leaders when implementing CT. Evidence of positive verbal persuasion, such as encouragement and constructive feedback, was analysed as examples where participants' efficacy was supported. On the other hand, examples of verbal dissuasion, such as criticism or lack of support, were analysed as an undermining influence for efficacy beliefs. Lastly, evidence of how physiological states influenced participant's planning and teaching of CT was analysed. Physiological states involve the physical and emotional conditions that affect teaching. Evidence from participants of positive physiological states, such as feelings of excitement and low stress, were analysed as a support contributing to effective CT planning and teaching. Conversely, evidence of negative physiological states, including high stress and feelings of overwhelm, was analysed as an undermining influence on planning and teaching CT. Analysis of all four sources of efficacy judgements was vital to form a comprehensive understanding of participant efficacy beliefs when planning and teaching CT.

Using the initial coding structure, self-efficacy framework and Nvivo functions, the rest of the qualitative data was analysed. Following this, an analysis of the school's strategy and policy documents was undertaken as a source of secondary data. The analysis of these documents was to identify the relationships between school strategy and collective efficacy themes. The justification for analysis of strategy documents for collective efficacy (as opposed to self, and teacher efficacy beliefs) was the interview questions related to strategy were aligned with how the participants believed the documents supported or undermined the group as a whole.

Once the first stage of data analysis was completed for Case study one, the coding structure was imported into the Case study two (and three) projects. The codes were refined for Case study three due to the different context.

3.9 Ensuring Quality

Lincoln and Guba (1985) argue there are four issues to be addressed to ensure quality of mixed methods research: credibility, transferability, dependability, and confirmability.
For research to have credibility, future users must have confidence that there is truth in the findings and interpretations of such findings (Lincoln & Guba, 1985). To strengthen the credibility of the findings, three activities can be completed: prolonged engagement, persistent observation, and triangulation (Lincoln & Guba, 1985). Prolonged engagement refers to the researcher having spent adequate time in the field to understand the context, build rapport with participants, and ensure that findings are not based on superficial observations. This strategy aimed to enhance the depth of understanding and reduce researcher bias. Prolonged engagement for the participants involved the researcher providing them with interview transcripts (if

requested) for them to review. This allowed the participants to reflect and verify the accuracy of the information they supplied and contributed to a more comprehensive understanding of their perspectives.

Persistent Observation involved the researcher focusing on specific aspects of the study and maintaining attention to detail to capture the nuances of the phenomena being studied. During interviews and observations, the researcher clarified what participants said by using probes or rephrasing questions. This ensured that responses were fully understood and accurately captured, allowing for more detailed and precise observations.

Triangulation involved the use of multiple methods or data sources to cross-verify findings and enhance the credibility of the results. Using audio recordings of interviews, and observation notes provided a reliable and verifiable record of the data collected, allowing for cross-checking and detailed analysis. In addition, the findings from each case were analysed individually, before cross-case analysis. This process helped to confirm patterns and themes, enhancing the validity of the findings through multiple perspectives (Lincoln & Guba, 1985). Methods triangulation involved gathering data from surveys, interviews, classroom observation (teachers only), and school/state strategy documents. Source triangulation involved data gathering from three cases (two in New Zealand, and one in the US) using the same methods, as well as from both teachers and school leaders within each case. Theory triangulation was also initially considered, and while self-efficacy theory (Bandura, 1986) was utilised as the most appropriate framework for this study, the potential contribution of other theories were also considered prior to data gathering (as explained in section 2.5.1), including activity theory (Engeström, 1999), TPACK (Koehler & Mishra, 2009), and the Arena framework (Davis, 2017). In addition to self-efficacy theory providing the framework for this research, when focusing on how professional development relates to efficacy beliefs, the teacher CT competencies, a model by Caskurlu et al. (2021) was utilised. The model is explained in section 3.8.

Transferability refers to whether other researchers can use the findings from this study and apply it to their own context. Although transferability of findings cannot be determined, the researcher aimed to provide enough information (through detailed description) for readers to see whether they can apply the findings to their own situational context and for educational researchers wanting to replicate the study in their own settings. Dependability of data in the current research is illustrated by assurances that the findings are reliable regardless of changes within the case study setting, or participants. Dependability was ensured in this study through maintaning an audit trail (see earlier Table 7) , where a reader can follow the steps through data collection, and analysis (Lincoln & Guba, 1985). By focusing on the four aspects, quality was maintained as best as possible throughout the research investigation.

3.10 Chapter Summary

This chapter has discussed the methodology underpinning the study, and the methods used to accrue, and analyse the data. The research questions were presented, and a constructivist paradigm was explored. Following this, case study methodology and the context of this study alongside ethical considerations were explained. The focus was then on the methods used to select cases, the research procedures, and data collection methods. Analysis of data was also outlined. After describing the underpinning methodology for this study, research findings are now presented, for each case in chapters four, five, and six. The results for each case are guided by the research questions, and further exploration of the findings occurs in as a cross-case analysis and discussion in chapter seven.

Chapter Four: Case Study One Results

The current study aimed to develop an understanding of the relationships between efficacy beliefs (self, teacher, and collective) and the planning and teaching of computational thinking (CT) at the primary/elementary school level. The following three chapters focus on the findings from the teachers and school leaders in case studies one, two and three. For each case, firstly there is a description of the case, including participant demographics. This is followed by presentation of findings separated into three parts. Part one addresses the first research question, namely the relationships between teachers' efficacy beliefs and the planning and teaching of CT. Part two focuses on the second research question and the relationships between school leaders' efficacy beliefs and the planning of CT. Lastly, part three addresses the third research question and presents the findings relating to the factors that either supported or undermined both teachers and school leader's efficacy beliefs when planning and teaching CT.

Throughout each chapter, the presentation of results is framed using self-efficacy theory (Bandura, 1977) and its four sources of efficacy judgements. These sources include enactive mastery (experiences of success or failure), vicarious experiences (observations of others' successes or failures), verbal persuasion (encouragement or discouragement from others), and physiological states (positive or negative emotional or physical states). A detailed discussion of the findings is presented as a cross-case analysis in chapter seven.

4.1 Description of Case Study One

Case study one (CS1) centred on a full primary school (years 1-8 or ages 5-13) outside of Tauranga in the central North Island of New Zealand. The school was semi-rural, and had just over 230 students, both boys and girls. The school is classified as decile 9, based on Census data pertaining to households with school-aged children in the surrounding area. Decile numbers are allocated based on factors like household income, parents receiving benefits, occupation, and education levels. There were 13 teachers at this school, and eight participated in the case study. Of the eight participants, seven had recently completed 100 hours of externally provided, government-funded professional learning and development (PD) on the new additions to the technology learning area of the curriculum, namely computational thinking and designing and developing digital outcomes.

The participants had not previously engaged with the new curriculum material but were motivated to start early to embed the digital technology curriculum in their classrooms. All the participants completed an online survey, followed by semi-structured individual interviews. Teacher participants were also observed during a single lesson in their classrooms. In addition, the school leaders provided access to the school strategy documents relating to CT and chose to discuss the documents for 20 minutes with the researcher. Of the eight teachers and school leaders participating, five were female and three were male. All participants were given pseudonyms. A summary of demographic information is provided in Table 9.

Table 9

Participant Demographics for Case Study One (CS1)

Participant Demographics CS1					
ID	**Participant**	**Age range**	**Ethnicity**	**Years in the Teaching Profession**	**Role**
P1	Kerry	41-50	European	5-10	Teacher
P2	Ashley	25-30	NZ European	5-10	Teacher
P3	Jennifer	25-30	NZ European	5-10	Teacher
P4	Rachel	31-40	NZ Māori*[2], NZ European	<5	Teacher
P5	Daniel	41-50	NZ European	10-20	Teacher
P6	Luke	25-30	NZ Māori*, NZ European	<5	Teacher
P7	Brent	41-50	NZ European	10-20	School leader
P8	Eliza	31-40	NZ European	10-20	School leader

Having described the context of case study one and the participant demographics, the following sections are a detailed presentation of findings, presented under the three research questions in the study.

PART ONE

4.2 Self-Efficacy Beliefs and the Conceptual Foundations of CT

What are the relationships between teachers' efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT?

This section presents findings from survey, interview, and observation data from teacher participants in case study one (CS1). For Likert-scale information and interpretation, please see Section 3.8.1. Taking all the self-efficacy survey results into account, Table 10 shows individual medians, and the group median of 56 for self-efficacy beliefs for CS1 teachers. The group median indicated that the teachers held *moderately* can do self-efficacy beliefs towards

[2] *Māori are the indigenous people of New Zealand.

understanding and planning CT concepts. The overall interquartile range (IQR) was 27 which suggested that some teachers understood and could plan particular foundation CT concepts more comfortably than others.

Table 10
Teacher Participants' Self-Efficacy

		Self-Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Kerry	30	20	Somewhat can do
P2	Ashley	50	13	Moderately can do
P3	Jennifer	62	25	Mostly can do
P4	Rachel	79	26	Mostly can do
P5	Daniel	62	10	Mostly can do
P6	Luke	30	26	Somewhat can do
Group median		**56**	**27**	**Moderately can do**

Conceptual foundations of CT include five CT concepts; decomposition, abstraction, pattern recognition, algorithmic thinking, and debugging. The teacher participants in CS1 were asked to rate their understanding of conceptual foundations of CT in the survey, and then discussed their understanding of conceptual foundations of CT, and how they planned lessons based on these concepts during the interview. A teacher's understanding of these concepts is used to form a picture of their self-efficacy beliefs. In the next section, Table 11 presents the aggregated data for each participant's responses for the five CT concepts (and general problem-solving) explained in section 3.7.1 to unpack what constitutes the group median for self-efficacy beliefs.

Table 11
Teacher Participants' Self-Efficacy subscale medians

ID	Pseudonym	Decomposition	Abstraction	Pattern Recognition	Algorithmic thinking	Debugging	General problem-solving
P1	Kerry	41	30	50	31	30	53
P2	Ashley	56	50	39	50	70	61
P3	Jennifer	78	53	68	51	50	77
P4	Rachel	88	84	100	70	80	83
P5	Daniel	82	62	72	60	71	61
P6	Luke	53	29	30	11	30	48
Group median		**67 Mostly can do**	**52 Moderately can do**	**59 Moderately can do**	**51 Moderately can do**	**60 Moderately can do**	**61 Mostly can do**

From the results in Table 11, decomposition (median = 67) had the highest group median for the teacher participants in CS1. This suggested that the teachers were *mostly* self-efficacious in their understanding of decomposition. Results related to abstraction (median = 52) suggested the group of teachers were *moderately* self-efficacious about the concept of focusing on important details and removing the irrelevant details from a problem. Results about pattern recognition (median = 59) showed *moderately can do* self-efficacy beliefs for the teacher group in CS1. Like abstraction (median = 52), the teachers reported that they were *moderately* self-efficacious in their understanding of algorithmic thinking (median = 51). The teachers were also *moderately* efficacious toward their understanding of debugging (median = 60) as a foundational CT concept. Lastly, the teachers were *mostly* self-efficacious toward their understanding of general problem-solving concepts (median = 61).

Tables 12 and 13 provide a summary of the findings from interviews and observations with teacher participants. Both tables provide further insight into the individual and group medians. The findings for decomposition (Table 12) and algorithmic thinking (Table 13) present the self-efficacy beliefs for those two foundation CT concepts. For brevity, the remaining joint displays for abstraction, pattern recognition, debugging, and general problem-solving can be found in Appendices 13-16.

Table 12

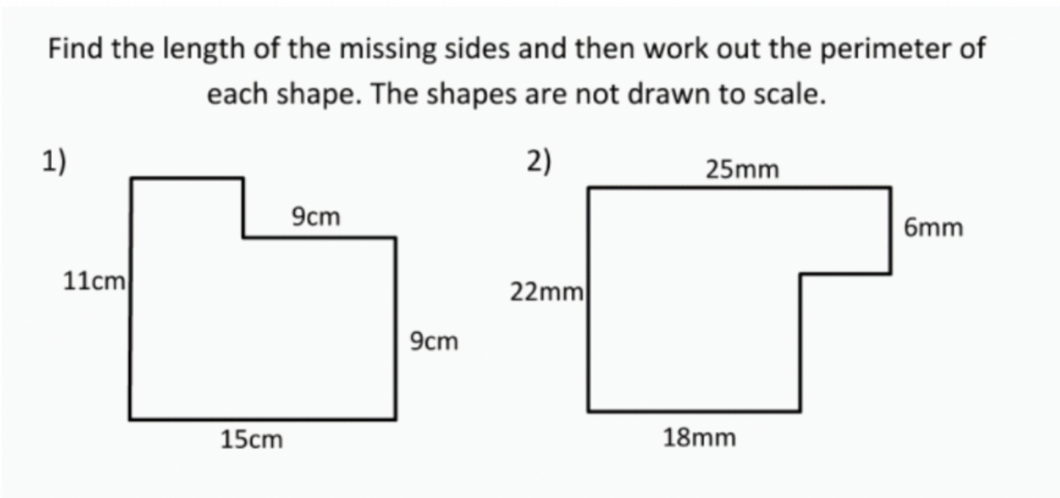
Teacher Participants' Understanding of Decomposition

ID	Pseudonym	Decomposition (median)	Interview evidence	Observation evidence
P1	Kerry	41 Moderately can do	"You know, solving problems, and breaking them down into steps" (Interview – CS1P1Q3)	"We're going to create a model, and develop a code for someone else to follow" (Observation – CS1P1)
P2	Ashley	56 Moderately can do	No interview evidence.	"Who can tell me what decomposition is?" (Ashley) [Student] – "when we break it all apart." (Observation – CS1P2)
P3	Jennifer	78 Mostly can do	"It would be the ability to problem-solve, to deconstruct a problem, or an idea, and use a range of problem-solving skills to then solve that problem" (Interview – CS1P3Q1)	The activity was using decomposition – moving through a map one section at a time to get to the goal. However, decomposition was not specifically mentioned (Observation – CS1P3)
P4	Rachel	88 Totally can do	"I kind of think of it as breaking down an idea into smaller chunks and then putting it back together" (Interview - CS1P4Q1).	"So it's one shape and then you break it into sections" (Observation -CS1P4).
P5	Daniel	82 Totally can do	"But it's just breaking it down into small parts, breaking something, anything (an activity) into a small part and being able to work out your thinking from there" (Interview – CS1P5Q1)	"You're going to think of one word that you want to do in the holidays and then write the code in binary" (Observation -CS1P5).
P6	Luke	53 Moderately can do	No interview evidence	Breaking down the writing recount into sections and assisting students to see how to do that (Observation – CS1P6)
Group median		**67** **Mostly can do**		

The survey findings for teacher participants' group median for decomposition was 67, which indicated they were *mostly* self-efficacious toward their understanding of decomposition. For example, one teacher, Rachel had the highest median of 88, which suggested she *totally can* understand, and plan decomposition-based lessons, thus contributing to her self-efficacy beliefs and median for decomposition Rachel described decomposition as, *"breaking down an idea into smaller chunks and then putting it back together"* (Interview - CS1P4Q1). Rachel further demonstrated her understanding and planning of decomposition during her classroom observation. During the observation, the students were engaged in a mathematics activity with Beebots (small, codable robots). The task was to use the code Rachel provided to draw the shape's perimeter on a whiteboard, code the Beebot to move around the shape's perimeter, and then calculate the area of the shape. Rachel had clearly completed this activity herself previously and was well prepared for the lesson (see Figure 3). She confidently helped students – not only with the Beebots but also with their mathematics and decomposition skills. Rachel's understanding of decomposition, shown in both the interview, and observation findings, contributed to her *totally* can do self-efficacy median of 88.

Figure 3

Slide Example during Rachel's Classroom Observation



Similarly, Daniel (median = 82) reported *totally can do* self-efficacy beliefs for decomposition and described it during the interview as, *"breaking it down into small parts, breaking something, anything into a small part and being able to work out your thinking from there"* (Interview – CS1P5Q1). However, during Daniel's classroom observation he did not explicitly use the term decomposition when explaining the binary instructions. Daniel commented that he had already covered binary with his students in previous lessons, so was confident the students would already break the binary code into sections to solve the problem. By not using the term decomposition explicitly, it was presumed that although Daniel was *totally* efficacious about his own understanding, he may not have been aware of how to utilise decomposition in his classroom instruction.

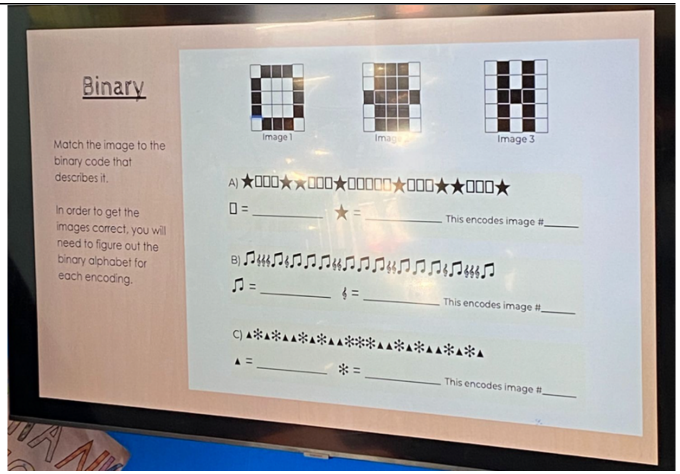
Ashley (median = 56) had *moderately can do* self-efficacy beliefs in relation to her understanding of decomposition as one of the conceptual foundations of CT. During the interview, Ashley described a task she had completed previously, and although decomposition skills were involved in the task, she did not explicitly use the term. In contrast, however, during Ashley's classroom observation, she directly asked the students what decomposition was, with a student answering correctly. Ashley's observation provided evidence of her *moderately can do* self-efficacy beliefs of decomposition when she was satisfied with the student's correct answer.

The findings presented illustrate how the teachers in CS1 defined decomposition, and demonstrated their understanding of decomposition throughout their interview, therefore contributing to the group self-efficacy median of 67 (*mostly can do*). Table 13, presents the findings from teacher participants' interview and observation data to further explain the group median for the CT concept of algorithmic thinking.

Table 13

Teacher Participants' Understanding of Algorithmic Thinking

ID	Pseudonym	Algorithmic Thinking (median)	Interview evidence	Observation evidence
P1	Kerry	31 Somewhat can do	No interview evidence	"What goes next? This code is going to help your buddy put the blocks in the right place so it hopefully matches the pattern you did with the blocks" (Observation – CS1P1).
P2	Ashley	50 Moderately can do	"I sometimes get them to write the code, and a buddy has to then try the code and see what it will do" (Interview – CS1P2Q4)	"At what point do we get the thing that we drink the coffee out of? You need to think about what people have to get out or get organised in order to create their food" (Observation – CS1P2). "What's the first thing your dad would do? What's the next step?" Observation – CS1P2).
P3	Jennifer	51 Moderately can do	"And looking at the different steps in problem-solving so that you can get from A to B" (Interview – CS1P3Q2).	[Looking at a group's code] Jennifer – "you've got to know which way to go" Observation – CS1P3).
P4	Rachel	70 Mostly can do	"So, step by step chunks of information that follow a logical pattern. Beginning, middle end kind of thing, and connect with each other to create what you are wanting to create, or solve whatever problem you have, or get the outcome you want, by breaking it into chunks and piecing it into a sequence" (Interview – CS1P4Q1).	[Student reads the algorithm/code and quickly draws the shape] Rachel - "That was really clever that you could draw that shape through just looking at the algorithm" Observation – CS1P4).

ID	Pseudonym	Algorithmic Thinking (median)	Interview evidence	Observation evidence
P5	Daniel	60 Moderately can do	"The steps in what might be the fastest way to do it, there might be an option for a slower way but it might be more complicated. So, it's just finding what's best for each situation because each situation could be a little bit different" (Interview – CS1P5Q1).	 Observation – CS1P5)
P6	Luke	11 Cannot do at all	No interview evidence	No observation evidence
Group median		**51** **Moderately can do**		

Overall, from the survey responses, the teacher participants in CS1 were less self-efficacious describing and understanding algorithmic thinking than they were for decomposition. The group median for algorithmic thinking was 51 which suggested that together, the teachers were *moderately* self-efficacious when describing and understanding algorithmic thinking as part of their planning for CT lessons. An example was from Rachel (median = 70) who was *mostly* self-efficacious and understood algorithmic thinking as *"step by step chunks of information that follow a logical pattern…breaking it into chunks and piecing it into a sequence"* (Interview – CS1P4Q1). Furthermore, Rachel used the term algorithm in her classroom observation when explaining a sequence her students had used, and her students understood what algorithm meant in that context. In contrast, results showed that Luke, (median = 11*) cannot do at all* algorithmic thinking which was supported by no interview or observation evidence. Luke was not part of the government funded 100 hours of professional development, which may indicate why he had low self-efficacy beliefs towards his understanding of how to plan algorithmic thinking at the time of this research.

The findings presented in this section illustrated how teachers in CS1 understood algorithmic thinking as a foundational CT concept. Such findings suggest there is a connection between teachers' self-efficacy beliefs and their understanding of algorithmic thinking as one of the five CT concepts, which contributed to their teacher group self-efficacy median of 51 (*moderately can do*).

In addition, from the survey responses, the teacher participants in CS1 held *moderately can do* self-efficacy beliefs when describing and understanding abstraction for their CT planning (median = 52). The teachers understood abstraction as identifying key information and ignoring the irrelevant information while solving problems. For example, Daniel (median = 62) *mostly* could understand abstraction, and described it as figuring out the best way to complete the task, what information is needed and what is not. In addition, during his classroom observation, Daniel discussed binary code representing letters in the alphabet. He repeatedly stated how the students needed to only focus on what the binary represented to solve the code problem. Similarly, although Kerry (median = 30) held *somewhat can do* self-efficacy beliefs towards abstraction from the survey, she demonstrated her understanding of abstraction several times throughout the observation. Kerry clearly stated what abstraction meant while the students were working on the task and stated how they needed to, *"get rid of that unnecessary information"* (Observation – CS1P1). While it was clear Kerry understood the meaning behind abstraction for the activity during the classroom observation, she was perhaps not as efficacious when relating abstraction to the survey items.

The teachers in CS1 also held *moderately can do* self-efficacy beliefs towards pattern recognition and CT planning. Despite the survey group median of 59, the teacher participants did not explicitly describe pattern recognition during their interviews. Some participants did not have any interview evidence of pattern recognition, yet described it throughout the classroom observation. For example, Kerry (median = 50) could *moderately do* pattern recognition, and explained patterns while the students were completing a snap block code activity. As the students were creating their codes, Kerry commented that they needed to focus on their pattern, both for the code, and the pattern for the snap blocks. On the other hand, Jennifer (median = 68) held *mostly can do* self-efficacy beliefs for pattern recognition, as identified from the survey. In support of this median, during the interview, Jennifer discussed a previous activity where the students had used pattern recognition when creating a code using compass directions. Jennifer also clearly explained the pattern behind binary code during her classroom observation. Similarly, Daniel (median = 72) was *mostly* confident he understood pattern recognition. During the classroom observation, Daniel explained the connection between the pattern the students needed to solve (adding extra 'code' onto the end) and what the pattern represented in terms of binary digits. The teachers in CS1 were moderately self-efficacious in their description and understanding of pattern recognition, yet did not explicitly describe it during the interviews. This may suggest that finding similarities and differences between problems is not as clearly understood in a CT context, and particularly when using digital tools for CT activities.

From the survey responses, the teacher participants in CS1 also held *moderately can do* self-efficacy beliefs when describing and understanding debugging as a core concept for CT planning (median = 60). Most teachers were capable of describing finding and fixing mistakes, both during the interview and the classroom observation. For example, Jennifer (median = 50) was *moderately* confident for debugging in the survey, yet stated during the interview how her students needed to understand debugging as a process when, *"something does go wrong, how do we then fix it"* (Interview – CS1P3Q3). Jennifer's understanding was also evidenced during the classroom observation when she explicitly used the word 'debugging' when asking the students about how they would fix their problem within their code. Similarly, Ashley (median = 70) held mostly confident self-efficacy beliefs. During the interview, Ashley commented that debugging was when the students, *"have to debug it* [a problem] *as well, which is obviously if they make a mistake they need to go and change it"* (Interview – CS1P2Q3). In contrast, one teacher, Luke (median = 30) could somewhat do debugging. While Luke *somewhat can* understand the debugging questions in the survey, he did not provide any evidence of debugging in either the interview or classroom observation. The likelihood behind this is that Luke was not part of the 100 hours of PD before participating in the study, and therefore was not as efficacious when using debugging as a core CT concept.

Lastly, the teachers in CS1 held *mostly can do* self-efficacy beliefs for general problem-solving. Despite the group median of 61, only one participant provided evidence of their understanding of general problem-solving during the interview. Jennifer (median = 77) was *mostly* confident in her general problem-solving skills and discussed how overall, she understood it as a way, *"to deconstruct a problem, or an idea, and use a range of problem-solving skills to then solve that problem"* (Interview – CS1P3Q1). A reason as to why there were minimal explicit descriptions for general problem-solving is because the teachers spent the majority of the interview/observation time explaining CT concepts, rather than problem-solving as a whole.

The findings presented in this section highlight how teachers in CS1 understood abstraction, pattern recognition, debugging, and general problem-solving as foundational CT concepts. Such findings suggest there is a connection between teachers' self-efficacy beliefs and their understanding which contributed to the group self-efficacy median of 51 (*moderately can do*) when planning CT.

4.2.1 Self-Efficacy Summary

In summary, the teachers in CS1 held *moderately can do* self-efficacy beliefs about understanding CT concepts and planning CT. With regards to specific CT concepts, the teachers were most at ease with decomposition, while algorithmic thinking, abstraction, pattern recognition and general problem-solving presented a challenge, and suggested a need for future support with these CT concepts.

4.3 Teacher Efficacy Beliefs and Planning CT Integration

Survey results from planning, sourcing, and designing CT lessons, and teaching CT concepts and CT integration were used to calculate a group median for teacher efficacy beliefs when teaching CT. The group teacher participants' median for teacher efficacy was 67 (see Table 14) and indicated *mostly can do* teacher efficacy beliefs towards planning and teaching CT. The IQR was 41 and this indicated a larger range for teacher efficacy beliefs when teaching particular CT concepts compared to self-efficacy beliefs.

Table 14

Teacher Participants' Teacher Efficacy

		Teacher Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Kerry	50	0	Moderately can do
P2	Ashley	100	0	Totally can do
P3	Jennifer	61	29	Mostly can do
P4	Rachel	100	11	Totally can do
P5	Daniel	73	5	Mostly can do
P6	Luke	36	31	Somewhat can do
Group median		**67**	**41**	**Mostly can do**

The next section details how planning, sourcing, and designing CT lessons, teaching CT concepts, and CT integration medians combined for the group teacher efficacy median. Firstly, focus now turns to the findings related to how participants' teacher efficacy beliefs related to their understanding of how to plan and source material for CT integrated activities. Planning CT integration is the planning and design of CT activities, and CT integrated activities is the enaction of integrating CT across curriculum areas as described in interviews and viewed in classroom observations. Table 15 shows the planning, sourcing, and designing CT lessons survey scale results for each teacher participant, as well as the group median. Rationale for the categories of Table 15 is described in section 3.8.1.

Table 15

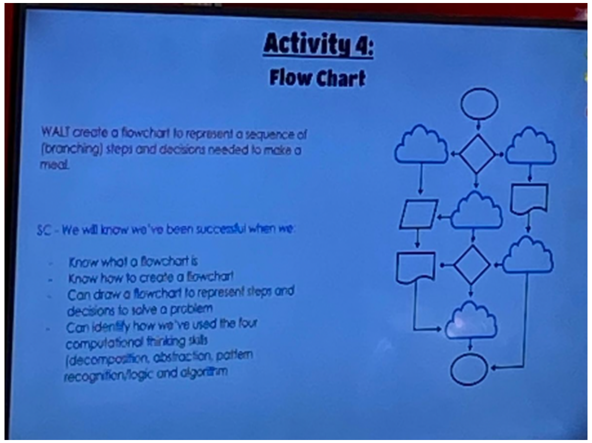
Teacher Efficacy and Planning, Sourcing, and Designing CT Lessons

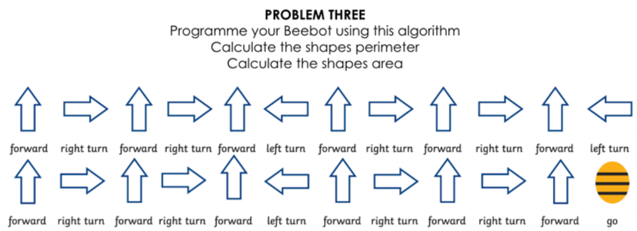
ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)
P1	Kerry	50
P2	Ashley	100
P3	Jennifer	43
P4	Rachel	100
P5	Daniel	64
P6	Luke	52
Group median		**58** **Moderately can do**

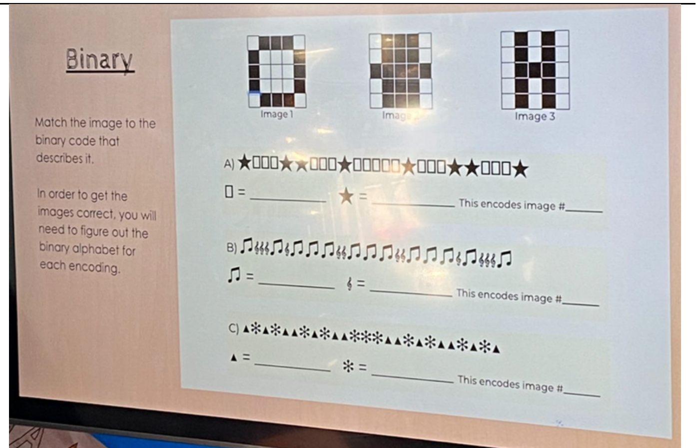
The group median for teachers' efficacy beliefs in CS1 when planning, sourcing, and designing CT lessons was 58 (see Table 15) and indicated the teachers were *moderately* efficacious. The joint display of findings for planning, sourcing and designing CT lessons (Table 16) is used to unpack and explain the group median from Table 15, using findings from interviews and observations.

Table 16

Teacher Efficacy and Planning, Sourcing, and Designing CT Lessons

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P1	Kerry	50 Moderately can do	"Planning side is ok. I guess I feel fairly confident." (Interview – CS1P1Q6) "I've shared resources with - resources that I used last year with new colleagues that are in the junior school this year." (Interview – CS1P1Q8)	Kerry appeared slightly nervous and was checking her planning material often during the session. However, the planning was very thorough and clear. "We're going to create a model, and develop a code for someone else to follow. You're going to create a code, for your friend to follow." (Observation – CS1P1)
P2	Ashley	100 Totally can do	"We plan with different ways [how] we can implement computational thinking." (Interview – CS1P2Q7) "Then we keep on providing, sending them out more resources that they can use as well." (Interview – CS1P1Q9) "We were able to give people resources and help people strengthen their understanding." (Interview – CS1P1Q10)	

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P3	Jennifer	43 Moderately can do	"I really enjoy planning for it - I actually enjoy trying to find ways to do it" (Interview - CS1P3Q6) "I make a lot of lessons and share them to staff, so I'm big on giving them a lesson they can actually do." (Interview - CS1P3Q7) "There aren't as many resources and stuff out there, whereas if you look up other areas you can find things kind of quickly." (Interview – CS1P1Q12)	Jennifer's classroom management skills allowed her to facilitate a CT learning experience for the students. Jennifer demonstrated confidence through her clear and authoritative communication, which made complex concepts more accessible to her students. Her preparedness was evident in the structured and organised way she delivered her lesson, showcasing the effectiveness of her detailed plan (Observation – CS1P3).
P4	Rachel	100 Totally can do	"The planning and getting things ready - I think I'm quite successful with that." (Interview – CS1P4Q6) "I share resources out to other teachers and they have used them, and I've got quite good feedback on that." (Interview – CS1P1Q6)	

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P5	Daniel	64 Mostly can do	"When we plan, I'm very involved in it, so I'm pretty confident. You know, I'm happy to take it and pull stuff apart with them [the team]." (Interview – CS1P5Q4) We've got the knowledge and we've got the resources." (Interview – CS1P1Q2)	
P6	Luke	52 Moderately can do	"I've started [planning] it by partaking in my own PD. So that's helped me develop what I can do, and also my limitations, like 'hey I don't know how to do that, or that'" (Interview – CS1P6Q6)	
Group median		**58 Moderately can do**		

The group teacher efficacy median for planning, sourcing, and designing CT lessons in CS1, was 58 (*moderately can do*). Looking more closely, survey results from Rachel and Ashley, indicated they *totally* could plan, source, and design CT lessons. Rachel and Ashley commented on how they planned both individually and with their teams, and shared sourced resources with other teachers in the school. The positive feedback these two teachers received from sharing their planning and resources contributed to their very high teacher-efficacy beliefs when planning CT integration. Rachel stated how she believed, *"the planning and getting things ready; I think I'm quite successful with that"* (Interview – CS1P4Q6). Furthermore, during the classroom observation of each teacher, it was clear that both Rachel and Ashley had created their own resources and both teachers were calm and confident throughout the observation.

Also, in CS1, were three teachers who were *moderately* efficacious towards planning, sourcing, and designing CT lessons for CT integration. For example, Kerry (median = 50, *moderately can do*) commented that the *"planning side is ok. I guess I feel fairly confident"* (Interview – CS1P1Q6). Kerry discussed how this was her first year teaching a higher year level of students, and because of this, she was not as efficacious towards her planning at the higher level. However, Kerry had previously shared resources that she had created with other teachers of the lower year levels as she had more experience with that age group. Both of these factors contributed to her *moderately* can do teacher efficacy beliefs. Another teacher, Jennifer (median = 43), was *moderately* efficacious in her ability to plan, source, and design CT lessons. During the classroom observation, Jennifer had created her own resource for the lesson. While Jennifer commented, *"I really enjoy planning for it* [CT]. *I actually enjoy trying to find ways to do it* [CT]*"* (Interview - CS1P3Q6), she also reflected that, *"there aren't as many resources and stuff out there* [for CT], *whereas if you look up other areas you can find things kind of quickly"* (Interview – CS1P1Q12). Although Jennifer liked planning for CT, she was less supported by resources already available, which may have contributed to her *moderately* can do teacher efficacy beliefs when planning, sourcing, and designing CT lessons for CT integration.

The findings presented in this section showed how teacher efficacy relates to the teachers' beliefs in their ability to plan, source, and design CT lessons, thus contributing to the overall teacher efficacy median of 58 (*moderately can do*).

4.4 Teacher Efficacy Beliefs, Teaching CT Concepts, and CT Integration

This section further elaborates on findings related to CS1 teacher participants' teacher efficacy beliefs relating to their understanding of how to teach CT concepts – both as a standalone lesson and integrated within other curriculum areas. Combined with planning, sourcing, and designing CT lessons, teaching CT concepts and CT integration contributed to overall group teacher efficacy beliefs. Table 17 shows the teacher efficacy scale results for each teacher participant, as well as the group median. Rationale for the categories of Table 17 is described in section 3.8.1.

Table 17
Teacher Efficacy and Teaching CT Concepts, and CT Integration

ID	Pseudonym	Teaching CT concepts (median)	CT Integration (median)
P1	Kerry	50	45
P2	Ashley	100	100
P3	Jennifer	76	70
P4	Rachel	100	83
P5	Daniel	59	74
P6	Luke	21	36
Group median		**68** **Mostly can do**	**72** **Mostly can do**

The group median for teaching CT concepts was 68 which indicated that teachers were *mostly* efficacious towards their teaching of CT in their classrooms. Table 18 presents findings from teacher participant's interview and observation data to provide a deeper understanding of what is contributing to the group median for teacher efficacy when teaching CT concepts.

Table 18

Teacher Efficacy and Teaching CT Concepts

ID	Pseudonym	Teaching CT concepts (median)	Interview Evidence	Observation Evidence
P1	Kerry	50 Moderately can do	"Finding the quickest route and noticing that there were different routes to get to the same place." (Interview – CS1P1Q3)	"Yes, because we want to use abstraction. So instead of writing purple, we would use what?" (Observation – CS1P1)
P2	Ashley	100 Totally can do	"They have to actually code it and work in teams, and they have to debug it as well, which is obviously if they make a mistake they need to go and change it" (Interview – CS1P2Q3)	"Abstraction - that's what we watched about the man and the car. He needed to focus on the most important thing he needed to do first. Does anyone remember what it was?" (Observation – CS1P2)
P3	Jennifer	76 Mostly can do	"Scratch was really good because you could give them a task and they had to go through the steps to try and get there, and then you had the lingo to be able to say, you know, they had to try to find out where they went wrong." (Interview – CS1P3Q3)	"Some of you did it in my workshop. You had to do a bit of debugging." (Observation – CS1P3)
P4	Rachel	100 Totally can do	"Step-by-step instructions and navigating through maps using different directions and things like that. Having children write down the instructions or follow instructions. Or give them the end output and get them to figure out the instructions behind it" (Interview – CS1P4Q3)	"So how would you work that one out?" [Points through each area of the perimeter and breaks it down alongside the student.] "What kind of shape is it?" (Observation – CS1P4)

ID	Pseudonym	Teaching CT concepts	Interview Evidence	Observation Evidence
P5	Daniel	59 Moderately can do	"I feel like I'm pretty confident, it just depends on the context." (Interview – CS1P5Q4)	"Have we seen any of these numbers before? 1, 2, 4, 8, 16 etc? Who can explain why it looks like that?" (Observation – CS1P5)
P6	Luke	21 Somewhat can do	"I'd say it's mainly around Minecraft. I'm figuring out the code builder, with the class. So, we sort of - I've got a few wizards in my class who teach me stuff, and we share it all out." (Interview – CS1P6Q3)	No explicit links to teaching CT concepts.
Group median		**68** **Mostly can do**		

Overall, the teachers in CS1 (median = 68) reported that they were *mostly* efficacious towards their teaching of CT concepts. Both Rachel and Ashley (median =100) were *totally* efficacious in their CT teaching ability. Ashley in particular mentioned debugging clearly during the interview within a teaching context, and commented, *"they have to debug it as well, which is obviously if they make a mistake they need to go and change it"* (Interview – CS1P2Q3). Both teachers also demonstrated their teaching of CT during the classroom observations when they utilised CT vocabulary with their students and discussed CT concepts as the students progressed through the activities. Another example was from Jennifer (median = 76), who explicitly used CT vocabulary (particularly debugging) during her teaching observation. Jennifer also described her use of Scratch as an example of teaching algorithmic thinking. Both examples from Jennifer illustrated her *mostly can do* teacher efficacy beliefs when teaching CT concepts. While Jennifer provided examples with debugging and algorithmic thinking, her *mostly can do* teacher efficacy median when teaching CT concepts suggested she was less confident with decomposition, pattern recognition, and abstraction.

Daniel (median = 59, *moderately can do*) however, commented how his efficacy when teaching CT was dependent on "the context" which meant he was more confident teaching CT using non-digital methods than with digital tools. In contrast, Luke (median = 21), reported being *somewhat* efficacious in his teaching of CT, and his lower survey median was reflected by no explicit links to his teaching of CT concepts during his classroom observation. The primary way he was teaching CT was through Minecraft (online programming tool), and although he discussed being motivated, and relatively confident when using the program, he discussed that he was at the beginning stages of linking Minecraft to CT concepts, which influenced his teacher efficacy beliefs.

The findings presented in this section showed how teacher participant's beliefs in their ability to teach CT concepts contributed to the overall teacher efficacy median of 68 (*mostly can do*) for CS1 teachers.

Attention now turns to the findings for teacher efficacy and facilitating CT integration. Facilitating CT integration is the teaching of CT activities which are integrated into other curriculum areas (for example, using decomposition as a CT concept within a literacy context). Table 19 presents the group median for CT integration as 72 (*mostly can do*) and presents interview and observation findings which provide insight into the overall group median for CS1 teacher efficacy (median = 68, *mostly can do*).

Table 19
Teacher Efficacy and CT Integration

ID	Pseudonym	CT Integration (median)	Interview Evidence	Observation Evidence
P1	Kerry	45 Moderately can do	"The children are discovering their place in the world - what continent they're in and what country they're in - and they've had to code their way, well, not code - write down on a grid of Oceania how to get to different countries in Oceania" (Interview – CS1P1Q5).	The CT activity was not integrated into another curriculum area (Observation – CS1P1).
P2	Ashley	100 Totally can do	"Particularly integrating it across other curriculum areas. The easiest one that we find is maths, but then I've talked to them about how they could do comprehension questions, they could code comprehension questions on Scratch and then the kids can then code in the answers, and it's a really nice interactive way to see the kids' understanding" (Interview – CS1P2Q7).	The CT activity was creating a flowchart as a series of instructions. This activity was integrated into literacy/writing (Observation – CS1P2).
P3	Jennifer	70 Mostly can do	"Yep, I did a PD on that. Last term. We integrated the school map - so we've got a new school map, and I basically put a table over top with coordinates and we turned it into a coordinates lesson on NSEW and moving in directions and they had to move around the different school zones" (Interview – CS1P3Q5).	The CT activity was using paper/pen code to move through a map. Although not explicit at the time, this activity was integrated into literacy/ social sciences (Observation – CS1P3).
P4	Rachel	83 Totally can do	"I still think that there is a lot more that I can learn in terms of different ideas and ways to integrate it into different subjects and stuff. But I feel confident in teaching it" (Interview – CS1P4Q4).	The CT activity was integrated into Mathematics (Observation – CS1P4).

ID	Pseudonym	CT Integration (median)	Interview Evidence	Observation Evidence
P5	Daniel	74 Mostly can do	"We tried to integrate it into our spelling, literacy etc" (Interview – CS1P5Q2). "Trying to relate it [CT] to our local context - so like, I think we had a Taurikura one, retelling the legend, and how can he get from one place to another" (Interview – CS1P5Q2).	The CT activity was not integrated into another curriculum area explicitly, although it could qualify for finding patterns in Mathematics (Observation – CS1P5).
P6	Luke	36 Somewhat can do	"So the Minecraft thing we did recently, that was around colours and using different colours. And in the code builder for Minecraft, you can actually mix colours using one of the codes" (Interview – CS1P6Q5).	The CT activity was integrated into literacy. The students were presenting their writing using Minecraft (Observation – CS1P6).
Group median		**72** **Mostly can do**		

Overall, the findings showed that teachers in CS1 (median = 72) were *mostly* efficacious towards their teaching ability when integrating CT. Four of the teachers reported *mostly can do* or *totally can do* for their teacher efficacy beliefs when teaching CT integrated activities. For example, Ashley (median = 100) commented how she perceived mathematics to be the 'easiest' subject in which to integrate CT activities (likely due to the cross-over of vocabulary and CT concepts). Yet she also discussed using CT integrated activities for reading comprehension. Furthermore, during the classroom observation, Ashley asked the students to complete handwritten flowcharts as a way to focus on CT concepts and literacy. These examples from Ashley contributed to her *totally can do* teacher efficacy beliefs when integrating CT concepts across other curriculum areas.

Daniel (median = 74) was *mostly* efficacious in his ability to facilitate CT integrated activities. Daniel discussed activities in the past where the students had used Scratch programming software to develop their Te Reo Māori literacy skills and commented, *"we tried to integrate it* [CT] *into our spelling* [and] *literacy"* (Interview – CS1P5Q2). Although Daniel provided examples of CT integration in his past teaching throughout the interview, his classroom observation did not explicitly demonstrate CT integration. In contrast, Luke (median = 34) was *somewhat* efficacious in his ability to teach CT integrated activities in his class. However, during his interview and classroom observation, Luke provided examples for how he had utilised Minecraft for his students to learn about colour combinations in Art as well as literacy, where the students wrote accounts from an off-site trip with pen and paper, and then built those accounts into Minecraft. Despite lower teacher efficacy beliefs for CT integration, Luke demonstrated that he could in fact integrate CT, which indicated that he perhaps was more efficacious towards integrating CT into some curriculum areas while using particular tools, than other areas.

The findings presented in this section provided evidence of how CS1 teachers' belief in their ability to facilitate CT integrated activities, contributed to the overall group median of 72 (*mostly can do*). Both sections for teacher efficacy; teaching CT concepts and integrating CT have presented findings that help to provide insight into the relationship between how teachers facilitate CT integration and their teacher efficacy beliefs contributing to the median of 67 (*mostly can do*).

4.4.1 Teacher Efficacy Summary

The CS1 teacher participants' group median for teacher efficacy was 67 and suggested *mostly can do* teacher efficacy beliefs towards planning and teaching CT. Contributing to this group median, was planning, sourcing, and designing CT lessons (median = 58) reflecting *moderately can do* teacher efficacy beliefs. While some participants held high teacher efficacy beliefs, others faced challenges and reported a lower teacher efficacy median. With regards to teacher efficacy when teaching CT concepts, the group median was 68, and suggested *mostly can do* beliefs. In terms of CT integration, the group median was 72, and also indicated *mostly can do* teacher efficacy beliefs. While the group as a whole could *mostly* teach CT, some participants faced challenges that impacted their perceived efficacy in teaching CT.

4.5 Teachers' Collective Efficacy Beliefs, their Professional Network, and the Planning and Teaching of CT

Collective efficacy beliefs are held by an individual in relation to how they perceive others as successful when working together on a collective endeavour. CS1 teacher participants' group collective efficacy median was 82 (see Table 20) and suggested *totally confident* efficacy beliefs in the group as a whole. The IQR for the group was 25, which suggested that there was moderate variation across collective efficacy beliefs.

Table 20
Teacher Participants' Collective Efficacy

		Collective Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Kerry	70	25	Mostly confident
P2	Ashley	95	11	Totally confident
P3	Jennifer	54	37	Moderately confident
P4	Rachel	100	10	Totally confident
P5	Daniel	82	22	Totally confident
P6	Luke	^^[3]	^^	
Group median		**82**	**25**	**Totally confident**

This section discusses findings connected to how CS1 teacher participants' collective efficacy beliefs related to their planning and teaching of CT. Professional network (from Section 3.9) describes the collaboration between teachers and school leaders and was used as a structure for understanding collective efficacy beliefs of the group. Table 21 presents the collective efficacy survey subscale results for each teacher participant in each category, as well as the group median.

[3] Luke answered 2/22 because he was new to the school and had not had the opportunity to engage with CT alongside the other teachers at the time of the study. Because of this, his data was not included in the teacher-wide total for Collective Efficacy.

The rationale for the categories of Table 21 is described in section 3.7.1. The scale responses for collective efficacy were related to 'confidence' as opposed to 'can do'.

Table 21
Teacher Participants' Collective Efficacy Subscale Medians

ID	Pseudonym	Group computing concepts knowledge and skills	Group technology collaboration and communication	Group capability	Group effort	Group quality of outcomes	General group satisfaction
P1	Kerry	70	100	75	60	50	50
P2	Ashley	50	100	90	81	96	95
P3	Jennifer	11	71	28	42	66	40
P4	Rachel	67	100	90	100	100	100
P5	Daniel	38	89	86	82	80	77
P6	Luke	38	98	68	*	*	*[4]
Group median		**44 Moderately confident**	**99 Totally confident**	**81 Totally confident**	**81 Totally confident**	**80 Mostly confident**	**77 Mostly confident**

For the teachers in CS1, group technology collaboration and communication had the highest group median of 99, and indicated they were *totally confident* in their collective efficacy beliefs in this area. In addition, the teachers were *totally confiden*t about the group's capability and the group's effort (median = 81) for planning and teaching CT. Group quality of outcomes (median = 80) and general group satisfaction (median = 77) indicated that the teachers were *mostly confident* about their peers for these factors. Group computing concepts, knowledge, and skills was lower, and at a median of 44, indicated the teachers were *moderately confident* in their colleagues' abilities when planning and teaching CT. Tables 22 and 23 present the findings from the teacher interviews to further explain the group survey medians. The findings for group capability, and group computing concepts, knowledge, and skills are presented to highlight the

[4] Luke did not answer the survey questions for these sections, so his data is ommited.

difference between the teachers' collective efficacy beliefs for the subscale sections. Findings from the observation will not be presented as the teachers were observed individually and observation information did not contribute to the collective efficacy medians. For brevity, the remaining findings for the other four subscales are presented in Appendices 17-20.

Table 22

Teacher Participants' Collective Efficacy Beliefs and Group Capability

ID	Pseudonym	Group capability (median)	Interview Evidence
P1	Kerry	75 Mostly confident	"Yeah there are some very capable team leaders at our school" (Interview – CS1P1Q11).
P2	Ashley	90 Totally confident	"We actually took the teachers through that [internal PD] and then they are able to take it back to their classrooms and use it, and then we keep on providing, sending them out more resources that they can use as well, and hoping that they are creating their own too" (Interview – CS1P2Q7).
P3	Jennifer	28 Somewhat confident	"That also though comes back to a teacher too - their philosophy, do they have a low floor high ceiling approach to teaching?" (Interview – CS1P3Q9).
P4	Rachel	90 Totally confident	"We have an awesome staff, everyone knows what their strengths are and everyone knows where to go to get the help they need" (Interview – CS1P4Q7).
P5	Daniel	86 Totally confident	"Then it's quite a bit [integrating CT] but everyone's willing to learn" (Interview – CS1P5Q7).
P6	Luke	68 Mostly confident	"But also because the school wants to do stuff, everyone shares different things" (Interview – CS1P6Q10).
Group median		**81** **Totally confident**	

The teachers in CS1 reported they were *totally confident* toward their capability as a group to plan and teach CT, strengthening their professional network. For example, Rachel (median = 90) and Ashley (median = 90) were *totally confident* in the capabilities of the group, commenting that following internal professional development, they perceived that the group was more prepared and capable when planning and teaching CT. Ashley said:

> We actually took the teachers through that [internal PD] and then they are able to take it back to their classrooms and use it, and then we keep on providing, sending them out more resources that they can use as well, and hoping that they are creating their own too (Interview – CS1P2Q7).

In addition, Rachel mentioned that she believed her group knew where to get help if they needed it. This statement was reiterated by Kerry (median = 75) who said that there were some very capable team leaders in the school to support others when implementing CT, which aligned with her *mostly confident beliefs for group capability.*

In contrast, Jennifer (median = 28) was *somewhat confident* in the groups' ability to plan and teach CT. During the interview, Jennifer discussed how she had planned with, and encouraged members of her team to teach CT, but wondered about their confidence levels or motivation to teach CT. Jennifer also discussed how she had completed observations to ensure her team were teaching CT but found that their integration of CT depended on the, *"teacher too. Their philosophy, do they have a low floor high ceiling approach to teaching?"* (Interview – CS1P3Q9). In other words, Jennifer wondered whether her colleagues understood how to provide an entry point for CT activities that were accessible and manageable for students while still offering the potential for more challenging engagement. She also wondered if her group understood how CT could be integrated using both non-digital and digital resources. Both instances contributed to her *somewhat confident* collective efficacy beliefs for group capability.

To further understand collective efficacy and the planning and teaching of CT for teachers in CS1, attention turns to the next subscale category, group computing concepts, knowledge, and skills. The group median for group computing concepts, knowledge, and skills was 44 and meant the teachers were *moderately confident* toward how the group understood computing, and the skills required to plan and teach CT. Table 23 presents interview findings which provide insight into the group median for CS1 teacher participants' collective efficacy beliefs towards group computing concepts, knowledge, and skills.

Table 23
Teacher Participants' Collective Efficacy Beliefs and Group Computing Concepts, Knowledge, and Skills

ID	Pseudonym	Group computing concepts, knowledge, and skills (median)	Interview Evidence
P1	Kerry	70 Mostly confident	"Sharing of resources, if I find good resources, or lesson plans, or come up with a good idea. With the hope that if you share it they'll use it or share back something good that they find" (Interview – CS1P1Q7).
P2	Ashley	50 Moderately confident	"[I've led internal PD] in the context where they're the ones who may not necessarily have the strongest knowledge, and they're able to then use that resource in their classrooms, so they not only have a better understanding of computational thinking, but they feel more confident implementing it into their classrooms as well" (Interview – CS1P2Q8).
P3	Jennifer	11 Not confident at all	"If you're someone that struggles to find those ideas it can be hard to then look at how you can teach it without it being isolated" (Interview – CS1P3Q9).
P4	Rachel	67 Mostly confident	"If you can kind of model how you would teach it to another teacher, or for them to have their kids come back with a really awesome, really excited about the way that you did something - that really opens up those conversations as well" (Interview – CS1P4Q7).
P5	Daniel	38 Somewhat confident	"We've got older teachers who are very able in a lot of areas, that do tried and true things that do work really well, and it's supporting them because they've got the ideas, but they might be a bit worried about trying it, because they're [used to] their reading programme working amazingly like that. And [CT] might not work like that" (Interview – CS1P5Q10).
P6	Luke	38 Somewhat confident	"In this school, I've seen a little bit of Scratch when I've gone and checked out [another teachers'] class" (Interview – CS1P6Q2).
Group median		**44** **Moderately confident**	

The group median for teacher participants' collective efficacy beliefs was 44 and suggested the teachers were *moderately confident* in the group's abilities towards group computing concepts, knowledge, and skills required to plan and teach CT. One teacher, Kerry (median = 70), held *mostly confident* collective efficacy beliefs, and although she did not explicitly discuss her thoughts on how the group understood computing concepts, knowledge, and skills, she did mention that her colleagues shared resources amongst themselves. Utilising resources made or found by another teacher contributed to Kerry's *mostly confident* efficacy towards the group's knowledge and understanding of CT. In addition, Rachel (median = 67) was *mostly confident* about the group's understanding of computing concepts, supported by her comment that her students had successfully completed CT activities with other teachers, and vice versa. Rachel said that by swapping classes, Rachel was confident in her colleagues' ability about their own understanding of computing concepts, knowledge, and skills, and their ability to teach it because she discussed it with them after their students had been in another teacher's class. On the other hand, Jennifer (median = 11) was *not confident at all* about the group's ability for understanding computing concepts, knowledge, and skills. Jennifer discussed instances when she had modelled for other teachers, yet wondered afterward if they had then planned and taught CT. Jennifer had lower collective efficacy beliefs about group computing concepts, knowledge, and skills required to plan and teach CT because she believed her group appeared to lack confidence/ability when they mentioned struggling to find resources, create lessons, and integrate CT.

For group effort (median = 81), the CS1 teachers held *totally confident* collective efficacy beliefs. This meant that as a group, the teachers believed everyone was putting in the required effort when planning and teaching CT. For example, Ashley (median = 81) was *totally confident* in the group and highlighted that the school had provided practical examples to understand CT implementation and next steps for classroom integration. Similarly, Rachel (median = 100) was *totally confident* in the group's effort because she believed there had been significant investment from leadership in teacher development and she believed this supported their confidence when planning and teaching CT. Despite having a lower collective efficacy median for group effort, Kerry (median = 60) reported she was *moderately confident* in the effort of the group. Kerry had shared resources to new colleagues, which was well received. Kerry interpreted this as her group putting effort into planning and teaching CT. Jennifer also held *moderately confident* efficacy beliefs for group effort (median = 42). Jennifer had completed 'walk throughs' of her team's classes, and believed most were putting in some effort for teaching CT. She commented that her group was starting with simple tasks and gradually increasing complexity which helped sustain planning and teaching CT.

The CS1 teacher participants reported *mostly confident* collective efficacy beliefs for group quality of outcomes (median = 80). The teachers who were *mostly confident* were Jennifer (median = 66) and Daniel (median = 80). These two teachers discussed how they believed the group had a systematic approach when reflecting on and implementing CT based on team discussions. Jennifer and Daniel also mentioned that their team, consisting of experienced lead teachers, was capable when planning and teaching CT. Therefore, they were both *mostly confident* in the outcomes of the group. Similarly, Ashley (median = 96, *totally confiden*t) commented that she believed the group understood CT much better after the PD, and they were confident implementing CT in their classes, leading to a high quality of outcomes. Rachel too (median = 100) was *totally confident* in the group's outcomes. She stated, *"our school has made it a priority and I think that it shows in the way that it* [CT*] has been delivered"* (Interview – CS1P4Q13).

For general group satisfaction, the teacher participants in CS1 reported a *mostly confident* group median score of 80. This group median was highlighted by Kerry (median = 50) who held *moderately confident* collective efficacy beliefs according to group satisfaction. Kerry believed her colleagues would be open to sharing their knowledge and allowing classroom observations, however she stated that she had yet to ask them to do so, reflecting her *moderately confident* beliefs for group satisfaction. Similarly, Jennifer (median = 40) was *somewhat confident* because although she was satisfied in the group while the PD was happening, she questioned CT planning and teaching without PD support. In contrast, Ashley (median = 95) and Rachel (median = 100) both held *total confidence* for group satisfaction. Both teachers appreciated the strong collaborative environment and integration of CT into school planning and noted how the group appeared supported which led to their high satisfaction in the group.

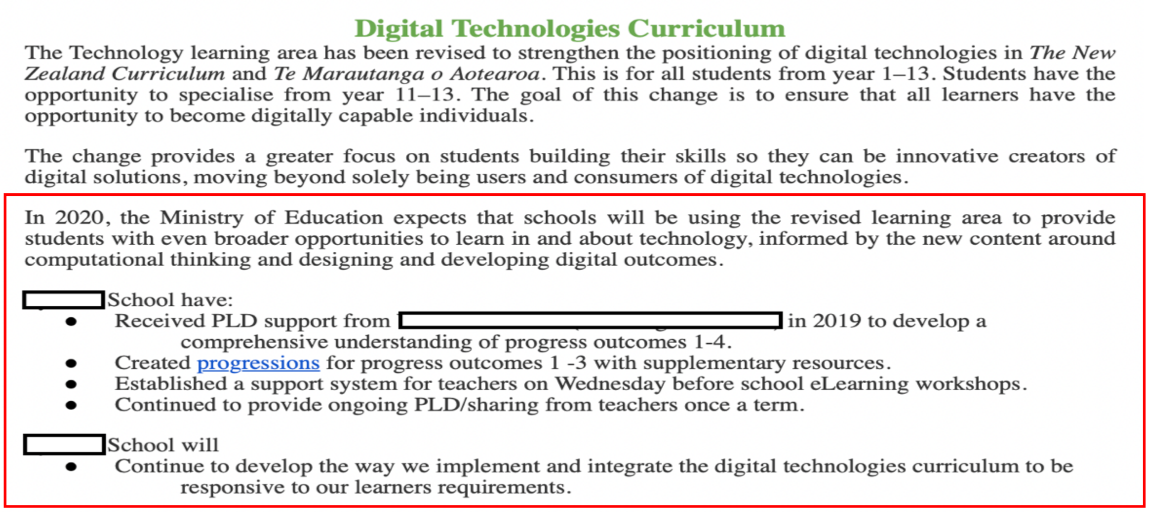
The teacher participants held *totally confident* collective efficacy beliefs for general technology collaboration and communication (median = 99). For example, Rachel (median = 100) believed that CT had become a habitual part of their school's culture, and stated, "*I'm at a school where we are doing a lot of CT and it's becoming a habit with everybody"* (Interview – CS1P4Q14). Daniel (median = 89, *totally confident*) reiterated this point. Daniel discussed the importance of staff collaboration and sharing resources/communication for CT planning and teaching. Jennifer (median = 71) also discussed the importance in collaborating and sharing resources using technology, which led to her *mostly confident* collective efficacy beliefs. Although Kerry (median = 100) and Luke (median = 98) held *totally confident* beliefs, they did not provide explicit evidence for how technology communication and collaboration supported their beliefs.

The findings presented in this section indicate how CS1 teacher participants' beliefs in their group's collective efficacy subscale factors contributed to the overall group median of 82. While individual teacher medians varied, which suggested differences in efficacy among participants, overall, the teachers in CS1 were *totally confident* in the group as a whole when planning and teaching CT.

4.6 Teachers' Collective Efficacy Beliefs and the School Strategy

CS1 had a detailed school strategy document where CT was introduced under the title Digital Technologies Curriculum. The document explained why students were learning CT, and also how school leaders had provided support for the teachers in order to plan and teach CT (see Figure 4). The highlighted section was the focus of the strategy. Throughout the interviews, the teacher participants recognised the importance of a CT school strategy, which was then used as evidence for their collective efficacy beliefs when teaching CT. The teacher participant's overall collective efficacy median was 82 indicating *totally confident* efficacy beliefs in the group when planning and teaching CT.

Figure 4
School Strategy Document



Digital Technologies Curriculum

The Technology learning area has been revised to strengthen the positioning of digital technologies in *The New Zealand Curriculum* and *Te Marautanga o Aotearoa*. This is for all students from year 1–13. Students have the opportunity to specialise from year 11–13. The goal of this change is to ensure that all learners have the opportunity to become digitally capable individuals.

The change provides a greater focus on students building their skills so they can be innovative creators of digital solutions, moving beyond solely being users and consumers of digital technologies.

In 2020, the Ministry of Education expects that schools will be using the revised learning area to provide students with even broader opportunities to learn in and about technology, informed by the new content around computational thinking and designing and developing digital outcomes.

[redacted] School have:

- Received PLD support from [redacted] in 2019 to develop a comprehensive understanding of progress outcomes 1-4.
- Created progressions for progress outcomes 1 -3 with supplementary resources.
- Established a support system for teachers on Wednesday before school eLearning workshops.
- Continued to provide ongoing PLD/sharing from teachers once a term.

[redacted] School will

- Continue to develop the way we implement and integrate the digital technologies curriculum to be responsive to our learners requirements.

Several teacher participants commented how the school strategy supported CT teaching and were aware that other teachers had the same access to those documents, which contributed to the group median for collective efficacy. For example, Rachel (median = 100, *totally confident*) believed the school prioritised CT via dissemination of the strategy document, and this was reflected in the teaching practices of her colleagues. She commented:

> To be honest, our school has made it a priority recently and we've had a lot of investment timewise, and money-wise into making sure that teachers, students and parents are all kind of on the same page with DT [digital technology] and CT. So, I think, yeah, our school has made it a priority and I think that it shows in the way that it [CT] has been delivered (Interview - CS1P4Q13).

Similarly, Daniel (median = 82) also described how the school strategy supported CT learning and placed high value on CT learning. Daniel's beliefs were reflected in his *totally confident* collective efficacy median. Daniel stated:

> We think about our [school] values. We want our kids to problem-solve and make things, you know, fix things themselves instead of always going to someone for help. Understanding CT and a step-by-step process is really valuable for our kids starting at five [years old] (Interview - CS1P5Q13).

In contrast, other teacher participants did not discuss how the school strategy documents supported their collective efficacy beliefs and CT teaching. One teacher, Luke, was new to the school and had not seen the school strategy at the time of data collection. Furthermore, Luke did not answer the survey questions related to group effort, group quality of outcomes, and general group satisfaction, so his collective efficacy total was not included in the results. Despite not having personally worked through the school strategy document, Luke described his perception of how the school strategy might support teaching CT and commented:

> Yeah, I suppose it's well supported. Yeah, I haven't actually had much of the digital curriculum shown to me - not to say that there isn't, I just haven't seen it much. I'd have to keep exploring, I mean I've only been here a term, so I've got a lot to figure out. I don't know enough at this stage to make a full comment on how it's going (Interview - CS1P6Q13).

4.6.1 Collective Efficacy Summary

In summary, the teacher participant median of 82 suggested *totally confident* beliefs in the group's ability to plan and teach CT. Contributing to the group median was the teachers' beliefs in how the group used technology for collaboration and communication (median = 99), the group's capability (median = 81), the group's effort (median = 81), the group's quality of outcomes (median = 80), general group satisfaction (median = 77) and group computing concepts, knowledge, and skills (median = 44). In addition, while some teachers explicitly credit the school strategy for their confidence, others mentioned positive perceptions despite not having personally seen the document. This finding indicates how a well-defined school CT strategy can influence collective efficacy beliefs, while also highlighting the need for ongoing communication between staff to ensure all teachers are aware of and engaged with the strategy.

Part One Summary

Part one has presented CS1 teacher participants' group medians for self-efficacy, teaching efficacy, and collective efficacy beliefs as well as interview and observational findings to support the medians. The overall median for self-efficacy of the teacher participants was 56 indicating the teachers in CS1 held *moderately can do* self-efficacy beliefs towards understanding the conceptual foundations of CT. The overall median for teacher efficacy was 67 and indicated the teachers had *mostly can do* teacher efficacy beliefs towards both facilitating and integrating CT into their classes. Finally, the overall group median for collective efficacy of the teacher participants was 82 indicating *totally confident* collective efficacy beliefs how their colleagues are planning and teaching CT, as discussed under the framing of professional network.

Part two now focuses on the self-efficacy and collective efficacy beliefs of the school leaders in CS1. Teacher efficacy is not reported as the school leaders did not teach CT themselves.

PART TWO

4.7 Self-Efficacy Beliefs and the Conceptual Foundations of CT

What are the relationships between school leaders' efficacy beliefs (self, and collective) and the implementation of CT?

This section presents findings from survey and interview data from school leader participants in case study one (CS1). The school leaders completed the same survey as the teachers (please see Appendix 8). For Likert-scale information and interpretation, please see section 3.8.1. Table 24 presents the group self-efficacy beliefs for school leaders in CS1 (median = 67) and suggested that the school leaders held *mostly* can do self-efficacy beliefs towards understanding and planning CT concepts. The overall IQR was 10 which meant that the school leaders were moderately similar in how they understood and could plan particular foundation CT concepts, contributing to the overall self-efficacy median.

Table 24

School Leader Participants' Self-Efficacy

		Self-Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P7	Brent	65	30	Mostly can do
P8	Eliza	70	10	Mostly can do
Group median		**67**	**10**	**Mostly can do**

Conceptual foundations of CT are perceived as five CT concepts; decomposition, abstraction, pattern recognition, algorithmic thinking, and debugging. The school leaders in CS1 were asked to define and explain their understanding of CT concepts in both the survey, and interview. From here, Table 25 presents the aggregated data for each school leader’s survey responses for the five CT concepts (and general problem-solving) as explained in section 3.7.1.

Table 25

School Leader Participants' Self-Efficacy Subscale Medians

ID	Pseudonym	Decomposition	Abstraction	Pattern Recognition	Algorithmic thinking	Debugging	General Problem Solving
P7	Brent	100*[5]	65	80	65*	*	58
P8	Eliza	70	65	90	70	60	65
Group median		**85 Totally can do**	**65 Mostly can do**	**85 Totally can do**	**68 Mostly can do**	**60 Moderately can do**	**62 Mostly can do**

[5] Brent answered 1/2 questions for decomposition, 2/3 questions for algorithmic thinking and did not answer the debugging question.

The school leaders in CS1 were *totally* self-efficacious in their understanding of decomposition and pattern recognition as conceptual foundations of CT. For abstraction, algorithmic thinking, and general problem-solving, the school leaders were *mostly* efficacious in their understanding, and the school leaders understood debugging the least (median = 60), which indicated they were *moderately* efficacious in their understanding. Tables 26 and 27 presents findings using the school leaders' interview data to explain the group medians. The findings for decomposition (Table 26) and algorithmic thinking (Table 27) are used to highlight the difference between the school leader's self-efficacy beliefs for the two CT concepts. The remaining tables for the other three CT concepts, and general problem-solving, are presented as Appendices 21-24.

Table 26
School Leader Participants' Understanding of Decomposition

ID	Pseudonym	Decomposition	Interview evidence
P7	Brent	100 Totally can do	"My understanding of CT is that it's multifaceted, and that it's like - I suppose I don't really have the application of it at classroom level as such" (Interview – CS1P7Q1)
P8	Eliza	70 Mostly can do	"I see it as a problem-solving process and being able to break aspects down into, you know, manageable components, to be able complete a task or to be able to show a process" (Interview – CS1P8Q1).
Group median		**85** **Mostly can do**	

The school leaders' in CS1 held *mostly can do* self-efficacy beliefs towards understanding decomposition as one of the foundation CT concepts, and the group median was 85. Although Brent (median = 100) stated that CT was, *"algorithms, decomposition, pattern recognition, a series of steps involved in problem solving"* (Survey – CS1P7Q1), later in the interview, he was less certain of his understanding of decomposition as a CT concept. This was likely due to the fact that he primarily works outside of the classroom and did not participate in the 100 hours of professional development. Even though Brent was *totally* self-efficacious towards decomposition as a process of breaking things into smaller problems, he did not have the context of how this is done when planning CT lessons and commented, *"I suppose I don't really have the application of it at classroom level as such"* (Interview – CS1P7Q1).

Another school leader, Eliza (median = 70), was *mostly* self-efficacious in her understanding of decomposition, and explained it in detail throughout the interview. Eliza understood decomposition as, *"a problem-solving process and being able to break aspects down into, you know, manageable components, to be able complete a task or to be able to show a process"* (Interview – CS1P8Q1). Despite this thorough description of decomposition, Eliza stated that she would have to refer back to her lessons and activities from when she was planning CT the previous year to believe she was completely comfortable. Now she was in a school leadership role, Eliza was less efficacious in her understanding of decomposition. Eliza's new role contributed to her *mostly can-do* self-efficacy beliefs towards understanding decomposition, as she was also out of the classroom during the year of data collection.

Attention now turns to the school leaders' self-efficacy beliefs towards their understanding of algorithmic thinking as a foundation CT concept. Table 27 presents findings using interview data to further explain the school leader's group median for algorithmic thinking.

Table 27

School Leader Participants' Understanding of Algorithmic Thinking

ID	Pseudonym	Algorithmic thinking	Interview evidence
P7	Brent	65[6] Mostly can do	"I wouldn't feel overly confident as being the person explaining or delivering it [CT concepts]. I have great confidence in some of my leaders sharing and disseminating that amongst staff, but me particularly as the principal, I wouldn't see that as my strength at present (Interview – CS1P7Q4).
P8	Eliza	70 Mostly can do	"To be able to complete a task or to be able to show a process" (Interview – CS1P8Q1).
Group median		**68** **Mostly can do**	

For algorithmic thinking, the group median was 68 and indicated the school leaders' were *mostly* self-efficacious towards the concept. However, Brent (median = 65) answered 2/3 questions in the survey and commented that he wasn't overly confident explaining the concepts in terms of planning for CT lessons. Brent said, *"I have great confidence in some of my leaders sharing and disseminating that amongst staff, but me particularly as* [a school leader]*, I wouldn't see that as my strength at present"* (Interview – CS1P7Q4). Again, this is likely because he was not involved in the 100 hours of PD, and did not relate his understanding of CT concepts to his particular role in the school. Eliza (median = 70) was also *mostly* self-efficacious in her understanding of algortihmic thinking, and commented that she understood it as, *"to be able to complete a task, or be able to show a process"* (Interview – CS1P8Q1). However, she expressed a desire for more opportunities to explore algorithmic thinking within real-world contexts, which influenced her self-efficacy median.

[6] Brent answered 2/3 questions for algorithmic thinking.

In terms of the school leaders' self-efficacy beliefs towards abstraction as a core CT concept, Brent and Eliza both showed a *mostly can-do* level of confidence, each with a median of 65. Eliza described abstraction as an aspect of breaking a problem into manageable components but did not explicitly discuss focusing on important aspects and ignoring irrelevant details. No specific evidence was provided during the interview for Brent's level of confidence in understanding abstraction. Brent was not involved in the CT PD, which may be a reason behind the lack of interview evidence.

The school leaders' in CS1 again held *totally can do* self-efficacy beliefs for their understanding of pattern recognition. Brent (median = 80) and Eliza (median = 90) both reported a high level of confidence in their ability to understand pattern recognition yet did not provide specific evidence during the interview.

The school leaders' understanding of debugging also lacked supporting evidence from the interview. Brent's confidence level was unspecified due to no survey evidence, while Eliza's confidence in debugging from the survey was *moderately can-do*, with a median of 60.

Similarly, the school leaders' held mostly can do self-efficacy beliefs with regards to general problem-solving. Brent (median = 58), had *moderately can do* beliefs, but there was no interview evidence to support this. Eliza (median = 65), held mostly can do self-efficacy beliefs when problem-solving. Despite these medians, neither school leader provided interview evidence towards their understanding of general problem-solving when planning CT.

As mentioned, the lack of interview evidence for pattern recognition, debugging, and general problem-solving likely stems from the school leaders not participating in the CT PD, and also not having to plan and teach CT themselves.

4.7.1 Self-Efficacy Summary

In summary, findings indicated that Brent and Eliza believed they either *mostly can*, or *totally can* understand CT concepts and this contributed to their overall median for self-efficacy of 67 (*mostly can do*). The school leaders viewed CT concepts in a somewhat holistic way so they could support their teachers, and they did not necessarily understand CT in a way that they themselves could contextualise CT concepts into planning units for students. The main factor explaining this was because the school leaders are out of the classroom, and although these leaders plan the CT strategy for their school, they do not necessarily have to plan with CT concepts in a context that students understand.

4.8 School Leaders' Collective Efficacy Beliefs, their Professional Network, and the Planning of CT

Collective efficacy beliefs are held by an individual in relation to how they perceive others as successful when working together on a collective endeavour. CS1 school leader participant's group collective efficacy median was 95 (see Table 28) and indicated *totally confident* efficacy beliefs in the group. The IQR was 6 and suggested that the school leaders held similar collective efficacy beliefs across the collective efficacy survey questions.

Table 28
School Leader Participants' Collective Efficacy

		Collective Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P7	Brent	100	20	Totally confident
P8	Eliza	90	9	Totally confident
Group median		**95**	**6**	**Totally confident**

This section discusses findings how CS1 school leader participants' collective efficacy beliefs related to their planning of CT. Professional network (from 3.9) describes the collaboration between teachers and school leaders and was used as a structure for understanding collective efficacy beliefs of the school. To support the results, Table 29 presents the collective efficacy subscale results for each school leader in each category, as well as the group median. Rationale for the categories of Table 29 is described in Section 3.8.1.

Table 29

School Leader Participants' Collective Efficacy Subscale Medians

ID	Pseudonym	Group computing concepts knowledge & skills	Group technology collaboration & communication	Group capability	Group effort	Group quality of outcomes	General group satisfaction
P7	Brent	80	80	80	100	100	100
P8	Eliza	60	85	90	100	90	90
Group median		**70 Mostly confident**	**83 Totally confident**	**85 Totally confident**	**100 Totally confident**	**95 Totally confident**	**95 Totally confident**

The school leaders held *totally confident* collective efficacy beliefs across five of the subscales in the survey. For group computing concepts, knowledge, and skills, the leaders were *mostly confident* in how the group planned and taught CT.

Tables 30 and 31 present the findings using the interview data from both school leaders to further explain the group medians. The table for group effort (Table 30) and group computing concepts, knowledge, and skills (Table 31) are used to display the similarities and differences between the school leaders' collective efficacy beliefs for the two subscale categories. The remaining joint displays are presented as Appendices 25-28.

Table 30

School Leader Participants' Collective Efficacy and Group Effort

ID	Pseudonym	Group effort	Interview Evidence
P7	Brent	100 Totally confident	"We want to ensure that everyone is progressing and supported" (Interview – CS1P7Q5).
P8	Eliza	100 Totally confident	"I'd like to think there is quite a bit of integration at our school already" (Interview – CS1P8Q4).
Group median		**100 Totally confident**	

Both school leaders were *totally confident* (median = 100) in their beliefs that their group were putting in the effort required for planning and teaching CT. The school leaders consistently discussed how confident they were in their leaders disseminating the appropriate information and supporting other teachers when implementing CT; linking the professional network of the school to their collective efficacy beliefs. Furthermore, Eliza commented how she was confident that many of the teachers were integrating CT across other areas of the curriculum. This reassurance meant Eliza reported a median of 100 for collective efficacy beliefs and group effort.

To further understand the school leader's collective efficacy beliefs towards the planning and teaching of CT in the school, group computing concepts, knowledge, and skills is presented next. Table 31 shows the findings using the school leader's interview data to further explain the group median for group computing concepts, knowledge, and skills.

Table 31

School Leader Participants' Collective Efficacy and Group Computing Concepts Knowledge and Skills

ID	Pseudonym	Group computing concepts knowledge and skills	Interview Evidence
P7	Brent	80 Mostly confident	"We try to work in our teams to support each other. We will always have the high flyers, but we don't try to build a culture of competition around the high flyers, we want to ensure that everyone is progressing and supported" (Interview – CS1P7Q5).
P8	Eliza	60 Moderately confident	"We sort of got everyone in one go rather than just one person and having to feed that back. So I guess that accelerates the process in terms of the confidence and competence to implement but also just the collegiality of our staff. You can walk into the staffroom and staff conversations are around, they're quite rich" (Interview – CS1P8Q6).
Group median		**70** **Mostly confident**	

The group median for the school leaders' collective efficacy beliefs towards group computing concepts, knowledge, and skills was 70. This median suggested the leaders had *mostly confident* beliefs that the group understood the computing concepts involved in planning and teaching CT. Brent (median = 80) believed there were 'high fliers' in the school who would be the early adopters of any new curriculum, but he also wanted to make sure that every teacher was supported in their CT learning to plan and teach CT. In contrast, Eliza (median = 60) held lower, *moderately confident* collective efficacy beliefs of how the group understood computing concepts, knowledge, and skills. This may be because previously, Eliza was in the classroom and was part of the 100 hours of PD. Her lower collective efficacy beliefs may be reflective of her having first-hand knowledge of the group's understanding of computing concepts, knowledge, and skills. Despite this, Eliza was relatively confident that the group understood group computing concepts, knowledge, and skills because she stated that *"you can walk into the staffroom and staff conversations are around* [CT]*, they're quite rich"* (Interview – CS1P8Q6).

The findings presented in this section demonstrate how collective efficacy related to the school leader participants' belief in their groups' understanding of computing concepts, knowledge, and skills, contributing to the group median of 70 (*mostly confident*).

The school leaders held *totally confident* collective efficacy beliefs (median = 83) for group technology collaboration and communication. Brent (median = 80) was *mostly confident*, noting that their successful initiation of technology in class was facilitated by the staff's readiness, with the CT curriculum falling naturally into place. Brent believed that the teachers were already capable collaborating and communicating when using technology. Similarly, Eliza (median = 85) was *totally confident*, and believed that for CT to be implemented in the school, everyone was already digitally fluent, capable, and competent.

The school leaders were also *totally confident* in their collective efficacy beliefs for group capability (median = 85). Both leaders mentioned their beliefs in the capabilities of the teacher team leads. For example, Brent (median = 80) was *mostly confident* in the groups' capability, particularly in his teacher leaders to effectively share and disseminate information among the staff. Eliza (median = 90) was totally confident, and noted that the staff were already quite confident with the process of planning and teaching CT.

In addition, the school leaders in CS1 were totally confident in the groups' quality of outcomes when planning and teaching CT. Brent (median = 100) was *totally confident* and believed the important factors were teachers' professional outreach and resourcing and commented that experience varied among educators in terms of their outcomes. Similarly, Eliza (median = 90) was also *totally confident* about the group integrating the full curriculum with digital technologies, and believed the quality of CT planning and teaching outcomes were high because the group understood the significance for learners' futures rather than merely fulfilling requirements.

Lastly, the school leaders in CS1 were highly satisfied with the group and how they planned and taught CT. The group median of 95 suggested *totally confident* collective efficacy beliefs and believed that they and the staff were all satisfied with CT implementation in the school. For example, Brent (median = 100) was *totally confident* and believed the whole staff had both an understanding and a willingness to adapt their teaching. Eliza (median = 90) shared this *total confidence* and commented that she believed their approach for CT implementation had not only accelerated the staff confidence and competence but also strengthened the collegiality and collaborative spirit among staff.

The findings presented in this section demonstrate how the survey subsection medians related to the school leaders' collective efficacy beliefs, contributing to the overall group median of 95 (*totally confident*).

4.9 School Leaders' Collective Efficacy Beliefs and the School Strategy

The school leaders had developed a school strategy document where CT was introduced under the title Digital Technologies Curriculum (see Figure 4). Interview findings were utilised from school leader participants discussing how the school strategy supported their collective efficacy beliefs. The school leader's overall collective efficacy median was 95 indicating *totally confident* efficacy beliefs in the school staff towards planning and teaching CT.

Both school leaders commented on their perception of how the CT school strategy supported their staff, which contributed to their own collective efficacy beliefs. Brent (median = 100) was *totally confident* the staff knew how to plan and teach CT, and discussed how the strategy was often a focal point during internal staff meetings. Brent commented how an important part of this was *"sharing way back at a leadership level, and then disseminating intentions, like incorporating into the strategic plan and then using the leadership team to sort of drive that, those initiatives across the school"* (Interview – CS1P7Q3). Similarly, Eliza (median = 90) was *totally confident* in her collective efficacy beliefs, and mentioned how the school strategy supported CT integration across wider strategic goals. Eliza said that there was a *"constant lens on CT, and this year in particular, a constant lens to make sure it's not just about 'oh we do CT one afternoon, one hour a week', it's around 'how can we deliver our curriculum through CT?'"* (Interview – CS1P8Q8).

4.9.1 Collective Efficacy Summary

In summary, the overall school leader participant median of 95 suggests *totally confident* beliefs in the group's ability to plan and teach CT. Contributing to this overall median was the school leader's beliefs in how the group utilised computing concepts, knowledge, and skills (median = 70), group technology use for collaboration and communication (median = 83), group capability (median = 85), group effort (median = 100), group quality of outcomes (median = 95), and general group satisfaction (median = 95). Furthermore, the school leaders believed their staff were well supported by the CT school strategy and knew where to find help or answers for their questions which also contributed to their *totally confident* collective efficacy beliefs.

Part Two Summary

Part two has presented the school leader participants' medians for self-efficacy, and collective efficacy beliefs as well as interview findings to help to understand the medians. The overall group median for self-efficacy of the school leader participants was 67 indicating the school leaders in CS1 *mostly can* understand and plan with CT foundation concepts. In addition, the group median for collective efficacy of the school leaders was 95 and indicated *totally confident* collective efficacy beliefs towards how their group are planning and teaching CT, as discussed as part of their professional network.

Part three of the chapter now turns to the factors that support or undermine sources of efficacy judgements for both teachers and school leaders of CS1 when planning and teaching CT.

PART THREE

4.10 Factors that Support or Undermine Efficacy Judgements

What factors support or undermine sources of efficacy judgements when planning and teaching CT?

This section discusses the group median for each efficacy type as well as the four sources of information on which efficacy judgements are made, and the factors that supported and/or undermined self, teacher, and collective efficacy beliefs when planning and teaching CT. Both teacher and school leader participants' findings are reported together because the results were not different between the two groups (see Table 32).

Table 32
School-wide Efficacy Medians and IQR for Case Study One

Efficacy Type	n	Median	IQR	Interpretation
Self-efficacy	8	62	23	Mostly can do
Teacher Efficacy	6	67	41	Mostly can do
Collective Efficacy	8	90	22	Totally confident

The school-wide self-efficacy median for teacher and school leader participants (collectively called participants in this section) was 62 (*mostly can do*) with an IQR of 23. The teacher efficacy median did not change (median = 67, *mostly can do*) with an IQR of 41, because the school leaders did not have teacher efficacy measured as they were not teaching CT. The school-wide collective efficacy median for both teacher and school leader participants was 90 (*totally confident*) with an IQR of 19.

In addition, Table 33 presents the factors that were identified to either support or undermine self, teacher, and collective efficacy beliefs. Table 33 indicates whether the four sources of efficacy judgements are supported (S) or undermined (U) for all participants in CS1. The four sources of efficacy judgements are enactive mastery, vicarious experiences, social/verbal persuasion, and physiological states (Bandura, 1997, as described in Chapter 2). The factors identified that supported efficacy judgements were Professional Development (PD), resources, and teacher collaboration. The factors that undermined efficacy judgements were PD, lack of resources, and lack of time. Both supporting and undermining sources of efficacy judgements are described under each factor.

Table 33

Factors Supporting/Undermining Sources of Efficacy Judgements of CS1 Participants

Sources of efficacy judgements	**Enactive mastery**			**Vicarious Experiences**			**Verbal Persuasion**			**Physiological States**		
Type of efficacy	SE	TE	CE	SE	TE	CE	SE	TE	CE	SE	TE	CE
PD	S/U	U	S	S	S	S	S		U			
Resources		S/U									S/U	
Time	U	U										
Collaboration	S	S	S			S						

SE – self efficacy, TE – teacher efficacy, CE – collective efficacy.
S supported, U undermined.

4.10.1 Professional Development (PD)

All teacher and school leader participants discussed PD as a factor that either supported their efficacy judgements (enactive mastery (i.e. success), vicarious experiences, and verbal persuasion or undermined their efficacy judgements (enactive mastery (i.e., failure), and verbal dissuasion) for planning and teaching CT (Table 33). PD was a factor that, depending on the situation, either supported or undermined efficacy judgements contributing to the school-wide self-efficacy median of 62 (*mostly can do*), the teacher efficacy median of 67 (*mostly can do*), and the school-wide collective efficacy median of 90 (*totally confident*).

PD Supporting/Undermining Enactive Mastery. The following findings are evidence of how PD (either through a government funded facilitator, internal school-wide PD, or off-site PD) contributed to school-wide enactive mastery (or failure) for planning and teaching CT. An enactive mastery experience is when a person has had previous experiences of success in an activity which leads to their future belief in their ability to succeed. Failure can result in a person focusing on the previous failure in future performance.

When asked about experiences Rachel thought were supportive in her understanding of CT contributing to her *mostly can do* self-efficacy beliefs (median = 79), she reflected on the PD she completed with a government-funded external facilitator. Rachel was supported because she actually engaged in learning the content and said that she, "*got really intensive training on what CT was and from there we actually got to do some hands-on activities to see what it is in action and how we can teach it"* (Interview – CS1P4Q2). Similarly, Jennifer (median = 62, *moderately can do*) believed the PD supported her ability to practice CT learning, because the content was organised into modules which could be referenced at a later date. Jennifer was positive about, *"having them* [CT information] *in modules so I can go 'oh I need to go back to the start' so I'll go back to the first module and I'll look at the basic stuff"* (Interview – CS1P3Q2). Ashley (median = 50) too, remarked how the time spent during PD sessions meant she was able to complete the activities herself prior to teaching the students. Despite this experience providing Ashley an opportunity to master the content, she still reported she *moderately can* understand CT and plan accordingly. This suggested she may require additional support to understand CT fully and be efficacious planning it. Ashley stated:

> We had a PD facilitator come in and teach it to us and then we were able to go teach our teams about computational thinking. So, it was done in a way where there was actually activities that helped cement the new knowledge that we were then able to use with our students (Interview – CS1P2Q2).

In contrast, Kerry (median = 30, *somewhat can do*) discussed that although the PD initially helped support her own enactive mastery in planning CT, her self-efficacy was lower because she was less confident due to a change in year level. Kerry commented how the PD had undermined her self-efficacy beliefs and believed CT planning PD should be more targeted to address the teachers' needs. Kerry said:

> The PD that we did, and that management [school leaders] did in addition to the external PD that we did, was so targeted to the year group that I was in, that I left feeling incredibly confident [last year]. And now with a change in year group, and not a small step - I've gone from teaching year one to teaching year four and five. It's been such a big change and I guess there is that added pressure (Interview – CS1P1Q4).

PD had both supported and undermined enactive mastery experiences for the participants in CS1, thus contributing to their school-wide self-efficacy median.

Enactive mastery experiences either supporting or undermining teacher efficacy beliefs by professional development (PD) were not discussed as often compared to self-efficacy beliefs. A possible explanation is because the participants in CS1 mentioned successful or failure experiences when they were teaching CT to their students; not while they were participating in PD. One noticeably different example, however, was from Kerry, where although she was part of the full 100 hours of government funded PD at all age levels, she was not efficacious in her teaching of CT at the higher age level she currently taught, which led to her *moderately can do* teacher efficacy beliefs (median = 50).

PD was also viewed as a way to support enactive mastery, contributing to collective efficacy beliefs. The school-wide collective efficacy median was 85, indicating that all participants were *totally confident* their group had mastered planning and teaching CT. The group had an overall interquartile range of 13, which meant that there was little variance in all participant's collective efficacy scores. An explanation for this, was that the school had initially focused on CT as a new technology learning area and provided PD to unpack the curriculum documents as a staff, before seeking external PD. School leader Brent (median = 100, *totally confident*) stated that PD access and funding through the Ministry of Education was a way forward for the school staff to engage in CT planning and teaching – he believed PD supported staff's enactive mastery:

> Another help to implement it [CT] was external funding, external resourcing. I think that was huge. The Ministry making that commitment to the implementation of the DTC [Digital Technologies Curriculum]. Like any time that the MoE [Ministry of Education] gets in there and resources it (Interview – CS1P7Q6).

The school leaders had also allocated time for teachers to learn CT (via internal PD) and this investment contributed to their high overall collective efficacy beliefs. The teachers believed internal PD allowed them time to practice CT activities further throughout the year. Rachel (median = 100) was *totally confident* and stated:

> [The] school does a relatively good job at teaching CT and I think it's because we had quite a big investment from leadership in getting the teachers confident in doing so, through [government funded] PD and the ongoing opportunities with that that we've had as a school. So, all the teachers feel confident, and they feel capable of teaching it (Interview – CS1P4Q10).

These findings indicate that PD supported and undermined teachers' and school leaders' enactive mastery for planning and teaching CT, contributing to the school-wide median for self, teacher, and collective efficacy beliefs.

PD Supporting Vicarious Experiences. According to Bandura (1997) the second most influential source of efficacy judgements are vicarious experiences. A vicarious experience is when a person observes successful behaviour from a valued role model and believes they can then successfully complete a similar task. The following findings are evidence of how external, government funded PD supported the vicarious experiences of teachers and school leaders, contributing to the overall self, teacher, and collective efficacy medians for CS1.

PD was discussed as a way for teachers to learn vicariously from the facilitator or a peer. This learning contributed to the school's self-efficacy (median = 62, *mostly can do*) and teacher efficacy (median = 67, *mostly can do*). For example, Jennifer (median = 62) believed her *mostly can do* self-efficacy beliefs were supported because of how "[the PD facilitator] *actually did the lessons with us and gave us, modelled the lessons, so I pretty much just keep thinking of the experience I had, and I remember it because I actually did it"* (Interview – CS1P3Q11). While Luke (median = 30, *somewhat can do*) had attempted to learn vicariously from another teacher who somewhat supported him, he had not participated in any formal PD for planning and teaching CT. Because of this lack of PD opportunity, had a lower self-efficacy median. Luke commented that:

> In this school, I've seen a little bit of Scratch when I've gone and checked out [another teacher's] class. I hadn't really seen it, my previous school didn't really use really any digital tech so I hadn't really seen much of it, but I'd heard about Scratch" (Interview – CS1P6Q2).

In terms of teacher efficacy, Ashley described how the external PD experience supported her to learn vicariously and gave her opportunities to ask questions and clarify any misunderstandings about CT. She noted that because of this PD experience she was able to empathise with how students feel when first being introduced to CT, which influenced how she believed she could *totally* teach CT to her students (median = 100):

> I found it really beneficial because we could actually experience what our students would be feeling like when we were introducing it. So, if there was anything that we didn't understand, we knew that we had to be really clear on that when we were explaining it to the students and that we clarified things we were unsure of before we taught it so we weren't just going in and winging it (Interview – CS1P2Q2).

With regards to collective efficacy, Brent commented how the PD was delivered as a supportive factor for vicarious learning (median = 100, *totally confident*). He discussed how a government funded PD facilitator taught the teachers, allowing the teachers to learn the content vicariously. This new learning was followed by observations with the facilitator in each teachers' class to see the new learning in action and provide feedback. Although Brent was not personally teaching CT, his understanding of the PD delivery contributed to the collective efficacy beliefs of the school as he was confident that all staff were learning the same content, and in the same manner. Brent commented that *"we particularly really appreciate opportunities for it* [CT] *to be modelled and then* [followed by] *classroom observations. I think that's the most powerful form of PD we can get"* (Interview – CS1P7Q2).

Internal PD was also a way for teachers to learn vicariously from their peers. An example was from Kerry whose collective efficacy beliefs (median = 70, *mostly confident*) were supported by her understanding that her peers were willing and able to demonstrate how to teach CT, and she could learn vicariously from them when needed. Although Kerry had not used the opportunity to learn vicariously yet, she commented, *"there are some very capable team leaders at our school. Yeah, and I'm sure if asked they would be more than willing to come and show or allow me or other teachers to observe them and learn"* (Interview – CS1P1Q11).

Both school leaders' and teachers' vicarious experiences were supported by government funded and internal PD. These experiences have contributed to their self, teacher, and collective efficacy belief medians.

PD Supporting/Undermining Verbal Persuasion. Verbal persuasion refers to encouragement from individuals whom the person performing the task values, which can significantly influence their self-efficacy beliefs. Conversely, verbal dissuasion from these valued individuals can have a negative effect (Bandura,). The following findings are evidence of how PD provided an opportunity for teachers and school leaders to discuss the planning and teaching of CT, which contributed to the school-wide self, and collective efficacy medians for CS1.

During PD, verbal persuasion was evident in the support provided for planning and teaching CT for teachers, and in school leaders' planning, positively contributing to the group's self-efficacy beliefs (median = 62, *mostly can do*). For example, Jennifer (median = 62) commented that after completing internal PD, her self-efficacy was *mostly* supported. She said that staff discussed CT and they, *"could just share what their feelings were* [about CT planning] *and from there they were able to create a conclusion"* (Interview – CS1P3Q8). In addition, Rachel (median = 79, *mostly can do*) believed that opportunities to discuss CT planning with other teachers, supported her self-efficacy beliefs. She stated:

> I think that's a cool way to do it because if you can kind of model how you would teach it to another teacher, or for them to have their kids come back with a really awesome, really excited about the way that you did something - that really opens up those conversations as well (Interview – CS1P4Q7).

However, some discussions during PD sessions had the opposite effect, dissuading certain participants and negatively impacting their collective efficacy beliefs and survey results. In terms of collective efficacy beliefs, Kerry believed that PD was a factor that undermined her collective efficacy beliefs through verbal dissuasion. Even though in the survey, Kerry reported an overall median of 70 (*mostly confident*), she believed that the school had "[done] *the PD and then it not be really talked about again. You know, it feels like it's in isolation. It would be great if the conversation was continued"* (Interview – CS1P1Q10). Furthermore, verbal dissuasion helps to explain Jennifer's moderately confident collective efficacy beliefs (median = 54. Jennifer stated:

> If you've got a couple [of staff members] who are in the staff room talking, it's easy for their opinion to become the main. So, I guess if you don't have someone pushing it, it could easily become overruled quickly, because you've got less people to bounce back (Interview – CS1P3Q10).

While PD supported CS1 participants self-efficacy through verbal persuasion, collective efficacy was undermined by verbal dissuasion. These experiences contributed to the school-wide self, and collective efficacy belief findings. The participants in CS1 did not feel that their physiological states were either supported or undermined by PD.

The previous sections provided insight into how PD affected teachers' enactive mastery (i.e. success), vicarious experiences, and verbal persuasion, or undermined their efficacy judgements (enactive mastery (i.e., failure), and verbal dissuasion for planning and teaching CT. The efficacy judgements either supported or undermined during PD provide insight into the school-wide self-efficacy median of 62 (*mostly can do*), the teacher efficacy median of 67 (*mostly can do*) and the school-wide collective efficacy median of 90 (*totally confident*).

4.10.2 Resources

The following findings help to provide insight into the school-wide teacher efficacy score of 67 (*mostly can do*) and how enactive mastery experiences, and physiological states (i.e., emotional experiences) were supported or undermined by the availability/or not of resources (digital and non-digital) when planning and teaching CT. School leaders are not included in this section because they were not teaching CT themselves. As a reminder, non-digital resources refer to paper lesson plans, pen, and paper activities whereas digital resources are technology devices (laptops, robotics, and online software). There were no examples of how self-efficacy or collective efficacy beliefs were supported or undermined by resources for CS1.

Resources Supporting/Undermining Enactive Mastery. Both digital and non-digital resource availability were discussed in relation to teachers' success or failure for teaching CT. The median for teacher efficacy was 67 or *mostly can do*, and the teacher participants described how access to non-digital and digital resources supported their teaching of CT, which also helped to support their teacher efficacy beliefs. For example, Ashley (median =100, *totally can do*) discussed her approach to teaching CT with non-digital resources and how they supported her enactive mastery, stating, *"I think you need to start off a device because if you have those foundations and the understanding really clear for the students, then when they get on a device they understand more"* (Interview – CS1P2Q5). Similarly, Daniel (median = 73*, mostly can do*) commented that he is moving away from device use as he has witnessed an increase in student engagement when the students are off a device. Daniel described his enactive mastery being supported by non-digital resources:

> We've used a lot of the non-digital stuff, because I find that quite good. We have a lot of [digital] devices and we're trying to, well I'm trying to get a little away from them in some ways, because the kids sort of engage a lot more with physically moving, or walking, or doing something (Interview – CS1P5Q2).

The teacher participants also identified the role of digital resources (hardware and software) as supportive of their enactive mastery (i.e., success) when teaching CT because they could practice with the tools. Access to particular hardware was a factor commonly mentioned, with Luke stating that, *"coming to this school where there are like 1:1 devices. Sorry, that's a huge thing already - access to devices"* (Interview – CS1P6Q10). Despite having limited exposure to teaching CT previously, Luke valued using online software tools to develop his enactive mastery when teaching CT. While his teacher efficacy median was 36, (*somewhat can do*), lower than that of other participants, Luke believed he had a natural affinity for teaching CT with technology and seeing the students enjoy the tasks drove his motivation. He commented that, "*I guess I have the bonus that it does come relatively naturally to me, and I know the kids really like it - so there are two really good motivators there"* (Interview – CS1P6Q9). Similarly, Ashley also valued digital resources when teaching CT, and commented that she was, *"very confident* [teaching CT]. *I was in a multimedia setting for 4 years"* (Interview – CS1P2Q4) which aligns with her very high *totally can do* teacher efficacy median of 100. To exemplify her high confidence when teaching CT, Ashley gave an example of when she has used Scratch (an online software programming tool) with her class:

> There are other things like using Scratch because that helps with teaching how to code and it's in a basic form so they can actually understand and they can see how if they write a particular code, that it'll make a particular shape, or something move. I sometimes get them to write the code, and a buddy has to then try the code and see what it will do (Interview – CS1P2Q4).

The discussion with the researcher about access to both digital and non-digital resources highlighted how the enactive mastery of CS1 teachers was either supported or undermined when teaching CT. This, in turn, influenced their *mostly can do* teacher efficacy beliefs.

Resources Supporting/Undermining Physiological States. Resources emerged as a factor that was related to teachers' positive and negative physiological states when teaching CT. In one example, Daniel (median = 73, mostly can do) commented how he had used non-digital resources for his class to learn CT, and how the student's reaction to the resources affected how he felt, and subsequently his teacher efficacy beliefs. Even though he discussed some students not enjoying a particular activity, Daniel was positive about teaching CT:

> I've [made] a really cool CT lesson, the kids didn't really like it, oh you know, they didn't really engage with it as much as I thought. I thought it was awesome but then you do one you think is only ok but they think is awesome, so it's sort of like, yeah, I'm pretty confident (Interview – CS1P5Q6).

In contrast, Kerry (median = 50, *moderately can do*) had changed year group, moving from teaching year one students (age 5/6) to teaching year four and five students (ages 8/9). Kerry commented how the change in student's ages affected her physiological state in a negative way because she was required to use more technology with the older students and did not feel as efficacious teaching CT with digital resources. Despite knowing she was fortunate to have the access to the resources, Kerry commented that the change was difficult, "[having] *gone from 6 iPads in a class to 1:1 devices. That's been a big change"* (Interview – CS1P1Q4). She continued that, *"I found it easy last year* [teaching CT]. *This year,* [I find it] *incredibly tricky with the new year group and learning. I currently feel like, um, like a duck frantically paddling on water"* (Interview – CS1P1Q3).

The previous sections provided insight into how accessibility to both digital and non-digital resources affected teachers' enactive mastery and physiological states, contributing to the school's overall *mostly can do* teacher efficacy median when teaching CT.

4.10.3 Time

Many teacher participants in CS1 discussed a lack of time as a factor that undermined their enactive mastery for planning and teaching CT, contributing to the school-wide self-efficacy median of 62 (*mostly can do*), and teacher participant median for teacher efficacy (median = 67, *mostly can do*).

Lack of Time Undermining Enactive Mastery. The teacher participants in CS1 mentioned a lack of time as a factor when attempting to plan and teach CT, due to not having the experiences required to understand, plan, and practice CT to build confidence. This impacted both self, and teacher efficacy beliefs. For example, Jennifer commented that a lack of time was an issue for her when trying to understand CT content, which influenced her mostly can do self-efficacy beliefs (median = 61). She stated, *"when I think about it, I often need to have to sit down* *and actually take my time to unpack it"* (Interview – CS1P3Q3). Furthermore, time was a factor that influenced her enactive mastery beliefs for teaching CT strategies and therefore impacted her teacher efficacy beliefs:

> [I need to] go through the process a little bit slower or do a reflection circle. So probably the planning side of it, it's got everything, it's just the teaching side of it, I need to make more time to make sure that they understand the whole reasoning (Interview – CS1P3Q6).

Similarly, Luke stated how a lack of time affected his enactive mastery beliefs for teaching CT, and his teacher efficacy beliefs (median = 36, *somewhat can do*). Luke believed he needed to dedicate more time to learn how to teach the content well rather than teaching it without having previously gone through it himself. He said:

> It's cool to teach those lessons but the time required for me to understand it, I have to fit that in somewhere - I can't just go 'hey we are doing a Minecraft lesson today' and do ten minutes beforehand and wing it. I did try that once and it didn't work [laughs] I realise now I've always got to do it first (Interview – CS1P6Q9).

Kerry (median = 50, *moderately can do*) had a similar perception of how a lack of time undermined her enactive mastery and efficacy when teaching CT. She emphatically spoke of:

> Time, a full curriculum and not enough time. The school day could be ten hours. There's nothing more to add. There is a lot to fit into my day. And Art and all the other great stuff gets missed, or dropped, or squashed – timewise (Interview – CS1P1Q9).

A lack of time undermined teachers' self, and teacher efficacy beliefs because they did not believe they had the time to practice planning and teaching CT, which helps to explain the school-wide self, and teacher efficacy belief medians for CS1. However, no evidence was found of a connection between lack of time either supporting or undermining CS1 participants' vicarious experiences, verbal persuasion, or physiological states.

4.10.4 Collaboration

An additional factor supporting the teachers and school leaders' sources of efficacy judgements was collaboration. Collaboration was supportive of enactive mastery and vicarious experience efficacy judgements for participants in CS1. Most participants discussed collaborative planning as a factor that supported the planning and teaching CT, contributing to the school-wide group medians for self-efficacy (median = 62), teacher efficacy (median = 67) and school-wide group collective efficacy (median = 90). There were no evidence from participants of how collaboration undermined the four efficacy judgements (see Table 33).

Collaboration Supporting Enactive Mastery. CS1 participants found collaboration to be supportive of their efficacy beliefs when planning and teaching CT. In particular, Daniel (median = 62, *mostly can do*) described how planning collaboratively supported his enactive mastery and contributed to his self-efficacy beliefs. He commented how, *"when we plan, I'm very involved in it, so I'm pretty confident. You know, I'm happy to take it and pull stuff apart with them"* (Interview – CS1P5Q4). In addition, Eliza (median = 70) believed her enactive mastery for planning CT was supported when collaborating with other staff members, contributing to her *mostly can do* self-efficacy beliefs. Eliza commented that, *"we plan as either team or as a school. Looking at, just like we do with all our curriculum areas, looking at how the theme for the term and the problems lend themselves toward CT"* (Interview – CS1P8Q3).

Sharing resources in collaboration with other teachers also supported some teacher's enactive mastery experiences and impacted their teacher efficacy beliefs for teaching CT. Ashley (median = 100, *totally can do*) commented, *"I make resources and share them out, and other staff do that as well"* (Interview – CS1P2Q9). Similarly, Kerry (median = 50, *moderately can do*) also commented that she had, *"shared resources that I used last year with new colleagues that are in the junior school this year. And they used it, which was great"* (Interview – CS1P1Q8) which showed that collaboration supported her enactive mastery for teaching CT, and Kerry's teacher efficacy beliefs were supported by knowing the other teachers used her shared resources.

In terms of collective efficacy, Daniel (median = 82) also commented how planning collaboratively with his team impacted his enactive mastery, contributing to his *mostly confident* collective efficacy beliefs:

> We share within our team. Our team at the moment is three lead teachers [and they] are very au fait with it as well. So, we have it in our plans and we try to integrate all our planning, one of our focuses is how can we bring it [CT] in? (Interview – CS1P5Q7).

Daniel believed collaboration supported his collective efficacy beliefs because when planning together, he witnessed his teammates' abilities for planning and teaching CT.

Findings presented here suggest that collaborative planning and sharing of resources affected these teachers' enactive mastery experiences, contributing to the school-wide self, teacher, and collective efficacy medians.

Collaboration Supporting Vicarious Experiences. Collaborative planning was also identified as a factor that supported vicarious experiences, that contributed to the school-wide collective efficacy beliefs (median = 90, totally confident) of CS1 participants. Several participants shared their ideas of how vicarious experiences were supported through planning as a team and sharing resources. For example, Ashley (median = 95, totally confident) commented:

> My team understands what we are doing with implementation and they are also able to ask questions, and it's quite a, we learn from each other type of thing as well. I think it's good, because it means that they feel confident in their understanding as well to share ideas (Interview – CS1P2Q6).

Eliza (median = 90) also commented how vicarious experiences via teacher collaboration supported her *totally confident* collective efficacy beliefs. Eliza stated that during meetings her colleagues shared their CT learning, and *"you've got to make sure we continue to celebrate the progress and remind ourselves not only of the expectations but the journey we've been on so that richness doesn't get lost"* (Interview – CS1P8Q9). In addition, Brent (median = 100, *totally confident*) had his collective efficacy supported via vicarious experiences when they shared their learning experiences and stated that during team meetings the staff were often:

> Sharing what's happening, sharing the positives, sharing the frustrations, and making everyone aware that we all have areas of need or areas that we are growing in, and also areas of strength. And then just making sure that we have the necessary support mechanisms along the way (Interview – CS1P7Q5).

Collaboration meant CS1 participants were able to work with each other to practice planning and teaching CT, supporting their enactive mastery and vicarious experiences which helps to explain the school-wide self, teacher, and collective efficacy belief medians. However, no evidence was found of a connection between collaboration either supporting or undermining CS1 participants' verbal persuasion, or physiological states.

Part Three Summary

Part three presented the factors identified as influencing the four sources of information on which efficacy judgements are made and whether the factors supported and/or undermined self, teacher and collective efficacy beliefs when planning and teaching CT. The school-wide self-efficacy median for CS1 participants was 62 (*mostly can do*) with an IQR of 14. The teacher efficacy median did not change from 67, *mostly can do* with an IQR of 41, because the school leaders did not have teacher efficacy measured as they were not teaching CT. The school-wide collective efficacy median for both teacher and school leader participants was 90 (*totally confident*) with an IQR of 19. The factors that either supported and/or undermined self, teacher, and collective efficacy beliefs were also presented and indicated whether the four sources of efficacy judgements were supported (+) or undermined (-) for all participants in CS1. The factors that supported efficacy judgements were PD, resources, and teacher collaboration. The factors that undermined efficacy judgements were PD, lack of resources, and lack of time.

PD generally supported efficacy beliefs by providing encouragement and guidance for planning and teaching CT. However, the effectiveness of PD varied; while it helped develop positive experiences in some instances, it also included elements that negatively impacted participants' confidence. For example, conversations during PD sometimes dissuaded individuals, negatively impacting participant's self and collective efficacy beliefs.

Resources influenced efficacy beliefs by ensuring that teachers and leaders had the tools needed for effective CT implementation. When resources were available, they positively supported efficacy judgments. However, if the resources were not available efficacy judgments were undermined by creating barriers to effective CT planning and teaching, leading to decreased confidence. In addition, insufficient time for planning and teaching CT affected participants' ability to prepare thoroughly and implement CT effectively, thereby undermining their efficacy beliefs. However, collaboration among teachers was supportive because it allowed for shared knowledge and mutual encouragement, reinforcing confidence and efficacy when planning and teaching CT.

4.11 Summary of Case Study One

This chapter has presented the findings from Case Study One. In particular, results were presented to understand the relationships between efficacy beliefs and teachers' and school leaders' understanding and confidence when planning and teaching CT.

Part One presented CS1 teacher participants' efficacy beliefs, with a self-efficacy median of 56 (*moderately can do*) in planning and understanding CT, teacher efficacy at 67 (*mostly can do*) when teaching and integrating CT, and collective efficacy at 82 (*totally confident*) in the group when planning and teaching CT. Part Two covered CS1 school leaders, and showed a self-efficacy median of 67 (*mostly can do*) when understanding and planning CT, and a collective efficacy median of 95 (*totally confident*) in the group's ability to CT plan and teach CT. Furthermore, by using self-efficacy theory as a framework (Bandura, 1977). Part Three highlighted the factors which supported or undermined teachers and school leaders' sources of efficacy judgements when planning and teaching CT were identified. The school-wide self-efficacy median was 62 (*mostly can do*), teacher efficacy remained at 67 (*mostly can do*), and school-wide collective efficacy was 90 (*totally confident*). Supporting factors included PD, resource availability, and teacher collaboration. However, PD sometimes had a negative impact, while a lack of resources and time constraints also undermined efficacy judgements and therefore efficacy beliefs.

In the next chapter, case study two findings are reported.

Chapter Five: Case Study Two Results

5.1 Description of Case Study Two

Case Study Two (CS2) centred on a state Intermediate School (years 7 & 8, or ages 11-13) from a large city in the South Island of New Zealand. The urban school had just under 500 students, both boys and girls. The school was classified as decile 5, based on Census data pertaining to households with school-aged children in the surrounding area. There were 24 teachers at this school at the time of the research, and six participated in the case study. Of the six participants, five had recently completed 100 hours of externally provided, government-funded professional development (PD) on the new additions to the technology learning area of the curriculum, namely computational thinking and designing and developing digital outcomes. This case study focused on computational thinking (CT). The participants had not previously engaged with the new curriculum material but were motivated to start early to embed digital technology in their classrooms. All participants completed an online survey, followed by semi-structured individual interviews. Teacher participants were also observed on a single occasion in their classrooms. In addition, the school leader participant provided access to the school strategy documents relating to CT and chose to discuss it for 15 minutes with the researcher. Of the six teachers and school leader participating, three were female and three were male. All participants have pseudonyms. A summary of demographic information is provided in Table 34.

Table 34

Participant Demographics for Case Study Two (CS2)

Participant Demographics CS2					
ID	**Pseudonym**	**Age range**	**Ethnicity**	**Years in the Teaching Profession**	**Role**
P1	Steven	25-30	NZ European	<5	Teacher
P2	Andrea	31-40	NZ European	10-20	Teacher
P3	Cherie	25-30	NZ European	5-10	Teacher
P4	Isla	41-50	NZ European	>20	Teacher
P5	Theo	25-30	NZ European	5-10	Teacher
P6	Nathan	41-40	NZ European	>20	School Leader

Having described the context of Case Study Two and the participant demographics, the following sections are a detailed presentation of findings, presented under the three research questions in the study.

PART ONE

5.2 Self-Efficacy Beliefs and the Conceptual Foundations of CT

What are the relationships between teachers' efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT?

This section presents findings from the survey, interview, and observation data from teacher participants in CS2. For Likert-scale information and interpretation, please see 3.8.1. Taking all the self-efficacy survey results into account, Table 35 shows individual medians, and the group median of 52 for self-efficacy beliefs for CS2 teachers. The group median suggested that the teachers held *moderately can do* self-efficacy beliefs towards understanding and planning CT concepts. The overall IQR was 13 which likely meant that some teachers understood and could plan particular foundation CT concepts more comfortably than others.

Table 35
Teacher Participants' Self-Efficacy

		Self-Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Steven	85	8	Totally can do
P2	Andrea	16	44	Cannot do
P3	Cherie	52	17	Moderately can do
P4	Isla	61	30	Mostly can do
P5	Theo	51	28	Moderately can do
Group median		**52**	**13**	**Moderately can do**

In this study, conceptual foundations of CT are perceived as five CT concepts; decomposition, abstraction, pattern recognition, algorithmic thinking, and debugging. The teacher participants in CS2 were asked to rate their understanding of conceptual foundations of CT and how they planned lessons on these concepts during the interview. The teacher's understanding of these concepts is used to form a picture of their self-efficacy beliefs. In the following section, Table 36 presents the aggregate data for each participant's survey scale responses for the five CT concepts (and general problem-solving) explained in section 3.7.1 to uncover what constitutes the group median for self-efficacy beliefs.

Table 36

Teacher Participants' Self-Efficacy Subscale Medians

ID	Pseudonym	Decomposition	Abstraction	Pattern Recognition	Algorithmic thinking	Debugging	General problem-solving
P1	Steven	83	85	84	84	86	80
P2	Andrea	38	41	57	0	0	16
P3	Cherie	62	52	57	49	79	56
P4	Isla	88	70	75	46	43	66
P5	Theo	83	50	52	27	61	61
Group median		**83** **Totally can do**	**52** **Moderately can do**	**57** **Moderately can do**	**46** **Moderately can do**	**61** **Mostly can do**	**61** **Mostly can do**

From the results in Table 36, decomposition (median = 83) had the highest group median for the teacher participants in CS2. This suggested that the teachers were *totally* self-efficacious in their understanding of decomposition. Results with regards for abstraction had a group median of 52 and indicated the teachers were *moderately* self-efficacious when focusing on important details and ignoring the irrelevant information within a problem. Results about pattern recognition (median = 57), showed that the teachers *moderately can* understand patterns in CT problems. Like abstraction and pattern recognition, algorithmic thinking (median = 46) indicated that the teachers had *moderately* self-efficacious beliefs towards their understanding of using a step-by-step set of instructions to solve a problem. The teachers were also *mostly* self-efficacious (median = 61) towards their understanding of debugging (finding and fixing mistakes). Lastly, the teachers were *mostly* self-efficacious in their understanding of general problem-solving skills (median = 61).

Tables 37 and 38 provide a summary of the findings from interviews and observations with teacher participants. Both tables provide further detail into the individual and group medians. The findings for decomposition (Table 37) and algorithmic thinking (Table 38) present the self-efficacy beliefs for the two foundation CT concepts. For brevity, the remaining joint displays for abstraction, pattern recognition, debugging, and general problem-solving can be found in Appendices 27 - 30.

Table 37

Teacher Participants' Understanding of Decomposition

ID	Pseudonym	Decomposition (median)	Interview evidence	Observation evidence
P1	Steven	83 Totally can do	"The students had to create a set of instructions to get someone from point A to point B. So we spent time working out what language they had to use" (Interview – CS2P1Q3).	"What do you think your first instruction would be?" (Observation – CS2P1Decomposition).
P2	Andrea	38 Somewhat can do	"It was unpacking steps on how to get from A to B" (Interview – CS2P2Q1).	"As humans, we can process things with our big hard drive, our brains, but for this, you're actually writing the whole code. How long steps are, how many etc" (Observation – CS2P2Decomposition).
P3	Cherie	62 Mostly can do	"CT is kind of like solving a problem, breaking it down" (Interview – CS2P3Q1).	Cherie explains the different codes and their meaning. "Is there anything else you want to have so they have to do it?" (Observation – CS2P3Decomposition).
P4	Isla	88 Totally can do	"Simplifying instructions" (Interview – CS2P4Q2). "When things don't go right, how we take a step back and really break it down" (Interview – CS2P4Q5).	No observation evidence.
P5	Theo	83 Totally can do	"Like you can't just focus on it as a whole movement, it's lots of little chunks of things" (Interview – CS2P5Q8).	Theo explains what each code block does, but does not explicitly use the term decomposition, or describe the process of breaking something down.
Group median		**83** **Totally can do**		

The survey findings for teacher participants' group median for decomposition was 83, which indicated they were *totally* self-efficacious toward their understanding. For example, three teachers were *totally* self-efficacious towards their understanding of decomposition. Steven (median = 83) demonstrated his *totally can do* self-efficacy beliefs during his classroom observation where the students were completing a mathematics activity with Sphero (round, codable robots). The task was to code the Sphero to move in the shapes (square, triangle, and pentagon). Steven had worked with Sphero before and was prepared for the lesson with his students. During Steven's observation, his *totally can do* self-efficacy beliefs for decomposition were demonstrated by comments to his students asking them to break down the code into individual parts in order to solve the problem. Similarly, Theo (median = 83) had *totally can do* self-efficacy beliefs for decomposition. Although Theo did not explicitly use the term during his interview, he did explain his understanding as breaking a problem down into smaller pieces to solve and commented, *"like you can't just focus on it as a whole movement, it's lots of little chunks of things"* (Interview – CS2P5Q8). However, contrary to his high self-efficacy beliefs, during the classroom observation, there was no evidence that Theo utilised decomposition as a foundational CT concept. This suggested that although Theo held *totally can do* self-efficacy towards decomposition, he did not use the specific vocabulary with his students which suggested that despite understanding the concept of decomposition, he may not have been aware of how to explicitly utilise the vocabulary in his classroom planning.

As a contrast, Andrea (median = 38) had lower, *somewhat can do* self-efficacy beliefs in relation to her understanding of decomposition as a foundation concept of CT. Andrea gave a generalised description of decomposition during the interview and stated she thought it was, *"unpacking steps on how to get from A to B"* (Interview – CS2P2Q1), but did not explicitly use the term or concept during the classroom observation. These examples provided evidence for her *somewhat* *can do* efficacy median towards her understanding of decomposition, and may have indicated that Andrea did not fully understand the foundations of CT, specifically decomposition.

The findings presented illustrate how the teachers in CS2 defined decomposition, and explained their understanding of decomposition throughout their interview, therefore contributing to the group self-efficacy median of 83 (*totally can do*). Table 38 presents the findings from teacher participants' interview and observation data to further explain the group median for the CT concept of algorithmic thinking.

Table 38

Teacher Participants' Understanding of Algorithmic Thinking

ID	Pseudonym	Algorithmic Thinking (median)	Interview evidence	Observation evidence
P1	Steven	84 Totally can do	"Or completing a set of instructions to show an audience about what we are learning about" (Interview – CS2P1Q5).	"In simple terms, it means to follow a set of instructions" (Observation – CS2P1AlgorithmicThinking)
P2	Andrea	0 Cannot do	"It was unpacking steps on how to get from A to B" (Interview – CS2P2Q1).	"And write step-by-step instructions which is called an algorithm. We've been doing procedural writing and that fits in there too. Where have you heard algorithm before?" (Observation – CS2P2AlgorithmicThinking).
P3	Cherie	49 Moderately can do	"Following directions or things like that" (Interview – CS2P3Q3).	"You have to write the instructions so they follow it exact" (Observation – CS2P3AlgorithmicThinking).
P4	Isla	46 Moderately can do	"Getting them to understand the steps that they start with and how they end up with the end result" (Interview – CS2P4Q3).	No observation evidence.
P5	Theo	27 Somewhat can do	"Following step-by-step instructions" (Interview – CS2P5Q1).	"He's only allowed to think about the instructions. What could we use to say 'big or small steps?'" (Observation – CS2P5AlgorithmicThinking).
Group median		**46** **Moderately can do**		

From the survey responses, the teacher participants in CS2 were less self-efficacious describing and understanding algorithmic thinking as a foundational CT concept than they were with decomposition. The group median for algorithmic thinking was 46 which suggested that together, they were *moderately* self-efficacious when describing and understanding algorithmic thinking as part of their planning for CT lessons. One teacher, Steven, was *totally* self-efficacious (median = 84) and this median was supported by both his interview and observation. His understanding of algorithmic thinking was that it was, *"completing a set of instructions to show an audience about what we are learning about"* (Interview – CS2P1Q5) and further demonstrated during the classroom observation when he stated algorithmic thinking was, *"to follow a set of instructions"* (Observation – CS2P1).

Interestingly, results showed that Andrea (median = 0) reported *cannot do at all* self-efficacy beliefs towards her understanding of algorithmic thinking in the survey. Although this score was supported by her lack of understanding during the interview, Andrea described the process of algorithmic thinking clearly during the classroom observation. The activity the students completed was giving each other instructions to move around the classroom. When Andrea was working alongside the students, she explained the task of writing the instructions clearly as an algorithm. This example indicated that while Andrea demonstrated algorithmic thinking concepts, she did not believe she understood algorithmic thinking as a foundational CT concept, which decreased her self-efficacy belief median.

The findings presented in this section illustrated how teachers in CS2 understood algorithmic thinking as a foundation CT concept. Such findings suggest there is a connection between teachers' self-efficacy beliefs and their understanding of algorithmic thinking as one of the five

CT concepts, which contributed to the teacher group self-efficacy median of 46 (*moderately can do*).

In addition, from the survey responses, the teachers in CS2 held *moderately can do* self-efficacy beliefs when describing and understanding abstraction for their CT planning (median = 52). However, during the interview, none of the teachers provided evidence of their understanding of abstraction as identifying key information and ignoring the irrelevant information while solving problems. For example, Steven (median = 85) *totally can* understand abstraction, and while he did not provide evidence during the interview, Steven highlighted abstraction during the classroom observation explaining to the students the need to focus on key details when solving the problem (Observation – CS2P1). While it was clear Steven understood abstraction as a concept for his students, he was perhaps less efficacious relating abstraction to the survey items. Similarly, although Andrea (median = 41) held *moderately can do* self-efficacy beliefs towards abstraction as reported from the survey, she demonstrated her understanding of abstraction throughout the observation. Andrea asked whether the students had simplified the problem and asked, *"if it was the one that worked, were they simple or overcomplicated?*" (Observation – CS2P2). Despite providing evidence Andrea understood abstraction for the CT activity during the classroom observation, she was less efficacious relating abstraction to the survey items.

The teachers in CS2 also held *moderately can do* self-efficacy beliefs towards pattern recognition and CT planning (median = 57). For example, Andrea (median = 57) *moderately can* understand pattern recognition and provided insights into how she supported students' pattern recognition on the use of commas between commands during CT classroom activities (Observation – CS2P2). Similarly, Cherie (median = 57) held *moderately can do* self-efficacy for pattern recognition and discussed symbols during the classroom observation, and asked, *"what symbol do you want for* *that? We've already got lots of arrows and that might be a bit confusing"* (Observation – CS2P3). Theo (median = 52) also held *moderately can do* self-efficacy beliefs and discussed the pattern involved in programming a simple square with Sphero (Interview – CS2P5Q3). His understanding was further demonstrated during the classroom observation when he addressed patterns involved for degrees in a circle during and programming the Sphero robot (Observation – CS2P5). Two other teachers held higher self-efficacy beliefs for understanding pattern recognition, Isla (median = 75, *mostly can do*), and Steven (median = 84, *totally can do*). However, despite higher medians from the survey, neither provided evidence of their understanding in the interview or classroom observation. Overall, while teachers showed moderate to high self-efficacy in their abilities towards pattern recognition, their specific evidence and detailed explanations varied, and suggests a nuanced understanding of this CT concept in practice.

From the survey responses, the teacher participants in CS2 also held *mostly can do* self-efficacy beliefs when describing and understanding debugging as a core concept for CT planning (median = 61). For example, Steven (median = 86) held *totally can do* self-efficacy beliefs in his ability to plan debugging activities, as evidenced by his detailed explanation of how to debug and fine-tune lines of code (Interview – CS2P1Q3). Similarly, Cherie (median = 79) *mostly can* understand debugging and provided evidence in both interview and observation. Cherie explained debugging as learning techniques for the process of finding and fixing errors (Interview – CS2P3Q1). Cherie provided further evidence during the classroom observation when she asked the students, *"they had to go back and fix it. What do we call that?"* (Observation – CS2P3). Theo (median = 61) also *mostly can* understand debugging, he commented in the interview that he likely hadn't explicitly described it. Theo said he doubted he had specifically said, *"I had this problem and I debugged, and all that sort of thing. Not explicitly I wouldn't imagine* (Interview – CS2P5Q8). However, while Theo had some reservations about debugging during the interview, he did provide evidence of his understanding during the classroom observation. Theo asked the students, *"what do you do if you've got a bug? You've got to debug it. You've got to fix it"* (Observation – CS2P5). While Theo may have been less self-efficacious from the survey and interview, he provided evidence of his understanding later in the observation. This suggested that Theo may not have understood how debugging practices related to the survey questions. Overall, while teachers exhibited varying levels of self-efficacy in debugging, their confidence in practical application differed, which suggested there was a diverse understanding of debugging practices for the teachers in CS2.

Lastly, the teachers in CS2 held *mostly can do* self-efficacy beliefs for general problem-solving (median = 61). Overall, the results showed that the teachers had varying levels of efficacy beliefs for general problem-solving, and supporting evidence was inconsistent. For example, Cherie (median = 56) held *moderately can do* beliefs, and described problem-solving as a key component of managing issues and figuring out solutions (Interview – CS2P3Q1), but lacked additional evidence during the classroom observation. Theo (median = 61) was *mostly* efficacious, and said he used a trial-and-error approach to learning new skills (Interview – CS2P5Q4). In addition, Steven (median = 80) was *mostly* confident in his abilities, but there was no supporting evidence from observations or interviews. A reason behind why there were minimal explicit descriptions for general problem-solving may have been because the teachers spent the majority of the interview/observation time explaining their understanding of specific CT concepts, rather than problem-solving as a whole.

The findings presented in this section highlight how teachers in CS2 understood abstraction, pattern recognition, debugging, and general problem-solving as foundational CT concepts. The findings suggest there is a connection between teachers' self-efficacy beliefs and their understanding which contributed to the group self-efficacy median of 52 (*moderately can do*) when planning CT.

5.2.1 Self Efficacy Summary

In summary, the teacher's in CS2 held *moderately can do* self-efficacy beliefs when understanding CT concepts and planning CT. With regards to specific CT concepts, the teachers were most at ease with decomposition, while algorithmic thinking, abstraction, pattern recognition and general problem-solving were more difficult concepts to understand and suggested that the teachers required more support with those concepts in future.

5.3 Teacher Efficacy Beliefs and Planning CT Integration

Survey results from planning, sourcing, and designing CT lessons, and teaching CT concepts and CT integration were used in conjunction to calculate a group median for teacher efficacy beliefs. The group teacher participants' median for teacher efficacy was 67 (see Table 39) and suggested *mostly can do* teacher efficacy beliefs towards planning and teaching CT. The IQR was 17 and this indicated that most teachers in CS2 held moderately similar teacher efficacy beliefs when teaching particular CT concepts.

Table 39
Teacher Participants' Teacher Efficacy

		Teacher Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Steven	84	13	Totally can do
P2	Andrea	16	38	Cannot do
P3	Cherie	60	14	Moderately can do
P4	Isla	*[7]	*	*
P5	Theo	30	29	Somewhat can do
Group median		**47**	**17**	**Moderately can do**

The attention shifts to how planning, sourcing, and designing CT lessons, teaching CT concepts, and CT integration medians combined for the group teacher efficacy median. Firstly, the findings related to how participants' teacher efficacy beliefs related to their understanding of how to plan and source material for CT integrated activities. Planning CT integration is the planning and design of CT activities, and CT integrated activities is the enaction of integrating CT across curriculum areas as described in interviews and viewed in classroom observations. Table 40 is used to show the planning, sourcing, and designing CT lessons survey scale results for each teacher participant, as well as the group median. Rationale for the categories of Table 40 is described in section 3.7.1.

[7]Isla did not answer the Teacher Efficacy questions because she was a specialist Art teacher and had not had the opportunity to engage with CT alongside the other teachers at the time of the study. Because of this, her data was not included in the teacher-wide total for Teacher Efficacy.

Table 40
Teacher Efficacy and Planning, Sourcing, and Designing CT Lessons

ID	Pseudonym	Planning, sourcing and designing CT lessons (median)
P1	Steven	79
P2	Andrea	7
P3	Cherie	59
P4	Isla	*
P5	Theo	22
Group median		**41** **Moderately can do**

The group median for CS2 teachers when planning, sourcing and designing CT lessons was 41 (see Table 40) and suggested that the teachers were *moderately* efficacious. The joint display of findings for planning, sourcing, and designing CT lessons (Table 41) is used to explain the group median from Table 40 using findings from interviews and classroom observations.

Table 41

Teacher Efficacy and Planning, Sourcing, and Designing CT Lessons

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P1	Steven	79 Mostly can do	"We're sort of expected to include in each of our maths units, a different activity that relates to CT and maths. So I've done a lot of stuff on Sphero and creating sets of instructions that use maths in certain ways" (Interview – CS2P1Q2).	The students worked through a handout that Steven had created (Observation – CS2P1).
P2	Andrea	7 Cannot do	"It was confusing. When we were delivering the digital technologies curriculum and CT to the staff after doing the maths programme, the terms were confusing to unpack" (Interview – CS2P2Q8).	Video on programming (Observation – CS2P2). The students worked through a handout that Andrea had sourced.
P3	Cherie	59 Moderately can do	"I'm head of maths currently here, and we've embedded digital technologies into the maths curriculum" (Interview – CS2P3Q2). "And I've just gone on and found activities or just made them up myself, or found websites" (Interview – CS2P3Q2).	The students worked through a handout that Cherie had created (Observation – CS2P3)
P4	Isla	*	"For the subject itself, it's quite natural to have [CT] within it. You go through a developmental process of what works well, you get people's point of view, you try different things out, and then at the end it could still go wrong" (Interview – CS2P4Q6).	No observation.

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P5	Theo	22 Somewhat can do	"It's not my area of expertise by any means. I think that I'm probably someone who will just give it a nudge anyway, give it a crack and see what happens" (Interview – CS2P5Q4).	Sphero app on Chromebook. Theo had familiarised himself with the app (Observation – CS2P5)
Group median		**41 Moderately can do**		

The group teacher efficacy median when planning, sourcing, and designing CT lessons was 41 (*moderately can do*). Delving deeper, Steven (median = 79) had created his own CT lesson plans for mathematics which aligns with his *mostly can do* teacher efficacy median. Steven had planned and designed CT lessons and commented that, *"we're sort of expected to include in each of our maths units, a different activity that relates to CT and maths. So, I've done a lot of stuff on Sphero and creating sets of instructions that use maths in certain ways"* (Interview – CS2P1Q2). Steven's proactive and innovative approach likely reflects his self-assessment of his teaching abilities, contributing to his teacher efficacy median. In addition, Cherie (median = 59), had worked in a team to embed CT activities into the mathematics curriculum at the school, and this experience contributed to *her moderately can do* teacher efficacy beliefs. By working in the mathematics team, Cherie was more confident in how she planned, sourced, and designed CT lessons. She also stated that after that experience, she had, *"just gone on and found* [CT] *activities or just made them up myself, or found websites"* (Interview – CS2P3Q2). Throughout both Steven and Cherie's classroom observation, the students worked through a CT lesson plan that each teacher had created individually, and both appeared calm and confident in their CT teaching ability with their planned and sourced CT activities. These teacher's classroom observations aligned with their survey efficacy medians.

On the other hand, Andrea (median = 7) had also initially worked with the mathematics team to create CT lessons, yet reported a *cannot do at all* median when planning, sourcing, and designing CT lessons. Andrea reflected on finding the breakdown of the CT terms confusing and found it difficult to create CT lessons, contributing to her *cannot do* teacher efficacy median. Andrea commented that, *"when we were delivering the digital technologies curriculum and CT to the staff after doing the maths programme, the terms were confusing to unpack"* (Interview – CS2P2Q8).

Despite this, during the classroom observation, Andrea had sourced a CT worksheet for the students to complete, but admitted it was a 'one off' lesson example as opposed to regularly sourced CT activity. Andrea acknowledged her confusion in understanding CT concepts which also appeared to impact her teacher efficacy beliefs when sourcing and designing her own CT lessons. In addition, Isla (no median) was in a different position to the other teachers in CS2 because she taught an Art rotation. Isla found it difficult to source CT specific resources for her subject, which explained why she did not answer the teacher efficacy survey questions, therefore her findings have been excluded from the group median.

The findings presented in this section illustrate how teacher participants' beliefs in their ability to plan, source, and design CT lessons related to their teacher efficacy beliefs (median = 41, *moderately can do*). Attention now turns to how facilitating CT integration contributed to the overall teacher efficacy beliefs of CS2 (median = 47, *moderately can do*).

5.4 Teacher Efficacy Beliefs, Teaching CT Concepts, and CT Integration

This section further elaborates on findings related to CS2 teacher participants' teacher efficacy beliefs related to their understanding of how to teach CT concepts – both as a standalone lesson and integrated within other curriculum areas. Combined with planning, sourcing, and designing CT lessons, teaching CT concepts and CT integration contributed to overall teacher efficacy beliefs. Table 42 is used to show the teacher efficacy scale results for each teacher participant, as well as the group median. Rationale for the categories of Table 42 is described in section 3.7.1.

Table 42

Teacher Efficacy and Teaching CT Concepts, and CT Integration

ID	Pseudonym	Teaching CT concepts	CT Integration
P1	Steven	79	84
P2	Andrea	0	32
P3	Cherie	60	64
P4	Isla	*	*
P5	Theo	61	33
Group median		**61** **Mostly can do**	**49** **Moderately can do**

The group median for teaching CT concepts was 61 and indicated that teachers in CS2 were *mostly* efficacious towards their teaching of CT concepts in their classrooms. Table 43 presents findings using the teacher participant's interview and observation data to provide more understanding of what is contributing to the group median when teaching CT concepts.

Table 43

Teacher Efficacy and Teaching CT Concepts

ID	Pseudonym	Teaching CT Concepts (median)	Interview Evidence	Observation Evidence
P1	Steven	79 Mostly can do	"We spent time working out what language they had to use, how to debug their program and then fine tune it to make sure it actually worked as intended" (Interview – CS2P1Q3).	"It's got to follow a program. Any time you do anything on a computer, it has to follow a program. There is a special word - it starts with A" (Observation – CS2P1).
P2	Andrea	0 Cannot do	"With my class this year, I think it's actually just MY lack of knowledge, because I think that they would just pick it up and go to be fair" (Interview – CS2P2Q9).	"Test your program, did it work? No, debug. What does debug mean?" (Observation – CS2P2).
P3	Cherie	60 Moderately can do	"They're just learning the language or how to debug something on paper. And then they slowly get introduced to Sphero and things like that so they're switching their mentality to using a digital device" (Interview – CS2P3Q3).	"But they had to go back and fix it. What do we call that?" (Observation – CS2P3). "Is that what you're expecting the person to do? Remember it has to be exact" (Observation – CS2P3).
P4	Isla	*	"Fold it and cut and end up with two pieces. That's ok, what went wrong, take a step back" (Interview – CS2P4Q4).	No observation.
P5	Theo	61 Mostly can do	"I couldn't say 'Hey I had this problem and I debugged' and all that sort of thing. Not explicitly I wouldn't imagine. I'm sure I have. When I would teach PE - like you can't just focus on it as a whole movement, it's lots of little chunks of things" (Interview – CS2P5Q8).	"What is a bug? What do you do if you've got a bug?" (Observation – CS2P5).
Group median		**61** **Mostly can do**		

The teachers in CS2 (median = 61) reported that they were *mostly* efficacious towards their teaching of CT concepts. For example, Steven (median = 79) was *mostly* efficacious and demonstrated his understanding of teaching CT concepts, particularly algorithmic thinking, decomposition, and debugging during both interview and classroom observation. Steven described teaching debugging as, *"we spent time working out what language they had to use, how to debug their program and then fine tune it to make sure it actually worked as intended"* (Interview – CS2P1Q3). He also asked the students about algorithms during his classroom observation and said, *"it's got to follow a program. Any time you do anything on a computer, it has to follow a program. There is a special word - it starts with A"* (Observation – CS2P1). Similarly, Cherie (median = 60) knew the CT terms well as she interacted positively with the students during the classroom observation. She also demonstrated her teaching of CT concepts by asking the students prompting questions and explaining to them how that concept related to the specific part of the activity. Cherie asked the students about debugging when, *"they had to go back and fix it. What do we call that?"* (Observation – CS2P3), and algorithmic thinking, *"is that what you're expecting the person to do? Remember it has to be exact"* (Observation – CS2P3). Both examples support her *moderately can do* teacher efficacy beliefs when teaching CT concepts. Another example was from Theo (median = 61) who commented in the interview that although he should teach CT concepts, he was yet to explicitly use CT concepts in his teaching. However, during the classroom observation, Theo regularly used CT terms and concepts and explained them to his students. This indicated that Theo may have realised he could in fact explicitly teach CT concepts to his students between the time of the interview and classroom observation, thus contributing to his *mostly can do* median when teaching CT concepts.

In contrast, Andrea reported a median of 0 and commented on her lack of knowledge when teaching CT concepts. Although she was less efficacious when teaching CT concepts, contributing to her *cannot do at all* teacher efficacy beliefs, Andrea demonstrated teaching debugging as a CT concept during her classroom observation. She asked the students, *"test your program, did it work? No, debug. What does debug mean?"* (Observation – CS2P2). These findings suggested that although Andrea did not report believe she was efficacious in her teaching of CT concepts, she may be teaching them effectively in her classes without being aware of it.

The findings presented in this section illustrated how teacher participants' beliefs in their ability to teach CT concepts (median = 61, *mostly can do*) contributed to the overall teacher efficacy median of 47 (*moderately can do*).

Focus turns to the findings for teacher efficacy and facilitating CT integration. Facilitating CT integration is the teaching of CT activities which are integrated into other curriculum areas (for example, using debugging as a CT concept within a mathematics context). Table 44 presents the group median for CT integration as 49 (*moderately can do*) and presents interview and observation findings which provide insight into the overall group median for CS2 teacher efficacy (median = 47, *moderately can do).*

Table 44
Teacher Efficacy and CT Integration

ID	Pseudonym	CT Integration (median)	Interview Evidence	Observation Evidence
P1	Steven	84 Totally can do	"I'm going to include it in my literacy curriculum rotation with a few activities about getting our Sphero to certain places and demonstrating a set of instructions to show an audience about what we are learning about" (Interview – CS2P1Q5).	The lesson was a one-off non-digital CT lesson and was not integrated (Observation – CS2P1).
P2	Andrea	32 Somewhat can do	"I do remember there was a bit of a sense that they would fit in quite well with literacy, but we found it hard to incorporate the terms and it was hard to unpack the terms" (Interview – CS2P2Q8).	The lesson was a one-off non-digital CT lesson and was not integrated (Observation – CS2P2).
P3	Cherie	64 Mostly can do	"So every strand, like number, measurement, algebra, it's compulsory to do one computational or digital technology component to it" (Interview – CS2P2Q2).	The lesson was a one-off non-digital CT lesson and was not integrated (Observation – CS2P3).
P4	Isla	*	"For the subject itself, it's quite natural to have [CT] within it. You reassess yourself and try and learn from it" (Interview – CS2P4Q6).	No observation
P5	Theo	33 Somewhat can do	"The Sphero in maths, talking about position and angles and things like that. So that has been integrated largely" (Interview – CS2P5Q5).	The activity was integrated into a Mathematics lesson. "How many degrees in a full circle? 360 degrees. How many degrees if I go right, backwards, left?" (Observation – CS2P5).
Group median		**49 Moderately can do**		

In CS2, the group median when integrating CT was 49 and indicated the teachers *moderately can* integrate CT across curriculum areas. For example, Steven (median = 84) *totally can* integrate CT activities CT and discussed his teaching CT activities within literacy. He provided evidence during the interview how he was ,*"going to include it* [CT] *in my literacy curriculum rotation with a few activities about getting our Sphero to certain places and demonstrating a set of instructions to show an audience about what we are learning about"* (Interview – CS2P1Q5). Although Steven was *totally* efficacious towards his teaching ability when integrating CT, during the classroom observation the lesson was a one-off non-digital lesson and was not integrated within any other curriculum area. Steven's plan for CT integration aligned with his *totally can do* teacher efficacy beliefs, yet he had not completed it at the time of the interview and observation.

Conversely, despite Theo (median = 33) believing he could only *somewhat* integrate CT across curriculum areas, he explained how he had integrated CT into a mathematics activity, using digital tools (Sphero). Theo said he had used, *"the Sphero in maths, talking about position and angles and things like that. So that has been integrated"* (Interview – CS2P5Q5). In addition, Theo further demonstrated how he integrated CT into mathematics during his classroom observation. The students were working in small groups completing a task using Sphero robotics. As Theo moved around the class, he asked his students mathematics questions (in particular, questions about angles) to get them thinking how they can then code the robot to complete the task. Theo's interview and observation provided evidence that did not support his lower median for integrating CT, and suggests that he may not have recognised CT integration within the survey questions. While also reporting a *somewhat can do* integrating CT teacher efficacy median of 32, Andrea's classroom observation of CT was not integrated into another curriculum area. She commented on her inital beleif that while CT might be easily integrated into literacy, Andrea had found it difficult to incorporate the CT terminology throughout other curriculum areas.

The findings presented in this section provide evidence of how CS2 teachers' belief in their ability to facilitate CT integrated activities, contributed to the group median of 49 (*moderately can do*). Both sections for teacher efficacy; teaching CT concepts and integrating CT have presented findings that help to provide insight into the relationship between how the teachers facilitate CT integration and their teacher efficacy beliefs contributing to the overall median of 47 (*moderately can do).*

5.4.1 Teacher Efficacy Summary

The CS2 teacher participants' median for teacher efficacy was 47 and indicated that the teachers held *moderately can do* teacher efficacy beliefs when planning and teaching CT. Contributing to this group median, was planning, sourcing, and designing CT lessons (median = 41) reflecting *moderately can do* teacher efficacy beliefs. While some participants demonstrated strong beliefs in their teaching efficacy, others encountered difficulties and reported a lower median for teacher efficacy. In addition, regarding teaching CT concepts, the group median was 61, and suggested *mostly can do* teacher efficacy beliefs. In terms of CT integration, the group median was 49, and indicated *moderately can do* teacher efficacy beliefs. The findings highlight the complex relationship between teacher efficacy and specific aspects of CT planning and CT facilitation. While the group as a whole was *mostly* efficacious in their teaching of CT, some participants faced challenges that impacted their perceived efficacy when teaching CT.

5.5 Teachers' Collective Efficacy Beliefs, their Professional Network, and the Planning and Teaching of CT.

Collective efficacy beliefs are held by a person in relation to their perception of others' success when working together on a collective endeavour. CS2 teacher participants' group collective efficacy median was 64 (see Table 45) and suggested *moderately confident* efficacy beliefs in the group as a whole. The IQR for the group was 5, and suggested that the teachers did not have much variation in their collective efficacy beliefs.

Table 45
Teacher Participants' Collective Efficacy

		Collective Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Steven	77	27	Mostly confident
P2	Andrea	74	30	Mostly confident
P3	Cherie	66	12	Mostly confident
P4	Isla	77	82	Mostly confident
P5	Theo	28	32	Somewhat confident
Group median		**64**	**5**	**Mostly confident**

This section discusses findings related to how CS2 teacher participants' collective efficacy beliefs related to their planning and teaching of CT. Professional network (from Section 3.9) describes the collaboration between teachers and school leaders and was used as a structure to further understand collective efficacy beliefs of the group. Table 46 presents the collective efficacy survey subscale results for each teacher participant in each category, as well as the group median. The rationale for the categories of Table 46 is described in section 3.7.1. A reminder that survey scale responses for collective efficacy were related to 'confidence' as opposed to 'can do'

.

Table 46
Teacher Participants' Collective Efficacy Subscale Medians

ID	Pseudonym	Group computing concepts knowledge and skills	Group technology collaboration and communication	Group capability	Group effort	Group quality of outcomes	General group satisfaction
P1	Steven	61	89	60	72	77	80
P2	Andrea	11	100	84	52	73	74
P3	Cherie	60	56	59	63	75	79
P4	Isla	44	0	0	81	82	100
P5	Theo	60	63	39	25	19	19
Group median		**60 Moderately confident**	**63 Mostly confident**	**59 Moderately confident**	**63 Mostly confident**	**76 Mostly confident**	**79 Mostly confident**

General group satisfaction had the highest group median for all teacher participants (median = 79) and suggested that the teacher participants in CS2 were *mostly confident* in their collective efficacy beliefs for this subsection of the survey. Additionally, the teachers were *mostly confident* towards the group's quality of outcomes (median = 76). Group technology collaboration and communication, and group effort (both median = 63) indicated that the teacher participants were *mostly confident* towards the group's communication and collaboration, and effort. The teacher participants were *moderately confident* (median = 59) towards the group's capability to plan and teach CT, and *moderately confident* (median = 60) in their how the group understood computing concepts, knowledge, and skills. Table 47 and Table 48 present findings using the teacher participants' interview data to further explain the group medians for each subsection, and how they contribute to the overall CS2 collective efficacy median. The findings for general group satisfaction (Table 47) and group capability (Table 48) will be used to further explain the group survey medians. Observation data was not used in this section because the teachers were observed individually. The remaining findings for the other four categories are discussed, and tables are presented in Appendices 31 – 34.

Table 47

Teacher Participant Collective Efficacy Beliefs and General Group Satisfaction

ID	Pseudonym	General group satisfaction (median)	Interview evidence
P1	Steven	80 Mostly confident	"And I think just the fact that, I don't know about other schools, but [the school] is really, like the community of staff is really good, like the fact that we share a lot of stuff and everyone's happy to drop everything and come and help if you're struggling with things" (Interview – CS2P1Q13).
P2	Andrea	74 Mostly confident	"We are a very willing school so there is about 400 other things that we are trying to get our heads around" (Interview – CS2P2Q10).
P3	Cherie	79 Mostly confident	"As teachers are growing in confidence they are using it in other areas which is quite cool" (Interview – CS2P3Q13).
P4	Isla	100 Totally confident	"Let's support each other, just like I would do in the classroom, the door is open" (Interview – CS2P4Q7).
P5	Theo	19 Somewhat confident	"So I think the school probably values it in that sense. We have other - not necessarily CT - but we have other digital groups that involve kids, so it's probably something that we recognise kids want to do" (Interview – CS2P5Q13).
Group median		**79 Mostly confident**	

The teachers in CS2 were *mostly confident* (median = 79) towards their general group satisfaction when planning and teaching CT. For example, Steven (median = 80, *mostly confident*), and Isla (median = 100, *totally confident*) reported the highest confidence in relation to their satisfaction with their school when planning and teaching CT. Both teachers described the ‘open-door’ policy at the school, and how there was a community of staff supporting each other, which contributed to their high beliefs for group satisfaction. In particular, Steven said, *“I think just the fact that, I don’t know about other schools, but* [the school] *is really, like the community of staff is really good, the fact that we share a lot of stuff and everyone’s happy to drop everything and come and help if you're struggling with things”* (Interview – CS2P1Q13). In addition, Andrea (median = 74) believed that the group were willing to try new ways for teaching and learning and this understanding contributed to her *mostly confident* beliefs for general group satisfaction. In contrast, even though Theo (median = 19) was only *somewhat confident* in his general group satisfaction towards CT planning and teaching, he did acknowledge that the school valued digital learning in general. Theo stated, *“I think the school probably values it* [CT] in that sense. *We have other - not necessarily CT - but we have other digital groups that involve kids, so it’s probably something that we recognise kids want to do”* (Interview – CS2P5Q13). His *somewhat confident* beliefs for general group satisfaction may be reflected by his perception that some of the group may not be planning and teaching CT, instead relying on when the students attended separate digital technology classes with specialist teachers.

To further understand collective efficacy and the planning and teaching of CT, the focus turns to the subscale category, group capability. The group median for group capability was 59 and suggested the teachers were *moderately confident* toward the capability of the group when planning and teaching CT. Table 48 presents interview findings to further explain the group median for CS2 teachers' collective efficacy beliefs and group capability.

Table 48

Collective Efficacy Beliefs and Group Capability

ID	Pseudonym	Group capability (median)	Interview evidence
P1	Steven	60 Moderately confident	"So we've found it's quite difficult to give a lot of explicit teaching on CT so this year it's been trying to incorporate it into other areas so we don't have to take too much time out of the day" (Interview – CS2P1Q10).
P2	Andrea	84 Totally confident	"I mean we are quite a willing school but I guess that everybody is at different levels of what they want to learn and what they don't" (Interview – CS2P2Q10).
P3	Cherie	59 Moderately confident	"Some of the activities to use Sphero for, I think that they might overthink it, but the kids absorb things really quickly and pick it up really fast. I think for us [teachers] it just takes a little longer to pick up activities and things" (Interview – CS2P3Q12).
P4	Isla	0 Not confident	"People have to be able to feel comfortable to share. Confident to share" (Interview – CS2P4Q11).
P5	Theo	39 Somewhat confident	"I do wonder if it probably didn't quite hit the mark because it was potentially another thing that we were doing. And although it's a focus, it probably wasn't THE focus for our school" (Interview – CS2P5Q10).
Group median		**59 Moderately confident**	

The group median for teacher participants' collective efficacy beliefs and group capability was 59 and indicated that the teachers were *moderately confident* in the group's capability to plan and teach CT. Examples included Andrea (median = 84) who had *totally confident* collective efficacy beliefs, and acknowledged that although the staff were, *"a willing school"* everyone had their own preferences for what they wanted to learn and teach. Andrea further explained how she believed, *"everybody is at different levels of what they want to learn and what they don't"* (Interview – CS2P2Q10). This indicated that although Andrea reported *totally confident* beliefs in group capability, she was still unsure as to how well CT was planned and taught in other classes. In contrast, Theo (median = 39) had *somewhat confident* collective efficacy beliefs for group capability when planning and teaching CT. His collective efficacy median may reflect his understanding that although CT was a focus at the school, it was not the sole focus at the time, and he believed some of the group may yet to have implemented CT. He specifically stated that, *"I do wonder if it probably didn't quite hit the mark because it was potentially another thing that we were doing. And although it's a focus, it probably wasn't THE focus for our school"* (Interview – CS2P5Q10).

For group computing concepts, knowledge, and skills (median = 60) and collective efficacy, the CS2 teachers' held *moderately confident* beliefs. This suggested that as a group, the teachers were *moderately confident* the members of the group had the understanding of computing concepts when planning and teaching CT. For example, while Cherie (median = 60) was *moderately confident* in the group, she did wonder whether some of the group might overthink what was required for CT planning and teaching, and need more time and support to adapt. Theo too (median = 60) was *moderately confident*, and his median aligns with his statement that the group had, *"people are willing to give things a go and technology is a bit more second nature to* *them because they've always had devices"* (Interview – CS2P5Q10). On the other hand, Andrea (median = 11) believed that the group may not have the time available to them in order to upskill and learn computing concepts, which was a reason behind her *not confident at all* median.

The CS2 teacher participants reported *mostly confident* collective efficacy beliefs for group technology collaboration and communication (median = 63). Despite this group median, no teachers provided evidence during the interview about how the group used technology to collaborate and communicate. Although no evidence was provided, Steven (median = 89) and Andrea (median = 100) were both *totally confident* in how the group collaborated and communicated with technology. A reason for their high medians, yet no interview evidence may be because they were focused on CT specifically during the interview, and perhaps did not consider general technology collaboration/communication of their group. In contrast, Isla (median = 0) was *not confident at all.* A possible explanation for Isla's median was she was in a slightly different teaching role than the others, so perhaps did not have much experience interacting with her colleagues when using technology. In addition, the teachers may not have been able to provide interview evidence for this subsection from the survey because they were focused on individual CT planning and teaching; many teachers discussed how they planned on their own, and this may have reduced their awareness of the group's technology communication and collaboration capabilities.

For group effort (median = 63), the teachers in CS2 were *mostly confident* towards the effort of the group when planning and teaching CT, therefore contributing to the overall group collective efficacy median. While Steven (median = 72) and Cherie (median = 63) were *mostly confident* in the efforts of the group, they both provided evidence during the interview how they were concerned about a lack of time constraining the effort of the group when planning and teaching

CT. Steven said, *"we've felt like our workload is quite a lot. So we've found it's quite difficult to give a lot of explicit teaching on CT"* (Interview – CS2P1Q10). Similarly, Cherie said that with, *"time table constraints and we've got heaps of other things to fit in with maths and things like that, I totally understand"* (Interview – CS2P3Q12). In addition, Andrea (median = 52) was *moderately confident*, and acknowledged that while the school staff was willing to plan and teach CT, there were varying levels of interest and readiness among staff which affected her beliefs toward group effort. On the other hand, Theo (median = 25) was *somewhat confident* in the group's effort. He commented that, *"I see people who get really comfortable. They teach this way because that's the way they've always done it and that's worked ok for them, maybe not the best"* (Interview – CS2P5Q14). Theo was *somewhat confident* because he believed there were group members who may have been reluctant to adopt new methods which may be due to comfort with traditional teaching practices, even if they are not the most effective when planning and teaching CT.

The teachers in CS2 were *mostly confident* in their collective efficacy beliefs and group quality of outcomes (median = 76). For example, Steven (median = 77) was *mostly confident* in the group's outcomes because he believed the school focused on sharing CT ideas and resources to support the planning and teaching of CT. Similarly, Andrea (median = 75) was *mostly confident* in the group because they had support from PD, and also technology to use, which meant that the teachers could see the CT learning outcomes. She said the group had, *"great support with the roll-out with the* [government-funded PD] *hours, and even with moving into lockdown and being able to use all the technology"* (Interview – CS2P2Q13). Theo however, (median = 19) was *not confident* in the group quality of outcomes. A reason behind this was, that while he thought some of the group might be implementing CT concepts without recognising them as such, there were other group members who may have believed that CT added extra work. Therefore, Theo was *not confident* in the groups' quality of outcomes when planning and teaching CT.

The findings presented in this section suggested how CS2 teacher participants' group medians for the survey subscale sections contributed to the overall group median of 64 for collective efficacy beliefs when planning and teaching CT. While individual teacher medians varied, suggesting differences in confidence, overall the teachers in CS2 were *mostly confident* in their group when planning and teaching CT.

5.6 Teachers' Collective Efficacy Beliefs and the School Strategy

CS2 had a school strategy document where CT was introduced under the title Digital Technology Long Term Plan. The document explained the CT progress outcomes in the New Zealand Curriculum, and the lesson outline as support for the teachers in order to plan and teach CT (see Figure 5). The highlighted section was the focus of the strategy. One school leader from CS2 shared the school strategy document with the researcher and detailed the length of digital technology unit and how it connected to the CT progress outcomes. There was also an outline of what tools could be utilised to teach CT in the classroom. Throughout the interviews with teacher participants, most recognised the importance of a CT school strategy, which was then used as evidence for their collective efficacy beliefs. The teacher participant's overall collective efficacy median was 64 indicating *mostly confident* efficacy beliefs in the group when planning and teaching CT.

Figure 5

School Strategy and CT

Planning:

Unit Plans should include:

- 13 week lesson content
- Progression
- Assessment opportunities
- Links to DTC Progress Outcomes
- Gate and learning needs students' needs/goals identified as appropriate

Integrated Inquiry should offer opportunities for authentic student-led initiatives.

Assessment:

Teachers are responsible for both formative and summative assessment and these will be used to inform and steer the teaching and learning program.

Anecdotal notes taken throughout the 13 weeks.
Student self and peer assessment.

End of Year Report - students marked accordingly against the following:

- Level of effort
- Can design and develop digital outcomes.
- Can give, follow, and debug simple algorithms in computerised and non-computerised contexts
- Is able to share their knowledge with others in a collaborative way

Digital Technology Long Term Plan
Year 7: Internet explained, Movie Making, Binary, inputs, Outputs, Coding (using blocks and colours), Pixel Design, Tinkercad - 3d Design, Scratch/Code.org.
Year 8: Digital Citizenship, Movie Making, Coding, Use of robotics, Makey Makey, Stop Motion, Minecraft, Binary. Project work.

Several teacher participants commented how the school strategy supported planning and teaching CT and they were aware that the group had the same access to those documents which contributed to the overall median for collective efficacy. For example, Steven was *mostly confident* in his collective efficacy beliefs (median = 77) and commented how it was helpful to have CT built into the school strategy for mathematics, and everyone had access to this information. Steven said, *"I think the strategy of having it as a big focus in maths is really handy. Just because the person in charge of maths has gone through each unit and sort of given us a few ideas on how we can incorporate it into maths"* (Interview – CS2P1Q13). Similarly, Andrea (median = 74) believed the school strategy contributed to her *mostly confident* collective efficacy beliefs, however, she viewed some discrepancy between strategy and the group's implementation of CT. Andrea commented, *"I actually think it probably is well documented through our* *paperwork, but it is a bit different it just being on paperwork and getting into classrooms"* (Interview – CS2P2Q13). In contrast, Theo (median = 28) was not as supported in his collective efficacy beliefs by the school strategy when CT planning and teaching. Theo held *somewhat confident* collective efficacy beliefs and wondered, *"I think the school probably values it in that sense. I don't know if it's in our charter and things like that. I wouldn't know"* (Interview – CS2P5Q13). While most of the teachers in CS2 understood the CT strategy was available to them (and others), there was still a general belief of it being something that was on paper, and yet to be implemented fully in the school.

5.6.1 Collective Efficacy Summary

In summary, the teacher participant median of 64 suggested *mostly confident* beliefs in the group's ability to plan and teach CT. Contributing to the group median was the teachers' beliefs in how the group used technology for collaboration and communication (median = 63), the group's capability (median = 60), the group's effort (median = 63), the group's quality of outcomes (median = 76), general group satisfaction (median = 79) and group computing concepts, knowledge, and skills (median = 60). In addition, some teachers viewed the strategy as supportive of their CT planning and teaching, particularly for mathematics. However, there were also other teachers who considered whether there was some disconnect between the CT strategy and how the group was implementing it. Combined, these factors provided evidence for the relationship between teacher's collective efficacy beliefs, and the planning and teaching of CT.

Part One Summary

Part one has presented the CS2 teacher participants' group medians for self-efficacy, teaching efficacy, and collective efficacy beliefs as well as interview and observational findings to support the medians. The group median for self-efficacy of the teacher participants was 52 and indicated the teachers in CS2 held *moderately can do* self-efficacy beliefs towards understanding foundational CT concepts and planning CT. The group median for teacher efficacy was 47 and suggested these teachers had *moderately can do* teacher efficacy beliefs towards planning and teaching CT, particularly when teaching CT concepts and integrating CT across curriculum areas. Finally, the group median for collective efficacy of the teacher participants was 64 and suggested *mostly confident* collective efficacy beliefs, as discussed as part of their professional network.

Part two now turns to the self-efficacy and collective efficacy beliefs of the school leader in CS2. Teacher efficacy is not reported as the school leaders did not teach CT themselves.

PART TWO

5.7 Self Efficacy Beliefs and the Conceptual Foundations of CT

What are the relationships between school leaders' efficacy beliefs (self, and collective) and the implementation of CT?

This section presents the findings from survey and interview data from the school leader participant in CS2. The school leader completed the same survey as the teachers (please see Appendix *). Table 49 presents the overall the self-efficacy beliefs for the school leader, and IQR. The median for self-efficacy of the school leader in CS2 was 45 which was interpreted as *moderately can do* self-efficacy beliefs towards understanding foundational CT concepts and ability to plan CT. The IQR of 27 meant the school leader had moderate variation in his understanding of some aspects of CT compared to others. Because there was only one school leader in CS2, the data is presented as the overall median and IQR. Teacher efficacy is not included because school leader did not answer the teacher efficacy survey questions as he was not teaching CT.

Table 49
School Leader Participant Self-Efficacy

		Self-Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P6	Nathan	45	27	Moderately can do
Overall median		**45**	**27**	**Moderately can do**

Conceptual foundations of CT are perceived as five CT concepts; decomposition, abstraction, pattern recognition, algorithmic thinking, and debugging. The school leader in CS2 was asked to define and explain his understanding of CT concepts in both the survey, and interview. Table 50 presents the aggregate data for the leader participant's survey responses for the five CT concepts (and general problem-solving) as explained in section 3.8.1.

Table 50

School Leader Participant Self-Efficacy Subscale Medians

ID	Pseudonym	Decomposition	Abstraction	Pattern Recognition	Algorithmic thinking	Debugging	General Problem Solving
P6	Nathan	46	52	51	25	52	40
Overall median		**46** **Moderately can do**	**52** **Moderately can do**	**51** **Moderately can do**	**25** **Somewhat can do**	**52** **Moderately can do**	**40** **Moderately can do**

The school leader in CS2 was *moderately* self-efficacious towards his understanding of the majority of the foundational CT concepts. He was, however, *somewhat* self-efficacious towards his understanding of algorithmic thinking (median = 25). As with the teachers, some CT concepts appeared to be more familiar to the school leader than others, however, the school leader had more variation in his self-efficacy beliefs for the CT concepts as indicated by his IQR of 27.

Table 51 and Table 52 present findings using the school leader's interview data to explain the median. The findings for decomposition (Table 51) and algorithmic thinking (Table 52) are used to show the difference between the school leader's self-efficacy beliefs for the two CT concepts. The remaining joint displays for the CT concepts, and general problem-solving are presented as Appendices 35 – 38.

Table 51
School Leader Understanding of Decomposition

ID	Pseudonym	Decomposition	Interview evidence
P6	Nathan	46 Moderately can do	No evidence of decomposition. "Personally, my experience with the digi curriculum has been quite cloudy (Interview – CS2P6Q1).
Overall median		**46 Moderately can do**	

Nathan had a median of 46 (*moderately can do*) for his understanding of decomposition, yet he did not explicitly discuss decomposition during his interview. Two reasons for Nathan's lack of evidence for decomposition may be because he was not teaching in a classroom, and he had not also participated in the 100 hours of professional development. The findings illustrated how the school leader did not explicitly define decomposition, yet was still *moderately* self-efficacious towards his understanding indicating that he was perhaps more familiar with the decomposition survey questions.

The following table (Table 52) presents findings using the school leader participant's interview data to further explain the overall median for the CT concept of algorithmic thinking.

Table 52
School Leader Participant Understanding of Algorithmic Thinking

ID	Pseudonym	Algorithmic Thinking	Interview evidence
P6	Nathan	25 Somewhat can do	"The process involved in making a command have an outcome, or an output" (Interview – CS2P6Q1).
Overall median		**25** **Somewhat can do**	

For algorithmic thinking, Nathan had a median of 25. Although he reported *somewhat can do* self-efficacy beliefs for understanding algorithmic thinking, he explained an algorithm was a process involving transforming a command into a specific outcome or output, even though he did not use the specific vocabulary. It is possible that Nathan had come across the term in the past, therefore contributing to his *somewhat can do* self-efficacy beliefs, yet did not have the context of algorithmic thinking in a classroom setting.

Nathan had *moderately can do* self-efficacy beliefs towards abstraction (median = 52), pattern recognition (median = 51), debugging (median = 52), and general problem-solving (median = 40). Nathan did not provide evidence during his interview to explain his survey medians. Likely, this was because he was not part of the government-funded professional development and did not learn the terms in detail. Additionally, since Nathan was not teaching CT in a classroom, he may not have the need to understand CT terms in that context.

5.7.1. Self-Efficacy Summary

Findings suggested that Nathan's self-efficacy beliefs towards CT concepts are around the *moderately can do* median. Even though the overall median for most CT concepts was *moderately can do*, Nathan did not provide evidence of a clear understanding of CT concepts during the interview. This is likely because he did not participate in the PD and was out of the classroom, therefore not teaching CT.

5.8 School Leaders' Collective Efficacy Beliefs, their Professional Network, and the Planning of CT

Collective efficacy beliefs are held by an individual in relation to how they perceive others as successful when working together on a collective endeavour. The CS2 school leader participant's overall collective efficacy median was 72 (see Table 53) and was interpreted as *mostly confident* efficacy beliefs in the group when planning and teaching CT. The IQR was 6 and suggested that the school leader held very similar collective efficacy beliefs across the collective efficacy survey questions.

Table 53
School Leader Participant Collective Efficacy

		Collective Efficacy		
ID	**Participant**	**Median**	**IQR**	**Interpretation**
P6	Nathan	72	6	Mostly confident
Overall median		**72**	**6**	**Mostly confident**

This section presents findings how the CS2 school leader participant's collective efficacy beliefs related to his planning of CT. Professional network (from 3.9) describes the collaboration between teachers and school leaders and was used as a structure for understanding collective efficacy beliefs of the school. Table 54 presents the collective efficacy subscale results for the school leader. Rationale for the categories of Table 54 is described in Section 3.7.1.

Table 54

School Leader Participant Collective Efficacy Subscale Medians

ID	Participant	Group computing concepts knowledge and skills	Group technology collaboration and communication	Group capability	Group effort	Group quality of outcomes	General group satisfaction
P6	Nathan	60	81	62	72	74	76
Overall median		**60 Moderately confident**	**81 Totally confident**	**62 Mostly confident**	**72 Mostly confident**	**74 Mostly confident**	**76 Mostly confident**

Group technology collaboration and communication had the highest overall median for the school leader participant in CS2 (median = 81). This suggested that Nathan was *totally confident* in his collective efficacy beliefs for how the group collaborate and communicate using technology. Nathan was *mostly confident* in his collective efficacy beliefs towards group effort (median = 72), group quality of outcomes (median = 74), and general group satisfaction (median = 76), and group capability (median = 62). Group understanding of computing concepts, knowledge, and skills (median = 60) indicated that Nathan was *moderately confident* in his collective efficacy beliefs for this subsection.

Table 55 and Table 56 present findings using interview data to further explain the overall median. The findings for group computing concepts, knowledge, and skills (Table 55), and general group satisfaction (Table 56) are used to show the difference between the school leader's collective efficacy beliefs for the two categories, and how they contribute to the overall median for collective efficacy. For brevity, the remaining joint displays of the other four categories are presented as Appendices 39 – 42.

Table 55

School Leader Participant Collective Efficacy and Group Computing Concepts, Knowledge and Skills

ID	Pseudonym	Group computing concepts knowledge and skills	Interview Evidence
P6	Nathan	60 Moderately confident	"They're a bit, I think they're a bit "meh" about stuff. I don't think things blow them away like they do me. So, a Sphero is just sort of like, okay, yeah, that's cool. Does that. What's the big deal? And I felt like they've been creating content for a long part of their life. But it's sort of a surface level, right?" (Interview – CS2P6Q5).
Overall median		**60** **Moderately confident**	

The overall median for Nathan's collective efficacy beliefs and group computing concepts, knowledge, and skills was 60. This meant that Nathan was *moderately confident* in the group's understanding of computing concepts, knowledge, and skills. Nathan thought that some of his staff were not as impressed by the robotics technology available for their classrooms because they had been using technology for a long time. This may suggest that Nathan held *moderately confident* beliefs because he was unsure whether the group understand the potential from the digital tools when planning and teaching CT, particularly robotics.

To further understand the school leader's collective efficacy beliefs towards the planning and teaching of CT, general group satisfaction is presented next. Table 56 uses findings from Nathan's interview data to further explain the overall median for collective efficacy beliefs and general group satisfaction.

Table 56
School Leader Participant Collective Efficacy and General Group Satisfaction

ID	Pseudonym	General group satisfaction	Interview Evidence
P6	Nathan	76 Mostly confident	"Is there a disconnect between what we're asking you to do and your ability to do it, or is it a disconnect between your willingness to do whatever we need to have some hard conversations. We don't have that. So they are very compliant, not the word, but they're very willing" (Interview – CS2P6Q6).
Overall median		**76** **Mostly confident**	

The overall median for Nathan's collective efficacy beliefs towards general group satisfaction was 76 and indicated he was *mostly confident* with the school staff and how CT was planned and taught at the school. He commented several times throughout the interview that he believed the staff was very willing to try new things, and that there were not many examples he could recall involving reluctant teachers when planning and teaching CT. Nathan's evidence of trust in the group for planning and teaching CT aligned with his *mostly confident* collective efficacy median for group satisfaction.

For group technology collaboration and communication, the CS2 school leader (median = 81) was *totally confident* in his collective efficacy beliefs. Nathan believed that the group was collaborating using technology because of the structured support via a unit plan using Sphero in mathematics. By providing the unit to teachers, Nathan was confident that the group could collaborate, and avoid creating resources from Scratch.

Nathan (median = 62) held *mostly confident* collective efficacy beliefs towards group capability. Despite having *mostly confident* beliefs, Nathan noted that he had not observed the group using particular digital tools outside of mathematics classes or inquiry lessons and had not seen robotics applied in other curriculum areas such as science. Regardless of this, Nathan still believed in the group's capability for planning and teaching CT and had perhaps seen CT in action using non-digital tools which align with his *mostly confident* median.

For group effort, Nathan (median = 72) was *mostly confident* in how the group planned and taught CT. While Nathan was confident the group was putting effort in, he admitted it may be more difficult to observe enthusiasm and effort. He commented that:

> The staff are very willing, we don't get a lot of resistance for new learning. If you're a facilitator who comes in, I don't think you walk in and go 'wow what a staff who just visibly blown away and are just so keen'. There's sort of like, 'okay, cool'. I'll do that' (Interview – CS2P6Q6).

Nathan (median = 74) was also *mostly confident* in his collective efficacy beliefs and the group's quality of outcomes when planning and teaching CT. Nathan found that successful CT outcomes varied based on the groups' confidence and their ability to adapt to new student learning within a subject they are still learning themselves.

The findings presented in this section demonstrate how the survey subsection medians related to the school leader's collective efficacy beliefs, contributing to the overall median of 70 (*mostly confident*).

5.9 School Leader Collective Efficacy Beliefs and the School Strategy

The school leader had worked in a team to develop a school strategy document where CT was introduced under the title Digital Technology Long Term Plan (see Figure 5 in section 5.6). Interview comments were used from the school leader participant (Nathan) as evidence how the school strategy supported his collective efficacy beliefs. Nathan's overall collective efficacy median was 72 and meant he had *mostly confident* efficacy beliefs in the group when planning and teaching CT. Nathan commented how he thought the school strategy supported the group because the CT strategy was:

> At the forefront of our curriculum. We identify that it's an important aspect of learning and it should be throughout, threaded through what we do. So, I mean, I don't think that's a surface thing chucked on a document. I think if you went around our school, I think you would see that [CT] happening in classes (Interview – CS2P6Q8).

Nathan's assurance that CT was embedded in the school strategy, and the group knew about it, contributed to his *mostly confident* collective efficacy beliefs. He commented, *"the last few years probably the last five, six years we've tried to be really open and transparent about why we're doing stuff and how it fits into the strategic direction"* (Interview – CS2P6Q9).

The findings suggest how the school strategy has supported the school leader's collective efficacy beliefs towards the CS2 group when planning and teaching CT.

5.9.1 Collective Efficacy Summary

In summary, in CS2 the school leader participant median of 72 suggests *mostly confident* beliefs in the group's ability to plan and teach CT. Contributing to this overall median was Nathan's beliefs in how the group utilised computing concepts, knowledge, and skills (median = 60), group technology use for collaboration and communication (median = 81), group capability (median = 62), group effort (median = 72), group quality of outcomes (median = 74), and general group satisfaction (median = 76). Furthermore, Nathan believed the group was well supported by the CT school strategy, and knew where to find help or answers to their questions, which also contributed to his *mostly confident* collective efficacy beliefs.

Part Two Summary

Part two has presented the CS2 school leader participant's median for self-efficacy, and collective efficacy beliefs as well as interview findings to help understand the survey medians. The overall median for self-efficacy of the school leader was 45 and indicated that the leader in CS2 *moderately can* understand and plan CT foundation concepts. In addition, the overall median for collective efficacy of the school leader was 72 and suggested *mostly confident* collective efficacy beliefs towards how the group planned and taught CT, as discussed as part of their professional network.

Part three of the chapter now turns to the factors that support or undermine sources of efficacy judgements for both teachers and school leaders of CS2 when planning and teaching CT.

PART THREE

5.10 Factors that Support or Undermine Efficacy Judgements

What factors support or undermine sources of efficacy judgements when planning and teaching CT?

This section discusses the group median for each efficacy type as well as the four sources of information on which efficacy judgements are made and the factors that support and/or undermine self, teacher, and collective efficacy beliefs when planning and teaching CT. Both teacher and school leader participants' findings are reported together because the results did not differ between the two groups (see Table 57).

Table 57
School-wide Efficacy Medians and IQR for Case Study Two

Efficacy Type	n	Median	IQR	Interpretation
Self-efficacy	6	52	13	Moderately can do
Teacher Efficacy	5	47	36	Moderately can do
Collective Efficacy	6	65	16	Mostly confident

The school-wide self-efficacy median for both teacher and school leader participants in CS2 (collectively called participants in this section) was 52 (*moderately can do*) with an IQR of 13. The teacher efficacy median did not change (median = 47, *moderately can do*) with an IQR of 36, because the school leader did not have teacher efficacy measured as they were not teaching CT. The school-wide collective efficacy median for both teacher and school leader participants was 65 (*mostly confident*) with an IQR of 16.

In addition, Table 58 presents the factors that were identified to either support or undermine self, teacher, and collective efficacy beliefs. Table 58 shows whether the four sources of efficacy judgements are supported (S) or undermined (U) for all participants in CS2. The four sources of efficacy judgements are enactive mastery, vicarious experiences, social/verbal persuasion, and physiological states (Bandura, 1997, as described in Chapter *). The factors identified that supported efficacy judgements were Professional Development (PD), resources, and teacher collaboration. The factors that undermined efficacy judgements were PD, lack of resources, and lack of time. Both supporting and undermining sources of efficacy judgements are described under each factor.

Table 57

Factors Supporting/Undermining Sources of Efficacy Judgements of CS2 Participants

Sources of efficacy judgements	**Enactive mastery**			**Vicarious Experiences**			**Verbal Persuasion**			**Physiological States**		
Type of efficacy	SE	TE	CE	SE	TE	CE	SE	TE	CE	SE	TE	CE
PD	S/U	S	S/U	S					S/U			
Resources	S	S	S/U	U	S					U		
Time	U	U	U									
Collaboration									S			

SE – self efficacy, TE – teacher efficacy, CE – collective efficacy.
S supported, U undermined.

5.10.1 Professional Development (PD)

The teachers and the school leader in CS2 stated that PD was a factor that either supported their efficacy judgements (enactive mastery (i.e. success), vicarious experiences, and verbal persuasion or undermined their efficacy judgements (enactive mastery (i.e. failure) for planning and teaching CT (Table 58). PD as a factor that, depending on the situation, either supported or undermined efficacy judgements contributing to the school-wide self-efficacy median of 52 (*moderately can do*), the teacher efficacy median of 47 (*moderately can do*), and the school-wide collective efficacy median of 65 (*mostly confident*).

PD Supporting/Undermining Enactive Mastery. The following findings are evidence of how PD (either through a government funded facilitator, internal school-wide PD, or off-site PD) contributed to teachers and the school leader having experiences of success (or failure) when planning and teaching CT. For example, Cherie (median = 52) said PD supported her experiences of success as it provided her opportunities to practice the content herself alongside an external facilitator. The PD contributed to her *moderately can do* self-efficacy beliefs. Cherie commented, "[the facilitator] *worked with three of us and then she would come and do one or two PD sessions with the whole staff or if the staff member wanted something done in their classroom or wanted something demonstrated then she would come in"* (Interview – CS2P3Q2). Similarly, Steven's (median = 85*) totally can do* self-efficacy beliefs were supported when practicing his skills with a facilitator when completing the PD. He commented, *"having access to the lady who came in last year to take our PD – she has a really good relationship with the school and she's always quite happy to come in, if she's got time, to help out or suggest things through an email. That definitely helps the implementation of it"* CS2P1Q11). On the other hand, Andrea (median = 16) had conflicting views for how the PD both supported and undermined her CT success, contributing to her lower, *cannot do at all* self-efficacy beliefs. Andrea commented on initial support and how, *"we had some hours from* [PD provider]*, and we had 100 hours. It actually did work quite extensively; I was helping with the maths programme"* (Interview – CS2P2Q2). However, Andrea also found the content confusing during internal PD which undermined her self-efficacy beliefs. She stated that, *"it was confusing. When we were delivering the digital technologies curriculum and CT to the staff after doing the maths programme, the terms were confusing to unpack"* (Interview – CS2P2Q8). PD had both supported and undermined enactive mastery experiences for the participants in CS2, thus contributing to the school-wide *moderately can do* self-efficacy median.

In terms of teacher efficacy beliefs, Cherie (median = 60) was comfortable explaining, and demonstrating CT teaching to her colleagues as internal PD, which was interpreted as supporting her experiences of success when teaching CT. Cherie had *moderately can do* teacher efficacy beliefs, Cherie explained she was, *"more than happy to sit down with just them and go through it with them after school, or at a time that they'll feel confident, not in front of other people"* (Interview – CS2P3Q7). In addition, Steven (median = 84) could *totally* teach CT to other teachers as internal PD, and was confident in a CT context more than other curriculum areas because although he was new to teaching, he had experience with technology. Steven said that he, *"really enjoy*[s] *that sort of experience* [modelling CT] *because this is my second-year teaching; obviously I don't have a lot of knowledge in certain areas, so I find that anywhere I can help other people is really good"* (Interview – CS2P1Q8).

PD also supported enactive mastery of the teachers, contributing to collective efficacy beliefs. An example was from Cherie (median = 66) who was involved in internal PD at the school and because she had supported the group's successful experiences, it increased her own *mostly* *confident* beliefs that the group knew how to plan and teach CT. She stated, *"once you go through it a few times, or show them the instructions and get them to do it themselves, then they gain a bit of confidence in it"* (Interview – CS2P3Q8).

Theo however, (median = 28) discussed that after the PD, he realised the group might not think they are already teaching CT across the curriculum. This realisation was interpreted as undermining his collective efficacy beliefs. Despite working through CT lessons together, Theo still wondered whether his group was confident in their ability to plan and teach CT, which explained his *somewhat confident* collective efficacy median. Theo commented, *"teachers probably don't know they are already doing this anyway and they think 'Oh god I've got to do something extra now' when they are actually already doing it"* (Interview – CS2P5Q11).

These findings indicate that PD both supported and undermined teachers' and school leaders' enactive mastery for planning and teaching CT, contributing to the school-wide median for self, teacher, and collective efficacy beliefs.

PD Supporting Vicarious Experiences. Evidence also showed that government-funded PD supported vicarious experiences for teachers and school leaders, contributing to the school-wide self, teacher, and collective efficacy medians for participants in CS2.

Two teachers commented that PD provided them with vicarious learning experiences which supported their self-efficacy beliefs. For example, Steven (median = 85) was supported when he had observed the facilitator modelling a session on Sphero robots with his class. He said, *"last year we had a lady come in and take a PD session with us around it, and she also came into our classes and did a one-off session with some Sphero robots"* (Interview – CS2P1Q2). This vicarious experience contributed to Steven's *totally can do* self-efficacy beliefs. In addition, Theo (median = 51) was supported by internal PD when he observed other teachers use Scratch. From watching other teachers plan with Scratch programming, Theo believed he could do the same, and this aligned with his *moderately can do* self-efficacy beliefs. He stated, *"I've seen Scratch done, I've done a little bit of Scratch coding over the years"* (Interview – CS2P5Q11). No participants in CS2 provided evidence for how their teacher efficacy or collective efficacy beliefs were either supported or undermined by vicarious experiences during PD. This may be due to a lack of opportunities for the participants to learn from each other; many participants commented how they primarily planned and taught CT independently.

PD Supporting/Undermining Verbal Persuasion. Verbal persuasion involves encouragement from valued individuals, which can significantly boost self-efficacy beliefs, while negative feedback from these individuals can harm them (Bandura, 1997). Evidence showed that PD provided opportunities for teachers and the school leader to discuss CT planning and teaching, which contributed to CS2 participants *mostly confident* collective efficacy beliefs. For example, Nathan (median = 72) was *mostly confident* because there was honesty between the group/staff as a whole. Nathan believed that because of the PD, everyone knew about CT and its importance in the school, and they were more likely to plan and teach it. Nathan commented how, *"we've tried to be really open and transparent about why we're doing stuff and how it fits into the strategic direction"* (Interview – CS2P6Q9). Despite a lower median of 28, Theo mentioned that discussions among staff during internal PD contributed to his *somewhat confident* collective efficacy beliefs. Theo said he believed the group were, *"pretty lucky at our school, we've got - dare I say - a young staff. It's a good thing because people are willing to talk and give things a go"* (Interview – CS2P5Q10). Despite not having a higher collective efficacy median, Theo did believe that the group were willing to discuss new pedagogies for CT planning and teaching, however, he did not elaborate on the specifics of what was discussed. While the conversations in CS2 supported their collective efficacy beliefs, the participants remained uncertain about whether their group had actually planned or taught CT following the discussions. As a result, this lack of follow-up knowledge contributed to a decrease in collective efficacy beliefs.

While PD supported and undermined opportunities for verbal persuasion, the CS2 participants did not mention how opportunities to discuss CT planning and teaching during PD contributed to either their self, or teacher efficacy beliefs. Furthermore, there was no evidence of how PD either supported or undermined physiological states of the participants.

5.10.2 Resources (Digital and Non-Digital)

The following findings help to provide insight for how resources contributed to the CS2 school-wide self-efficacy median of 52 (*moderately can do*), teacher efficacy median of 47 (*moderately can do*), and school-wide collective efficacy median of 62 (*mostly confident)*. This section explains how enactive mastery experiences, vicarious experiences, and physiological states (such as emotional experiences) were influenced by the availability or lack of resources (both digital and non-digital) when planning and teaching CT.

Resources Supporting/Undermining Enactive Mastery. Both digital (laptops, robotics, and online software) and non-digital (paper lesson plans, pen, paper activities) resources were discussed in relation to teachers' enactive mastery (or failure) when planning and teaching CT. The school-wide median for self-efficacy was 52 or *moderately can do*, and the teacher participants described how access to non-digital and digital resources supported their planning of CT, which also helped to support their self-efficacy beliefs. Some teachers from CS2 discussed how having the resources readily available ensured they could practice using them and think about how the resources could be put into their CT planning. One example was from Steven (median = 85) who had Sphero robotics available to him which he could use to model for other teachers. Modelling the robotics tools was supportive of his *totally can do* self-efficacy beliefs because he could show others how to use the resource to plan with it in future, as opposed to teaching with it. Steven said he had demonstrated to a colleague where, *"recently I had a teacher who hadn't worked with Sphero. He came in one afternoon and we sat down, and I got him all set up and showed him how to do it"* (Interview – CS2P1Q8).

The teacher participants also identified the role of digital resources (hardware and software) as supportive of their enactive mastery (i.e., success) when teaching CT because they could practice with the tools, contributing to the *moderately can do* group teacher efficacy median of 47. Steven (median = 84) had successful experiences modelling how to teach using digital resources to other teachers, therefore contributing to his *totally can do* teacher efficacy beliefs. Steven said, *"I think I'm quite a tech savvy person and it's quite known amongst the* [school*] staff. So, I've had quite a few people come and see me and seek ideas or double check how they should be teaching it"* (Interview – CS2P1Q7). Similarly, Cherie (median = 60) had also used Sphero as a digital resource modelling CT activities to a colleague which supported her *moderately can do* teacher efficacy beliefs. She said, *"I used a Sphero so the teacher can kind of just watch"* (Interview – CS2P3Q7). In addition, Cherie believed she had an advantage because the digital resources were stored in her classroom, and meant that she had more opportunities to use them in her classroom, further strengthening her teacher efficacy beliefs. Cherie commented, *"I have probably got access to the resources more than other teachers because the Sphero are in my room, or I've just got the activities made"* (Interview – CS2P3Q6). It was interesting to note that while Theo (median = 30) was not as confident to model CT teaching to a colleague as some of the other staff, he still commented about how well his class was resourced and how the resources available supported his *somewhat can do* teacher efficacy median. Theo had the resources so he was able to teach CT with his students, and commented that:

> My class have 1:1 devices, because I've got enough kids in my class who do BYOD [bring your own device] and then I've got enough school ones, so everyone has a device and there are a couple of spares. That creates its own - it enables quite a lot rather than creates challenges (Interview – CS2P5Q13).

Resources was also identified as a factor that supported enactive mastery experiences, that contributed to the school-wide collective efficacy beliefs (median = 62, *mostly confident*) of CS2 participants. Although as a school leader, Nathan did not teach CT to students, he thought the group were well resourced to plan and teach CT, contributing to his *mostly confident* collective efficacy median of 74. Nathan stated that there was, *"no barrier in terms of school funding. I don't know if you've seen resources around here. These kids have access to anything they need. Staff have access to huge amount of resources around digital technologies"* (Interview – CS2P6Q5). In contrast, Cherie noticed that resource constraints might limit the group's ability to successfully teach CT, and therefore lowered her belief that the group were planning and teaching CT. Despite her collective efficacy median being 66 (*mostly confident*), because of these constraints, she commented that:

> We have 6 Sphero so it can only go to one class at a time, and you can only teach in small groups, so sometimes there is a backlog, or some

> teachers can't get to what they need to teach it. So that's been a little niggling issue at the moment, trying to get everyone to have an equal amount of time with it during the term. That's probably our major one at the moment, just lack of resources (Interview – CS2P3Q10).

The discussion with the researcher about access to both digital and non-digital resources highlighted how the enactive mastery of CS2 participants was either supported or undermined when planning and teaching CT. This, in turn, influenced their school-wide self-efficacy median of 52 (*moderately can do*), teacher efficacy median of 47 (*moderately can do*), and school-wide collective efficacy median of 62 (*mostly confident)*.

Resources Supporting/Undermining Vicarious Experiences. Resources emerged as a factor that was related to teachers' positive and negative vicarious experiences when planning and teaching CT. For example, while Andrea (median = 16), believed learning from a facilitator initially helped her confidence, she still reported a *somewhat can do* self-efficacy median. Andrea commented, *"it was so successful when I did it with* [the facilitator] *because she would come into the class and model a lesson, and you'd be like 'Ohhh' and easily do it again so modelling works really well for me* (Interview – CS2P2Q2). Although Andrea initially had a positive vicarious experience when the facilitator modelled CT, she did not believe it continued to contribute to her self-efficacy beliefs when planning CT, and she perhaps needed more support with resources being modelled in future to increase her confidence when planning CT.

In terms of teacher efficacy, Theo (median = 30) stated that after he had the opportunity to watch a Sphero demonstration, he believed he *somewhat can do* CT teaching. Theo was excited to learn how to use the robotics in his teaching after observing the facilitator and commented, *"I think the* *first time I saw the Sphero I thought 'Man these are cool, I want to play with these' and then going from playing with them to 'I have been able to write a program or create something to control these'. That was pretty cool to see that"* (Interview – CS2P5Q11). Theo acknowledged that learning how to teach with available resources from a facilitator was a positive start, but also likely needed additional support to increase his teacher efficacy beliefs.

These findings suggested that resources provided opportunities for vicarious experiences that supported teachers' self, and teacher efficacy beliefs for planning and teaching CT. There was no evidence provided from participants where vicarious experiences either supported or undermined their collective efficacy beliefs.

In addition, no participant in CS2 provided evidence for how verbal persuasion due to the resources either supported or undermined their self, teacher, or collective efficacy beliefs. This may have been due to most participants attributing resources to either enactive or vicarious experiences; the participants would have been discussing how to use the tools while they were practicing with them, or learning from one another. Resources were not viewed as something to be discussed independently of them being used for planning and teaching CT.

Resources Undermining Physiological States. Digital and non-digital resources emerged as a factor that was related to CS2 participants' negative physiological states when planning CT. For example, Theo (median = 51) believed the curriculum documents and activities undermined his *moderately can do* self-efficacy beliefs. He stated, *"I remember sitting with the facilitator and thinking 'Oh man PO1, what are all these things I've got to remember' - I think that's pretty daunting"* (Interview – CS2P5Q11). The comment of feeling 'daunted' implied that

Theo required more support when planning CT with particular resources that were available to him, which might have contributed to his reported negative physiological state.

The previous sections provided insight into how accessibility to both digital and non-digital resources affected teachers' enactive mastery, vicarious experiences, and physiological states, contributing to the CS2 school-wide self-efficacy median of 52 (*moderately can do*), teacher efficacy median of 47 (*moderately can do*), and school-wide collective efficacy median of 62 (*mostly confident).*

5.10.3 Time

The participants in CS2 discussed a lack of time as a factor that undermined their enactive mastery experiences when planning and teaching CT, which contributed to the school-wide self-efficacy median of 52 (*moderately can do*), teacher participant median for teacher efficacy (median = 47, *moderately can do*), and school-wide collective efficacy median of 65 (*mostly confident*).

Lack of Time Undermining Enactive Mastery. The participants in CS2 provided evidence how a lack of time was a factor when attempting to plan and teach CT, due to not having the experiences required to understand, plan, and practice CT. This in turn, influenced self, teacher, and collective efficacy beliefs. For example, Andrea (median = 16) believed a lack of time was a barrier for her when trying to understand and practice CT content, which influenced her self-efficacy beliefs when planning CT lessons. She commented that, *"my knowledge is a big stumbling block of course. Time to upskill is tricky"* (Interview – CS2P2Q3). Similarly, despite Isla reporting a *mostly can do* median of 61, she also mentioned that a lack of time was a factor that influenced her ability to plan CT. She said "*if you plan something really* *well, on the thinking process* [of CT], *it can be wrapped up within your planning* [as a whole]. *So, I think the time* [having the time to do it]" (Interview – CS2P4Q9).

A lack of time also impacted enactive mastery beliefs for teaching CT, and two teachers discussed how they thought timetabling, and students out of class restricted their ability to teach CT. While Cherie (median = 60) *moderately can* teach CT, she had reservations because of timetable constraints. She said:

> I think for us [teachers] it just takes a little longer to pick up activities and things. I do understand with timetable constraints and we've got heaps of other things to fit in with maths and things like that, I totally understand (Interview – CS2P3Q12).

In addition, Steven (median = 84) was hindered in his ability to practice teaching CT because the students were often out of his class for other activities. Despite his *totally can* teach CT median, Steven acknowledged a lack of time meant he, *"won't be with my class for nearly a full day each week, well, no a full day each week because of other classes and sport and such. I think time is probably the biggest one* [factor]*"* (Interview – CS2P1Q10). While Steven *totally can* teach CT, he also needed the time with his students in class.

The school leader was the only participant in CS2 to discuss how he believed a lack of time reduced the group's ability to plan and teach CT, thus affecting his collective efficacy beliefs. Nathan (median = 72), was *mostly confident* that the group had enough time to plan and teach CT. However, he also acknowledged that sometimes the group were pressed for time and could not allow the students to complete CT activities in a thorough way. Nathan stated that:

> I think sometimes kids don't get the chance just to sit and work through things like kids do. Because teachers are worried about time. And haven't got enough time. Yeah, ‘I haven't got enough time to do that because it's new learning and it'll suck up a lot of time in my week’ (Interview – CS2P6Q5).

Nathan believed that although the group sometimes struggled to cover all curriculum content, especially CT, they would not use that as a reason to avoid planning and teaching CT. He commented that, *“everyone's time poor, very busy. You've got all this other stuff to do. But they won't use that as an excuse to not do something. It just might stop them doing it* [CT], *that much”* (Interview – CS2P6Q6). This may explain why he had *mostly confident* collective efficacy beliefs, as opposed to a lower median.

A lack of time undermined teachers’ self, and teacher efficacy beliefs because they did not believe they had the time to practice planning and teaching CT, which helps to explain the school-wide self, teacher, and collective efficacy belief medians for CS2. However, no evidence was found of a connection between lack of time either supporting or undermining CS2 participants’ vicarious experiences, verbal persuasion, or physiological states.

5.10.4 Collaboration

An additional factor supporting CS2 sources of efficacy judgements was collaboration. Collaboration supported verbal persuasion, and the participants provided evidence for how collaborative planning supported planning and teaching CT, contributing to the school-wide collective efficacy score of 65 (*mostly confident*). There was no evidence from participants of how collaboration either supported or undermined the four efficacy judgements for either self-efficacy, or teacher efficacy beliefs.

Collaboration Supporting Verbal Persuasion. Collaborative planning was identified as a factor that supported verbal persuasion, which contributed to the school-wide *mostly confident* collective efficacy median. When the group were able to work together on their CT planning, they had opportunities to discuss positive aspects of how CT could be implemented. For example, Cherie (median = 66) commented that after staff discussions, she believed the group was positive about planning and teaching CT, which therefore supported her *mostly confident* collective efficacy beliefs. She stated, *"I guess, teacher attitude. The staff here are pretty engaged and want to learn how to do this stuff"* (Interview – CS2P3Q9). Similarly, Steven (median = 77) was *mostly confident* in how the group planned and taught CT because of the level of collaborative discussion with staff. His collective efficacy was supported because he believed, *"the community of staff is really good, like the fact that we share a lot of stuff and everyone's happy to drop everything and come and help if you're struggling with things. That's definitely shown through*" (Interview – CS2P1Q13).

As a school leader, Nathan had *mostly confident* collective efficacy beliefs (median = 72) because the group collaborated and communicated well when planning and teaching CT. Nathan commented how the teachers, *"are very willing, we don't get a lot of resistance for new learning"* (Interview – CS2P6Q6). In addition, Nathan discussed how accountability was used as a form of verbal persuasion which also supported his collective efficacy beliefs. Nathan commented that in the school there is a, *"lot of high trust. Accountability, but in a way that is sort of not a hard level of accountability. I think it's it grows throughout the school so people sort of take care of it themselves* [when collaborating]*"* (Interview – CS2P6Q9).

Collaboration meant CS2 participants were able to discuss planning and teaching CT, which helps to explain the school-wide collective efficacy belief median. However, no evidence was found of a connection between collaboration either supporting or undermining CS2 participants' enactive mastery, vicarious experiences, or physiological states.

Part Three Summary

Part three presented the factors identified as influencing the four sources of information on which efficacy judgements are made, and whether the factors supported and/or undermined self, teacher and collective efficacy beliefs when planning and teaching CT. The school-wide self-efficacy median for CS2 participants was 52 (*moderately can do*) with an IQR of 13. The teacher efficacy median was 47 (*moderately can do*) with an IQR of 36, and the school-wide collective efficacy median was of 65 (*mostly confident*) with an IQR of 16. The factors that either supported or undermined self, teacher, and collective efficacy beliefs were also presented and indicated whether the four sources of efficacy judgements were supported (S) or undermined (U). The factors that supported efficacy judgements were PD, resources, and teacher collaboration. The factors that undermined efficacy judgements were PD, a lack of time, and a lack of available resources.

PD generally supported efficacy beliefs by providing opportunities to practice, alongside encouragement and guidance when planning and teaching CT. However, the effectiveness of PD varied; while it helped develop positive experiences in some instances, it also included elements that negatively impacted participants' efficacy beliefs. For example, PD provided negative learning experiences for some teachers, when they initially found the CT curriculum content confusing. Resources influenced efficacy beliefs by providing the necessary tools for effective CT implementation, thereby supporting positive efficacy judgements. When resources were lacking, however, it created barriers to effective CT planning and teaching, which undermined efficacy beliefs. Additionally, insufficient time for planning and teaching CT further decreased participants' efficacy beliefs, particularly because participants did not have the time to practice CT planning and teaching. Lastly, collaboration among participants encouraged positive discussion, which increased collective efficacy beliefs when planning and teaching CT.

5.11 Summary of Case Study Two

This chapter has presented the findings from Case Study Two. In particular, results were presented to understand the relationships between efficacy beliefs and teachers' and school leaders' understanding and confidence when planning and teaching CT. Part One presented CS2 teacher participants' efficacy beliefs, with self-efficacy at a median of 52 (*moderately can do*) in planning and understanding CT, teacher efficacy at 47 (*moderately can do*) teach and integrate CT, and collective efficacy at 64 (*mostly confident*) in group's capability and effort when planning and teaching CT. Part Two presented the CS2 school leader findings, identifying a self-efficacy median of 45 (*moderately can do*) when understanding and planning CT, and a collective efficacy median of 72 (*mostly confident*) in the group's ability to CT plan and teach CT. Part Three highlighted the factors influencing efficacy judgments in CT planning and teaching. The school-wide self-efficacy median was 52 (*moderately can do*), teacher efficacy remained at 67 (*mostly can do*), and collective efficacy was 65 (*mostly confident*). Supporting factors included PD, resource availability, and teacher collaboration. However, PD had a negative impact, while a lack of resources and time constraints also undermined efficacy judgements and therefore efficacy beliefs.

In the next chapter, case study three findings are reported.

Chapter Six: Case Study Three Results

6.1 Description of Case Study Three

Case Study Three (CS3) was different to CS1 and CS2 in that the teachers were from a district of schools in a Mid-West state of The United States of America. The teachers all taught grades two-six (ages 6 – 10) in semi-urban elementary schools in the area. The schools ranged in size from 300 to 700 students. The teachers in CS3 participated in professional development (PD) through a local University which involved an asynchronous online course on CT, half a day online PD, and two days in-person PD. The participants had not previously engaged with CT curriculum material but were motivated to start early to embed digital technology in their classrooms. The school leaders were in coaching roles, where they supported the teachers when requested. All participants completed an online survey, followed by semi-structured individual interviews. Teacher participants were also observed on a single occasion in their classrooms. Of the 12 teachers and school leaders/coaches participating, ten were female and two were male. All participants were given pseudonyms. A summary of demographic information is provided in Table 59.

Table 58
Participant Demographics for Case Study Three (CS3)

Participant Demographics CS3						
ID	**Pseudonym**	**Age range**	**Ethnicity**	**Years in the Teaching Profession**	**Grade level taught**	**Role**
P1	Linda	31-40	Asian	10-20	4	Teacher
P2	Daryl	31-40	White	5-10	4	Teacher
P3	Addison	41-50	White	>20	4	Teacher
P4	Maria	31-40	White	10-20	4	Teacher
P5	Jessica	31-40	Asian	10-20	2	Teacher
P6	Ted	41-50	White	>20	4	Teacher
P7	Susan	31-40	White	5-10	2	Teacher
P8	Christina	20-24	White	<5	2	Teacher
P9	Kelly	31-40	White	10-20	3	Teacher
P10	Holly	41-50	White	10-20	4	Teacher
P11	Ruth	31-40	White	5-10	All	Coach
P12	Beth	41-50	White	10-20	All	Coach

Having described the context of case study three and the participant demographics, the following sections are a detailed presentation of findings, presented under the three research questions in the study.

PART ONE

6.2 Self-Efficacy Beliefs and the Conceptual Foundations of CT

What are the relationships between teachers' efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT?

This section presents findings from the survey, interview, and observation data from teacher participants in case study three (CS3). For Likert-scale information and interpretation, please see 3.8.1. Taking all the self-efficacy survey results into account, Table 60 presents the individual medians, and the group median of 57 for self-efficacy beliefs. The group median indicated that the teachers held *moderately* can do self-efficacy beliefs towards understanding and planning CT concepts. The overall IQR was 20 which likely meant that some teachers understood and could plan particular CT concepts more comfortably than others, contributing to the overall self-efficacy median.

Table 59

Teacher Participants' Self-Efficacy

		Self-Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Linda	70	18	Mostly can do
P2	Daryl	59	51	Moderately can do
P3	Addison	65	32	Mostly can do
P4	Maria	52	49	Moderately can do
P5	Jessica	50	38	Moderately can do
P6	Ted	34	25	Somewhat can do
P7	Susan	55	79	Moderately can do
P8	Christina	45	12	Moderately can do
P9	Kelly	72	31	Mostly can do
P10	Holly	69	30	Mostly can do
Group median		**57**	**20**	**Moderately can do**

In this study, conceptual foundations of CT are perceived as five CT concepts; decomposition, abstraction, pattern recognition, algorithmic thinking, and debugging. The teacher participants in CS3 were asked to rate their understanding of conceptual foundations of CT in the survey, and then discussed their understanding of conceptual foundations of CT, and how they planned lessons based on these concepts during the interview. A teacher's understanding of these concepts is used to form a picture of their self-efficacy beliefs. Table 61 presents the aggregated data for each participant's responses for the five CT concepts (and general problem-solving) explained in section 3.5.2. to explore what constitutes the group median for self-efficacy beliefs.

Table 60

Teacher Participants' Self-Efficacy subscale medians

ID	Pseudonym	Decomposition	Abstraction	Pattern Recognition	Algorithmic Thinking	Debugging	General Problem Solving
P1	Linda	80	70	90	50	70	83
P2	Daryl	47	47	62	55	10	71
P3	Addison	75	70	90	0	60	70
P4	Maria	52	80	84	44	30	72
P5	Jessica	60	50	50	20	20	75
P6	Ted	39	41	41	16	15	30
P7	Susan	45	75	90	0	70	40
P8	Christina	60	48	68	39	46	38
P9	Kelly	86	100	93	51	71	70
P10	Holly	74	76	93	54	57	78
Group median		**60** **Moderately can do**	**70** **Mostly can do**	**87** **Totally can do**	**42** **Moderately can do**	**52** **Moderately can do**	**71** **Mostly can do**

From the results in Table 61, pattern recognition (median = 87) had the highest group median for all teacher participants. This suggested that the teachers *totally can* understand pattern recognition as a CT concept. From the survey results related to pattern recognition, it seemed that the concept of pattern recognition as finding similarities and differences between problems seemed to be more familiar to teachers than some of the other CT concepts. For example, results related to abstraction (median = 70) and general problem-solving (median = 71) indicated that the teacher group were *mostly* self-efficacious when focusing on the important details of a problem (abstraction) and they could *mostly* solve other general problems. Decomposition (median = 60) and debugging (median = 52) suggested that the teacher group were *moderately* self-efficacious when breaking problems down, and finding and fixing mistakes in their algorithms. In addition, algorithmic thinking had a group median of 42 which suggested that the teachers were *moderately* self-efficacious in their understanding of algorithms as a set of step-by-step instructions.

Tables 62 and 63 provide a summary of the findings from interviews and observations with teacher participants. Both tables provide further insight into the individual and group medians. The findings for pattern recognition (Table 62) and decomposition (Table 63) present the self-efficacy beliefs for those two foundation CT concepts. As with CS1 and CS2, the remaining joint displays for the other three CT concepts (abstraction, pattern recognition, and debugging) and general problem-solving can be found as Appendices 43 – 46.

Table 61

Teacher Participants' Understanding of Pattern Recognition

ID	Pseudonym	Pattern Recognition (median)	Interview evidence	Observation evidence
P1	Linda	90 Totally can do	"To have different strategies or different ways to think about a problem" (Interview – CS3P1Q1).	"If it's a one digit answer, you can do this, if it's a two digit answer, you can do this" (Observation – CS3P1).
P2	Daryl	62 Moderately can do	No interview evidence.	He asked the students what they noticed about the pattern - the rows and the columns.
P3	Addison	90 Totally can do	"Pattern recognition is probably the one that I feel the most comfortable with. I feel like we are constantly as teachers helping students to guide them into identifying patterns. So looking for consistencies across problems that you could then turn into some kind of formula, some kind of equation that might help you to solve future problems" (Interview – CS3P3Q1).	"What are the characteristics of a square?" (Observation – CS3P3).
P4	Maria	84 Totally can do	No interview evidence.	"How about where the sides meet? What's that fancy word that starts with a P. They're going to meet perfectly at 90 degrees?" (Observation – CS3P4).
P5	Jessica	50 Moderately can do	"Then patterns, just looking for things that are similar, like looking for things that are the same, looking for things that are different" (Interview – CS3P5Q1).	No observation evidence.

ID	Pseudonym	Pattern Recognition (median)	Interview evidence	Observation evidence
P6	Ted	41 Moderately can do	No interview evidence.	“What patterns did you see in your circuit that we can see around the classroom? What similarities are there with this circuit? Can we relate this to anything else?” (Observation – CS3P6).
P7	Susan	90 Totally can do	No interview evidence.	“We need to add that in, to make them match” (Observation – CS3P7).
P8	Christina	68 Mostly can do	“Seeing the patterns in between the different shapes, to see which shapes have, what shapes have this in common. And what shapes have this different” (Interview – CS3P8Q3).	No observation evidence.
P9	Kelly	93 Totally can do	No interview evidence.	No observation evidence.
P10	Holly	93 Totally can do	No interview evidence.	No observation evidence.
Group median		**87** **Totally can do**		

The survey findings for teacher participants' group median for pattern recognition was 87, interpreted as *totally can do*. Five teachers were *totally* self-efficacious in their understanding of pattern recognition, however, only two teachers provided both interview and observation evidence of their understanding. One example was from Linda (median = 90) who described pattern recognition as having, *"different strategies or different ways to think about a problem"* (Interview – CS3P1Q1), and further exemplified her understanding during the observation where she explained to the students the similarities and differences between the maths problem they were working on. Linda told the students, *"If it's a one digit answer, you can do this* [points to image], *if it's a two digit answer, you can do this* [points to image]" (Observation – CS3P1). In addition, Addison (median = 90) was also *totally* self-efficacious towards pattern recognition and explained:

> Pattern recognition is probably the one that I feel the most comfortable with. I feel like we are constantly helping students to guide them into identifying patterns. So, looking for consistencies across problems that you could then turn into some kind of formula, some kind of equation that might help you to solve future problems (Interview – CS3P3Q1).

To further support her *totally can do* self-efficacy beliefs towards pattern recognition, during the observation, Addison explained the activity to her students, and asked them to think about the characteristics of a square. The students were consistently finding patterns during the lesson and Addison assisted them in finding similarities and differences when solving the task, reiterating her *totally can do* understanding of pattern recognition.

Interestingly, although reporting *totally can do* beliefs towards pattern recognition in the survey, Susan (median = 90), Kelly (median = 93), and Holly (median = 93), had very little (or none at all) evidence of their understanding from their interview and observation. This indicated that although they were self-efficacious during the survey questions with regards to pattern recognition, they did not explicitly describe it during the interview or observation, and those teachers may not be as confident planning pattern recognition as they believe themselves to be.

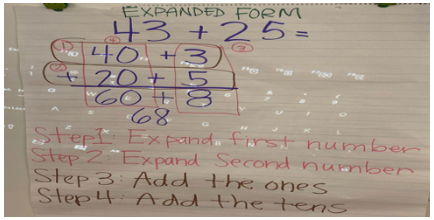
In contrast, Ted (median = 41) was *moderately* self-efficacious towards his understanding of pattern recognition, yet described it clearly to his students during the classroom observation. Ted asked his students, *"what patterns did you see in your circuit that we can see around the classroom? What similarities are there with this circuit? Can we relate this to anything else?"* (Observation – CS3P6). Although not as efficacious in his survey answers, Ted demonstrated his understanding of pattern recognition during the classroom observation which aligned with his *moderately can do* self-efficacy beliefs towards pattern recognition as a foundation CT concept. This may suggest that Ted did not recognise pattern recognition in the survey context, yet was more comfortable in his understanding during the observation.

The findings presented illustrate how the teachers in CS3 understood pattern recognition, and demonstrated that understanding during the interview and observation, therefore contributing to the group median of 87 (*totally can do*). The following table (Table 63) presents findings from the teacher's interview and observation data to further explain the group median for the CT concept of decomposition.

Table 62

Teacher Participants' Understanding of Decomposition

ID	Pseudonym	Decomposition (median)	Interview evidence	Observation evidence
P1	Linda	80 Mostly can do	"Try to break down a problem, to help them to better figure out the steps that they might need to do" (Interview – CS3P1Q1).	Linda asked the students for examples where they have used decomposition. "When we think about the strategies we have been using, we can decompose them into smaller pieces" (Observation – CS3P1).
P2	Daryl	47 Moderately can do	"Break down problems and solve them in unique ways" (Interview – CS3P2Q1).	"If I said this was an algorithm, how would you break it down?" (Observation – CS3P2).
P3	Addison	75 Mostly can do	"Decomposition. That's probably the other one that I really like, because I do like breaking things down into smaller, manageable tasks" (Interview – CS3P3Q1).	"What do you think is the most challenging thing to get started?" (Observation – CS3P3).
P4	Maria	52 Moderately can do	"Decomposition is breaking down the task into steps" (Interview – CS3P4Q1).	Maria explained the activity. "Let me simplify that. Each team member is going to get 3 strips of paper, there are 4 members in your group, and you can only touch the colour of your own paper. They're going to try to work together to make squares" (Observation – CS3P4).

ID	Pseudonym	Decomposition (median)	Interview evidence	Observation evidence
P5	Jessica	60 Moderately can do	"For decomposition, breaking things down into smaller pieces" (Interview – CS3P5Q1).	"I have to pull out each part, I have to decompose the problem" (Observation – CS3P5). 
P6	Ted	39 Somewhat can do	"A way to break down problem solving" (Interview – CS3P6Q1).	"Decomposition - we took it step by step. There was a process we followed. Once he attaches it, does it work? So the first thing you tried, it didn't work, so talk about a different way to try it. Break it down" (Observation – CS3P6).
P7	Susan	45 Moderately can do	"A way of breaking things into smaller, more manageable parts" (Interview – CS3P7Q1).	"What do you think? If I'm starting here - we've already determined that we're starting on the top row. What would stop one be?" (Observation – CS3P7).
P8	Christina	60 Moderately can do	No interview evidence	While helping a student. "The first step is moving a block. Drag the block over there." (Observation – CS3P8).
P9	Kelly	86 Totally can do	"If it's not working, being able to break it down" (Interview – CS3P9Q1).	Kelly worked with a student to explain the task. "What do we need first, now what? Do we have to go forward again or do we have to turn?" (Observation – CS3P9).
P10	Holly	74 Mostly can do	"How could we break down this sentence" (Interview – CS3P10Q6).	"When you're feeling overwhelmed with a big math problem, we can use decomposition to break it down into smaller bits." (Observation – CS3P10).
Group median		**60 Moderately can do**		

Overall, from the survey responses, the teacher participants from CS3 were less self-efficacious describing and understanding decomposition than pattern recognition. The group median for decomposition was 60 which suggested that together, they were *moderately* self-efficacious when describing and understanding decomposition as part of their planning for CT lessons. For example, Kelly (median = 86), was *totally* self-efficacious in her understanding of decomposition as the ability to understand how to separate a problem into smaller parts. Kelly stated, *"if it's not working, being able to break it down"* (Interview – CS3P9Q1). Similarly, Linda (median = 80), Addison (median = 75), and Holly (median = 74) all had *mostly* self-efficacious beliefs towards understanding decomposition as a CT concept. During the observation, Linda asked her students for situations where they have used decomposition. Linda said, *"when we think about the strategies we have been using, we can decompose them into smaller pieces"* (Observation – CS3P1). Addison was also *mostly* self-efficacious describing decomposition, and commented, *"decomposition is probably the other one that I really like, because I do like breaking things down into smaller, manageable tasks"* (Interview – CS3P3Q1). Similarly, Holly demonstrated her understanding during the observation, and explained to her students, *"when you're feeling overwhelmed with a big math problem, we can use decomposition to break it down into smaller bits"* (Observation – CS3P10) which contributed to her *mostly can do* self-efficacy beliefs towards decomposition.

Although reporting *moderately can do* self-efficacy for decomposition, both Daryl (median = 47), and Susan (median = 45) provided evidence of their understanding in both the interview and observation. Daryl described decomposition a way to, *"break down problems and solve them in unique ways"* (Interview – CS3P2Q1) and again in the observation, when he asked the students, *"if I said this was an algorithm, how would you break it down?"* (Observation – CS3P2). Susan also described decomposition clearly, which aligned with her *moderately can do* self-efficacy median. She described decomposition as, *"a way of breaking things into smaller, more manageable parts"* (Interview – CS3P7Q1). These examples indicated that although survey results showed *moderately* self-efficacy beliefs towards decomposition, Daryl and Susan were more efficacious in their understanding of the CT concept during the interview and classroom observation.

The findings presented in this section illustrated how teachers in CS3 understood the conceptual foundations of CT, specifically decomposition. Such findings suggest there is a connection between teachers' self-efficacy beliefs and their understanding of decomposition as one of the five CT concepts, which contributed to their group self-efficacy median of 60 (*moderately can do*).

In addition, from the survey responses, the teacher participants in CS3 held *mostly can do* self-efficacy beliefs when describing and understanding abstraction for their CT planning (median = 70). For example, Daryl (median = 47), Jessica (median = 50), Ted (median = 41) and Christina (median = 48) all held *moderately can do* self-efficacy beliefs towards abstraction. During the interview Jessica explained that*, "abstraction is focusing just on one thing, not focusing on everything, but just focusing on one main thing"* (Interview – CS3P5Q1) which aligns with her *moderately can do* self-efficacy beliefs. Although Jessica detailed her understanding of abstraction in the interview, she did not provide evidence of her understanding during the classroom observation. Similarly, Christina explained her understanding of abstraction during the interview when she said, *"they* [the students] *can see if they're abstracting the important information the game goes a little bit quicker, than if they're focusing on stuff that isn't as important"* (Interview – CS3P8Q3). Christina also did not provide evidence of her understanding of abstraction during the classroom observation. Both examples may suggest that these teachers were more comfortable in their own understanding of abstraction, and therefore their self-efficacy beliefs, yet perhaps needed more support with abstraction when they were teaching their students. There were also teachers in CS3 who held *mostly can do* self-efficacy beliefs towards their understanding of abstraction for their CT planning. For example, Linda (median = 70) said during the interview that abstraction was focusing on, *"the important parts of the problem"* (Interview – CS3P1Q1). Linda further exemplified her understanding during the classroom observation when she asked the students whether they were focusing on the important parts of the problem to be, *"successful with their algorithm"* (Observation – CS3P2). Maria (median = 80) also held *mostly can do* self-efficacy beliefs for abstraction. Maria clearly understood abstraction during the interview and defined it as, *"ignoring certain aspects of the problem and focusing on a particular part of the problem"* (Interview – CS3P4Q1), yet did not provide evidence during her classroom observation. Overall, the teachers in CS3 could describe abstraction during the interview, but perhaps needed more support when using abstraction with their students during CT activities, which aligned with the group median of *mostly can do* for understanding abstraction when planning CT.

The teachers in CS3 held *moderately can do* self-efficacy beliefs towards algorithmic thinking and CT planning. Despite the group median of 42, there were two teachers who *cannot do* algorithmic thinking. From the survey results, both Addison and Susan had medians of 0. Addison did not provide evidence of her understanding in either the interview or observation, yet Susan demonstrated her understanding in a singular instance during the classroom observation. Susan was showing her students how to specifically count their 'steps' when working through a non-digital algorithm. She asked her students, *"if I go two stops, watch me. One, two."*

(Observation – CS3P7). From the survey, while Susan did not believe she could do algorithmic thinking, she tentatively explained it during the classroom observation. This suggests that Susan may have been more efficacious when teaching with algorithms when off a digital device, compared to the survey questions which related algorithms to programming. In contrast, Linda (median = 50) and Kelly (median = 51) were *moderately* self-efficacious towards algorithmic thinking. Linda said in the interview that algorithmic thinking was about supporting students to understand the, *"steps that they might need to do"* (Interview – CS3P1Q1). Linda further demonstrated her understanding during the classroom observation when she asked the students the sequence of what they needed to write to solve their problems (Observation – CS3P1). Both examples provide evidence towards Linda's *moderately can do* self-efficacy beliefs towards algorithmic thinking. Similarly, during the classroom observation, while completing an online programming task, Kelly examined the directions on the screen and asked the students how to move from one point to another. As she asked the students, Kelly moved her finger across the screen in a step-by-step motion. While this example provides some evidence towards her *moderately can do* self-efficacy beliefs for algorithmic thinking, Kelly did not explicitly use the term during her classroom observation. Overall, the teachers in CS3 *moderately can* describe algorithmic thinking during the interview, and explain it during the classroom observation, which indicates they may need more support in how to explicitly use the term in their lessons when planning CT.

From the survey responses, the teacher group in CS3 had *moderately can do* self-efficacy beliefs when describing and understanding debugging for their CT planning (median = 52). For example, during the interview, Kelly (median = 71) understood debugging as troubleshooting through problem-solving steps. She further exemplified her understanding of debugging in the classroom observation when she asked the students to fix their mistake and, *"see if it works for you. Remember it won't do it until you hit reset and run"* (Observation – CS3P9). Evidence from the interview and observation supported Kelly's *mostly can do* self-efficacy beliefs for debugging. Similarly, both Linda (median = 70) and Susan (median = 70) had *mostly can do* self-efficacy beliefs towards debugging. Despite these medians, neither teacher provided evidence of their understanding in the interview, but did explicitly use debugging during the observation. Linda asked her students to identify which parts of their algorithm was clear or difficult to understand, and asked them to think of what they could change so it can be 'debugged'. Susan also asked her students what debugging meant, and asked the students to test their code to see where there were errors. While Linda and Susan did not explicitly describe debugging in the interview, their classroom observations matched their *mostly* confident survey medians. In contrast, from the survey results, Daryl (median = 10), Jessica (median = 20), and Ted (median = 15) *cannot do* debugging. While their survey results indicated lower self-efficacy, they all demonstrated understanding during their interview and/or classroom observation. For example, Jessica said she had explained to her students that when there is a problem, they have to go back to figure out what the issue is, and look for the specific step that may have gone wrong (Interview – CS3P5Q1). Furthermore, Jessica said to her students during the observation that they had to, *"find out where did I make a mistake, go back and solve that problem"* (Observation – CS3P5). Ted also *could not do* debugging according to his survey results. Despite this, Ted explained debugging clearly during his classroom observation. When his students were connecting wires in a circuit, he asked, *"I heard a lot of groups use the word debug. What did you have to debug? Tell me what it was? And then how you went back and fixed your mistake"* (Observation – CS3P6). The examples from Jessica and Ted suggested they found debugging difficult when related to the survey questions, thus lowering their self-efficacy medians. However, during observation, they explained debugging clearly when the situation in a more familiar context. This meant Jessica and Ted could discuss debugging well in situations they were comfortable with but had trouble applying those ideas in a programming context. Overall, some teachers in CS3 had a firm understanding of debugging and could apply it in different situations, whereas teachers with lower medians may understand debugging in a familiar context, but have trouble using it in complex or new problems. Both situations have contributed to the group median of 52, *moderately can* understand debugging for CT planning.

The teachers in CS3 had *mostly can do* self-efficacy beliefs for general-problem solving. Some teachers believed they understood how to problem-solve more effectively than others. For example, Linda (median = 83) *totally can* problem-solve, and said, "*I think being able to think through that a little bit more intentionally, instead of just trying problem after problem after problem"* (Interview – CS3P1Q3). She also demonstrated her depth of understanding by asking probing questions during the observation, such as, *"What do you mean by that? When you say you multiply them, what do you mean by that?"* (Observation – CS3P1). In addition, Daryl (median = 71) *mostly can* problem-solve and reflected that he thought design thinking was a problem-solving strategy where he focused on creative and personalised solutions. Although Daryl provided evidence during the interview that supported his self-efficacy median, he did not exhibit strategies for general problem-solving in the classroom observation. Maria (median = 72) *mostly* could solve problems, and related it to various contexts, such as reading and science units. Conversely, those with lower medians believed they had limited problem-solving skills. Ted (median = 30, *somewhat can do*) related general problem-solving with how he approached the skill with his students. He suggested that providing students with multiple problem-solving options was beneficial, stating, *“when they get stuck on the problem, they've got some other options rather than just raising their hand every time and asking you as an adult”* (Interview – CS3P6Q1). In addition, Susan (median = 40) and Christina (median = 38) had survey medians suggesting they *somewhat can* problem-solve, but without additional evidence, their capabilities remained less clear.

The findings presented in this section highlight how teachers in CS2 understood abstraction, algorithmic thinking, debugging, and general problem-solving as foundational CT concepts. Such findings suggest there is a connection between teachers’ self-efficacy beliefs and their understanding which contributed to the group self-efficacy median of 60 (*moderately can do*) when planning CT.

6.2.1 Self-Efficacy Summary

In summary, the teacher’s in CS3 held *moderately can do* self-efficacy beliefs about understanding CT concepts and planning CT. With regards to specific CT concepts, the teachers were most at ease with pattern recognition, while decomposition, algorithmic thinking, abstraction, and general problem-solving were more difficult concepts to understand and suggested a need for future support.

6.3 Teacher Efficacy Beliefs and Planning CT Integration

Survey results from planning, sourcing, and designing CT lessons, and teaching CT concepts and CT integration were used to calculate a group median for teacher efficacy beliefs when teaching CT. The group teacher participants’ median for teacher efficacy was 72 (see Table 64) and indicated *mostly can do* teacher efficacy beliefs towards planning and teaching CT. The IQR was

10 and this indicated most had moderately similar teacher efficacy beliefs when teaching particular CT concepts.

Table 63

Teacher Participants' Teacher Efficacy

		Teacher Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Linda	80	14	Mostly can do
P2	Daryl	40	14	Moderately can do
P3	Addison	75	25	Mostly can do
P4	Maria	89	15	Totally can do
P5	Jessica	90	20	Totally can do
P6	Ted	22	8	Somewhat can do
P7	Susan	65	27	Mostly can do
P8	Christina	68	9	Mostly can do
P9	Kelly	69	18	Mostly can do
P10	Holly	92	1	Totally can do
Group median		**72**	**10**	**Mostly can do**

The following section details how planning, sourcing, and designing CT lessons, teaching CT concepts, and CT integration medians combined for the group teacher efficacy median. Focus now turns to the findings related to how participants' teacher efficacy beliefs related to their understanding of how to plan and source material for CT integrated activities. Planning CT integration is the planning and design of CT activities, and CT integrated activities is the enaction of integrating CT across curriculum areas as described in interviews and viewed in classroom observations. Table 65 shows the planning, sourcing, and designing CT lessons survey scale results for each teacher participant , as well as the group median. Rationale for the categories of Table 65 is described in section 3.7.1.

Table 64

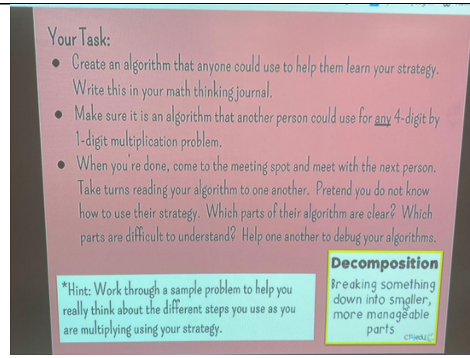
Teacher Efficacy and Planning, Sourcing, and Designing CT Lessons

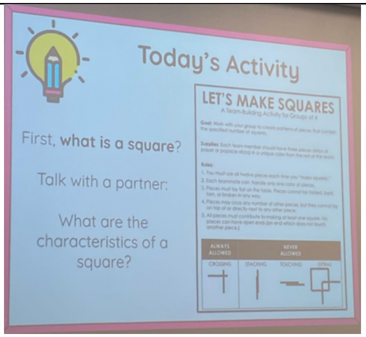
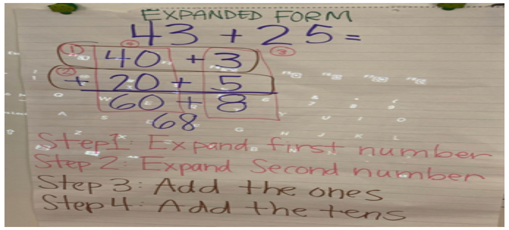
ID	Pseudonym	Planning, sourcing and designing CT lessons
P1	Linda	88
P2	Daryl	39
P3	Addison	75
P4	Maria	90
P5	Jessica	100
P6	Ted	21
P7	Susan	60
P8	Christina	65
P9	Kelly	65
P10	Holly	92
Group median		**70** **Mostly can do**

The group median for teachers' efficacy beliefs in CS3 when planning, sourcing, and designing CT lessons was 70 (see Table 65) and indicated the teachers were *mostly* efficacious. The joint display of findings for planning, sourcing and designing CT lessons (Table 66) is used to explain the group median from Table 65, using findings from interviews and observations.

Table 65

Teacher Efficacy and Planning, Sourcing, and Designing CT Lessons

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P1	Linda	88 Totally can do	"I think moderately. Now we do more activities where we are thinking about incorporating all of those" (Interview – CS3P1Q5). "Being more intentional about even just using the CT vocabulary, or how can I use some of these CT strategies to make it a little bit more interesting for them, or come up with different different problems that they can solve. That is now more subject and concept based" (Interview – CS3P1Q5).	
P2	Daryl	39 Somewhat can do	"[I'm] really kind of figuring it out. Even the spheros We're using the spheros now" (Interview – CS3P2Q4).	Parity bits activity from CS unplugged (Observation – CS3P2).
P3	Addison	75 Mostly can do	"I feel like I'm able to find resources and tap into those and identify when something really would lend itself well to computational thinking" (Interview – CS3P3Q5).	Addison had the labels on the board and briefly recapped CT concepts. "When we are doing problem-solving, we do two different types of activities - non-digital and Digital" (Observation – CS3P3).

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P4	Maria	90 Totally can do	"I think once we get deeper into our content, we would be better at planning it within content areas" (Interview – CS3P4Q6).	
P5	Jessica	100 Totally can do	"I feel fairly confident, and I feel like I'm not trying to reinvent the wheel. I'm just taking the CT strategies and kind of plugging them into where we've probably already been doing that [before]. But I just didn't use that vocabulary. So I feel pretty confident now, knowing how the vocabulary is looking in the lessons I've already created" (Interview – CS3P5Q5).	
P6	Ted	21 Somewhat can do	"I think it's really easy to fit into almost anything that you're doing. How do I need to problem solve? It's pretty easy to fit." (Interview – CS3P6Q5).	The lesson was prepared, however, Ted relied on the CT posters consistently.

ID	Pseudonym	Planning, sourcing, and designing CT lessons (median)	Interview Evidence	Observation Evidence
P7	Susan	60 Moderately can do	"I think I feel successful because I am able to connect it; my mindset really has changed from this isolated type of - this activity is not isolated, it really can be incorporated into different things" (Interview – CS3P7Q5).	Susan had completed the activity with the students previously, so they used a different context. She had clearly planned the lesson in detail, and explained CT concepts throughout (Observation – CS3P7).
P8	Christina	65 Mostly can do	"I think it kind of makes instruction a little more fun for them. But I just wish there's more time to explore those a little, like specific activities more" (Interview – CS3P8Q5).	Although the non-digital activity was explained, there was no explanation of the code.org tasks.The non-digital activity was well planned (albeit from the PD), and the code.org task was online so did not involve explicit planning (Observation – CS3P8).
P9	Kelly	65 Mostly can do	"A lot of the stuff we did with Scratch was, you know, things that were already designed, and we had limited choices. So kind of starting from Scratch I'm not quite as confident on" (Interview – CS3P9Q4).	The code.org task was online so did not involve explicit planning (Observation – CS3P9).
P10	Holly	92 Totally can do	"I've never explicitly taught CT, so I'm keeping my bar kind of low for this first year, and I'm just experimenting. I'm just playing. I'm just kinda seeing what works and what doesn't work" (Interview – CS3P10Q5).	Holly recapped the CT concepts using the posters from the PD. She also had a Code.org video organised. The code.org task was online so did not involve planning (Observation – CS3P10).
Group median		**70** **Mostly can do**		

The group teacher efficacy median in CS3 when planning, sourcing, and designing CT lessons was 70 (*mostly can do*). From the survey results, four teachers reported *totally can do* teacher efficacy beliefs towards planning, sourcing, and designing CT activities. For example, Maria (median = 90, *totally can do*) had prepared an hour-long activity for her students with detailed slides. Maria also stated that as she progressed through the activities, and formed a deeper understanding of CT concepts, her teacher efficacy beliefs for CT integration would likely increase. Maria commented, *"I think once we get deeper into our content, we would be better at planning it within content areas"* (Interview – CS3P4Q6). In addition, Jessica (median = 100) had planned a mathematics lesson integrating CT vocabulary for her grade two students. There were several posters explaining the task that Jessica had created, and she was clearly confident in her source material, which aligned with her *totally can do* teacher efficacy beliefs. Jessica stated:

> I feel fairly confident, and I feel like I'm not trying to reinvent the wheel. I'm just taking the CT strategies and kind of plugging them into where we've probably already been doing that [before]. But I just didn't use that vocabulary [in the past]. So I feel pretty confident now, knowing how the vocabulary is looking in the lessons I've already created (Interview – CS3P5Q5).

In contrast, Daryl (median = 39) was not as efficacious towards his planning, and commented, "[I'm] *really kind of figuring it out. Even the spheros...We're using the spheros now"* (Interview – CS3P2Q4). Daryl's *somewhat can do* median was further supported by his classroom observation, where although he had sourced an activity from CS unplugged, he had not created it himself, and was not as efficacious teaching it to his students. Ted (median = 21) also had *somewhat can do* teacher efficacy beliefs when planning, sourcing, and designing CT lessons. During the interview, Ted explained that he thought CT was, "*really easy to fit into almost* *anything that you're doing. How do I need to problem solve? It's pretty easy to fit"* (Interview – CS3P6Q5). Despite confidence in the interview, during the classroom observation, Ted consistently relied on PD provided resources placed around the room and this reliance aligned with to his *somewhat can do* teacher efficacy median.

The findings presented in this section illustrated how teacher efficacy relates to the teachers' beliefs in their ability to plan, source, and design CT lessons, thus contributing to the overall teacher efficacy median of 70 (*mostly can do*). Attention now turns to how facilitating CT integration contributed to the group teacher efficacy beliefs of CS3 participants.

6.4 Teacher Efficacy Beliefs and Facilitating CT Integration

This section further elaborates on findings related to CS3 teacher participants' teacher efficacy beliefs as related to their understanding of how to teach CT concepts – both as a standalone lesson and integrated within other curriculum areas. Combined with planning, sourcing, and designing CT lessons, teaching CT concepts and CT integration contributed to overall group teacher efficacy beliefs. Table 67 shows the teacher efficacy scale results for each teacher participant, as well as the group median. Rationale for the categories of Table 67 is described in section 3.7.1.

Table 66

Teacher Efficacy and Teaching CT Concepts, and CT Integration

ID	Pseudonym	Teaching CT concepts	CT Integration
P1	Linda	75	65
P2	Daryl	58	38
P3	Addison	60	85
P4	Maria	91	81
P5	Jessica	65	90
P6	Ted	19	23
P7	Susan	70	50
P8	Christina	54	70
P9	Kelly	60	72
P10	Holly	91	93
Group median		**63** **Mostly can do**	**71** **Mostly can do**

The group median for teaching CT concepts was 63 which indicated that teachers were *mostly* efficacious towards teaching CT in their classrooms. Table 68 presents findings from teacher participant's interview and observation data to provide a deeper understanding of what was contributing to the group median for teacher efficacy when teaching CT concepts.

Table 67

Teacher Efficacy and Teaching CT Concepts

ID	Pseudonym	Teaching CT Concepts (median)	Interview Evidence	Observation Evidence
P1	Linda	75 Mostly can do	"I think that it fits very naturally into a lot of what I do already, but in terms of using the vocabulary, or making sure to make those connections. That part, I think, is something that I need to work on more" (Interview – CS3P1Q4).	Linda asked the students for examples where they have used decomposition. "When we think about the strategies we have been using, we can decompose them into smaller pieces" (Observation - CS3P1).
P2	Daryl	58 Moderately can do	"Abstraction I'm still not wonderful with, but understand those concepts, and then to be able to integrate them. Which is ultimately my goal" (Interview – CS3P2Q5). "I would say things like, solve your problem. And now I can say things like debug the situation or debug the problem. And that's kind of a shift" (Interview – CS3P2Q6).	Daryl connected CT to how data is stored and transmitted, particularly abstraction and debugging. Daryl said "when I did that trick, I was finding the error. Computers can do it on a much grander scale. Computers can find and check for errors" (Observation – CS3P2).
P3	Addison	60 Moderately can do	"Oh, you're debugging, and you know it looks like you're looking for patterns. So I think really just giving breath to it and making sure that we're talking about the vocabulary, and using similar vocabulary." (Interview – CS3P3Q6).	"Think about the problems you ran into, and how you could debug to get around that problem" (Observation – CS3P3).

ID	Pseudonym	Teaching CT Concepts (median)	Interview Evidence	Observation Evidence
P4	Maria	91 Totally can do	"Debugging, how that is going to work. [And] you know 'who went first? Who went second' that kind of stuff" (Interview – CS3P4Q3).	"I heard 'four sides'. How about where the sides meet? What's that fancy word that starts with a P. Another thing I heard was that they all have to be the same size" (Observation – CS3P4).
P5	Jessica	65 Mostly can do	"These are the steps you're putting in. Okay, Now we're decomposing it, pulling out one step, completing that, pulling up the next step" (Interview – CS3P5Q3).	"They looked at the problem, and then they decomposed the problem, going step by step by step" (Observation – CS3P5).
P6	Ted	19 Somewhat can do	"Oh, right now we're debugging because I had the wire connected but the light didn't turn on, I'm going to disconnect it and try it a different way" (Interview – CS3P6Q3).	"How did you and your group use abstraction? Were there some things that we didn't really need? We're focusing on using the generator, next we focused on how to hook those clamps on" (Observation – CS3P6).
P7	Susan	70 Mostly can do	"[CT] really helped identify the goal so as far as decomposition. It really helped us focus on each step, and then, when we introduced abstraction, we looked at mazes and we looked at maps, and I talked about how I get home" (Interview – CS3P7Q3).	" We have to test our code. Who remembers what debugging means? To fix our mistakes. Is debugging bad? No. Just like in writing, when we have to go back and edit, it's the same" (Observation – CS3P7).

ID	Pseudonym	Teaching CT Concepts (median)	Interview Evidence	Observation Evidence
P8	Christina	54 Moderately can do	"I think, on the scale of one to ten, maybe like a four right now. But the more I do it it gets easier. The students understand the terminology way easier than I expected them to. And then we talk about the terminology afterwards" (Interview – CS3P8Q4).	While helping a student. Christina said - "the first step is moving a block. Drag the block over there" (Observation – CS3P8).
P9	Kelly	60 Moderately can do	"So I would say, applying CT concepts into the curriculum I feel very solid on. With technology, it just depends on my level of exposure to it" (Interview – CS3P9Q4).	Kelly worked with a student to explain the task and utilised decomposition. "What do we need first, now what?" (Observation – CS3P9).
P10	Holly	91 Totally can do	"I like debugging, because we use that in math. And I've kind of forced myself to use that vocabulary. When we're trying to find a mistake? Or does my answer make sense, or can I go back and like I messed one step? What can I debug?" (Interview – CS3P10Q3).	Holly breaks down the problem clearly with the student. "You can do as many runs as you would like to solve the problem" (Observation – CS3P10).
Group median		**63 Mostly can do**		

The group median for teacher efficacy beliefs when teaching CT concepts was 63 and meant the teachers were *mostly* efficacious. For example, Holly (median = 91) *totally can* teach CT to her students. Holly demonstrated her efficacy when teaching CT concepts, particularly debugging and decomposition. Holly stated:

> I like debugging, because we use that in math. And I've kind of forced myself to use that vocabulary. When we're trying to find a mistake? Or does my answer make sense, or can I go back and like I messed one step? What can I debug?" (Interview – CS3P10Q3).

Further exemplifying her *totally can do* teacher efficacy median during the observation, Holly broke down the problem clearly with a student and commented, *"you can do as many runs as you would like to solve the problem"* (Observation – CS3P10). In addition, Jessica reported a median of 65 for her teacher efficacy beliefs when teaching CT. Interestingly, although she *mostly can* teach CT, Jessica demonstrated a clear understanding of how to explicitly teach CT concepts, especially decomposition. During the interview, Jessica said that she had explained decomposition to her grade two students as, *"these are the steps you're putting in. Okay, Now we're decomposing it, pulling out one step, completing that, pulling up the next step"* (Interview – CS3P5Q3). Furthermore, Jessica demonstrated her teacher efficacy towards decomposition (and algorithmic thinking) during the observation when she explained to the class how some students had solved a mathematics equation. She commented, *"they looked at the problem, and then they decomposed the problem, going step by step by step"* (Observation – CS3P5).

Christina (median = 54) was less efficacious than Jessica and Holly and could *moderately* teach CT. During the interview, Christina rated her CT teaching as '4 out of 10' but that she became more efficacious with more experience. She also highlighted that students understood the CT terms better than expected and that discussing them after they've been introduced was beneficial

(Interview – CS3P8Q4). Christina further demonstrated her CT teaching during an observation when she directed a student to "move a block" as an initial action to create an algorithm (Observation – CS3P8).

In contrast, Ted (median = 19*)* had *somewhat can do* teacher efficacy beliefs when teaching CT. Although he had a lower median from the survey results, Ted provided evidence of his understanding of abstraction as one of the CT concepts during the classroom observation. The activity involved circuits and Ted asked his grade five students, *"how did you and your group use abstraction? Were there some things that we didn't really need? We're focusing on using the generator, next we focused on how to hook those clamps on"* (Observation – CS3P6). This suggested that although Ted was not particularly efficacious when answering the survey questions about teaching CT, he provided evidence of his ability during the classroom observation which suggested Ted may have required more clarity on what the survey questions were asking.

The findings presented in this section illustrated how teacher efficacy relates to the teacher participants' beliefs in their ability to teach CT concepts. Next, the results for facilitating CT integration are presented. Facilitating CT integration is the teaching of CT activities integrated across discipline areas and was used to further understand teacher efficacy beliefs in CS3. The group median for facilitating CT integration was 71, interpreted as *mostly can do*. Table 69 presents interview and observation findings which provide insight into the survey group median for CS3 teacher efficacy, therefore contributing to the overall group teacher efficacy median of 63 (*mostly can do*).

Table 68

Teacher Efficacy and CT Integration

ID	Pseudonym	CT Integration (median)	Interview Evidence	Observation Evidence
P1	Linda	65 Mostly can do	"I think I need to work more on incorporating that into everyday language in terms of thinking through problems with lots of different subjects, and not just making it like a separate time that we think about these things" (Interview – CS3P1Q4).	The students chose the strategy for completing multiplication problems. The students are to write the instructions for someone else to follow so they can complete their multiplication problem. CT integrated into mathematics (Observation – CS3P1).
P2	Daryl	38 Somewhat can do	"But it's also, I think, definitely popping up in math. In reading I've introduced it as a part of the main idea" (Interview – CS3P2Q6).	There was no CT integration during the observation. The activity was a sole CT activity (Observation – CS3P2).
P3	Addison	85 Totally can do	"I think that CT is going to be able to impact my instruction when I start to really figure out how to merge the things that we're talking about" (Interview – CS3P3Q6).	The activity was integrated into mathematics (geometry) – the students were problem-solving in groups to create as many squares as possible with their paper strips (Observation – CS3P3).
P4	Maria	81 Totally can do	"We do it [CT] a lot in math. I think it just lends itself really nicely when we are dealing with actual mathematical algorithms, and debugging" (Interview – CS3P4Q6).	The activity was integrated into mathematics (geometry) – the students were problem-solving in groups to create as many squares as possible with their paper strips (Observation – CS3P4).

ID	Pseudonym	CT Integration (median)	Interview Evidence	Observation Evidence
P5	Jessica	90 Totally can do	"Yeah, so definitely in math. Definitely, even in working with words like our phonics" (Interview – CS3P5Q6). "In reading, I had already made a lesson for the main idea, and like using abstraction like we're only pulling out the most important thing. One thing that we're focusing on" (Interview – CS3P5Q6).	The activity involved using different CT strategies for multiplication problems (Observation – CS3P5).
P6	Ted	23 Somewhat can do	"Definitely used it with math. Think about how you can use one of these to work your way through this on your own. (Interview – CS3P6Q6).	CT was integrated into a science lesson on circuits (Observation – CS3P6).
P7	Susan	50 Moderately can do	"I can see it being integrated into many different subjects, such as reading where it is like when we look at abstraction and taking out what we don't need" (Interview – CS3P7Q1).	The activity was using CT concepts to clarify writing instructions for English Language Learners. "We then need to write that into our code, where would that have to go in our code? Yes, the beginning, so we need to debug our code" (Observation – CS3P7).

ID	Pseudonym	CT Integration (median)	Interview Evidence	Observation Evidence
P8	Christina	70 Mostly can do	"We started using the [CT] language through both guided reading and math and we have skills that we can do to debug, and we I emphasize if you need to debug, you don't, erase the whole problem. And then we've used abstraction to figure out for main idea the most important part" (Interview – CS3P8Q5).	The non-digital activity was integrated into mathematics and shape recognition. There was no CT integration during the Digital activity (Observation – CS3P8).
P9	Kelly	72 Mostly can do	"So we have talked through a lot with our math processes. As far as like, we've been working with multiplication and division and using different models to show multiplication and division" (Interview – CS3P9Q6).	There was no CT integration during the observation (Observation – CS3P9).
P10	Holly	93 Totally can do	"For example, me as a math teacher. I like to give them two or three different strategies, and they have to. Yes, they have to know those strategies" (Interview – CS3P10Q6).	There was no CT integration during the observation (Observation – CS3P10).
Group median		**71** **Mostly can do**		

In CS3, the group median for teacher efficacy beliefs when integrating CT was 71 (*mostly can do*). An example was from Jessica, who held high teacher efficacy beliefs for CT integration (median = 90). In support of her *totally can do* teacher efficacy beliefs for CT integration, Jessica explained how she integrated CT concepts into both mathematics and literacy activities and commented that, *"in reading, I had already made a lesson for the main idea and used abstraction. We're only pulling out the most important thing. One thing that we're focusing on"* (Interview – CS3P5Q6). Moreover, during the observation, Jessica had integrated CT into a mathematics lesson where the students used different strategies to solve a multiplication problem. Jessica consistently used CT vocabulary and the students utilised it too and demonstrated a clear understanding of how the CT concepts connected to the mathematics task. Similarly, Maria (median = 81), also *totally can* integrate CT in mathematics. In the interview, Maria detailed how CT terminology was frequently used in her maths classes and found it particularly useful for mathematical algorithms (algorithmic thinking) and finding and fixing mistakes (debugging) (Interview – CS3P4Q6). Maria further demonstrated her totally can do teacher efficacy beliefs during the observation where the activity involved students problem-solving in groups using CT to create as many squares as possible with paper strips as part of a geometry lesson (Observation – CS3P4).

Another example was from Christina (median = 70) who reported *mostly can do* teacher efficacy beliefs when integrating CT across curriculum areas. Christina had used specific CT vocabulary in reading and mathematics and mentioned how she had:

> Started using the [CT] language through both guided reading and math and we have skills that we can do to debug, and I emphasise if you need to debug, you don't erase the whole problem. You just find out where you

> need to fix the problem. And then we've used abstraction to figure out the main idea, the most important part (Interview – CS3P8Q5).

In addition, Daryl reported a *somewhat can do* median of 38. When reflecting on CT integration, Daryl commented, "*it's also, I think, definitely popping up in math. In reading, I've introduced it* [CT] *as a part of the main idea"* (Interview – CS3P2Q6). Although he reported he was *somewhat* efficacious towards CT integration, Daryl did not demonstrate CT integration during his classroom observation; instead asking the students to complete an activity on parity bits. This was solely a CT activity, although Daryl discussed the various CT concepts and vocabulary with his students throughout the lesson which reflected his *somewhat can do* median, however, the CT lesson was not integrated within a core curriculum area. Ted (median = 23) also held *somewhat can do* teacher efficacy beliefs when integrating CT across curriculum areas. During the interview, Ted mentioned he had used CT in math, encouraging students to think about how to apply CT terminology to solve problems on their own (Interview – CS3P6Q6). Furthermore, Ted used CT terms in the classroom observation during a science lesson on circuits, demonstrating his *somewhat can do* teacher efficacy beliefs (Observation – CS3P6).

The findings presented in this section provided evidence of how CS3 teachers' belief in their ability to facilitate CT integrated activities, contributed to the overall median of 71 (*mostly can do*) for teacher efficacy. Both sections for teacher efficacy; teaching CT concepts and integrating CT have presented findings that help to provide insight into the relationship between how teachers facilitate CT integration and their teacher efficacy beliefs contributing to the overall group median of 72 (*mostly can do)*.

6.4.1. Teacher Efficacy Summary

The CS3 teacher participants' group median for teacher efficacy was 72 and indicated that the teachers held *mostly can do* teacher efficacy beliefs. Contributing to this overall median, was planning, sourcing, and designing CT lessons (group median = 70) reflecting *mostly can do* teacher efficacy beliefs. In addition, when teaching CT concepts, the group median was 63, and suggested the teachers *mostly can* teach CT. Finally, in terms of CT integration, the group median was 71, and indicated *mostly can do* teacher efficacy beliefs. While the group as a whole *mostly can* teach CT, some participants faced challenges that impacted their perceived efficacy in teaching CT.

6.5 Teachers' Collective Efficacy Beliefs, their Professional Network, and the Planning and Teaching of CT

An individual's collective efficacy beliefs are based on their perception of the groups' success when working together to achieve a task. CS3 teachers had a group collective efficacy median of 87 (see Table 70) which was interpreted as *totally confident* efficacy beliefs in the group when planning and teaching CT. The IQR was 20 and showed that the teachers had moderate variation in their collective efficacy beliefs across all subscales from the collective efficacy survey.

Table 69
Teacher Participants' Collective Efficacy

		Collective Efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P1	Linda	85	20	Totally confident
P2	Daryl	81	9	Mostly confident
P3	Addison	100	0	Totally confident
P4	Maria	89	6	Totally confident
P5	Jessica	100	0	Totally confident
P6	Ted	45	7	Moderately confident
P7	Susan	100	27	Totally confident

P8	Christina	79	28	Mostly confident
P9	Kelly	93	47	Totally confident
P10	Holly	55	68	Moderately confident
Group median		**87**	**22**	**Totally confident**

This section discusses findings connected to how CS3 teacher participants' collective efficacy beliefs related to how they planned and taught CT. Professional network (from Section 3.9) describes the collaboration between teachers and school leaders and was used as a structure for understanding collective efficacy beliefs. Table 71 presents the collective efficacy survey subscale results for each teacher participant in each category, as well as the group median. The rationale for the categories of Table 71 is described in section 3.7.1. A reminder that survey scale responses for collective efficacy were related to 'confidence' as opposed to 'can do' .

Table 70
Teacher Participants' Collective Efficacy Subscale Medians

ID	Pseudonym	Group computing concepts knowledge & skills	Group technology collaboration & communication	Group capability	Group effort	Group quality of outcomes	General group satisfaction
P1	Linda	80	100	100	80	75	100
P2	Daryl	35	83	83	77	81	88
P3	Addison	80	100	100	100	100	100
P4	Maria	84	88	91	90	91	90
P5	Jessica	80	100	100	100	100	100
P6	Ted	14	68	65	43	45	41
P7	Susan	70	100	100	100	70	100
P8	Christina	49	52	62	81	86	93
P9	Kelly	50	55	70	85	100	100
P10	Holly	85	51	79	57	0	0
Group median		**75 Mostly confident**	**85 Totally confident**	**87 Totally confident**	**83 Totally confident**	**84 Totally confident**	**97 Totally confident**

For the teachers in CS3, general group satisfaction had the highest overall median for all teacher participants (median = 97) and suggested that the teacher participants were *totally confident* in the group. Additionally, the teachers were *totally confident* towards the group's technology collaboration & communication abilities (median = 85), group capability (median = 87), group effort (median = 83), and group quality of outcomes (median = 84). Group computing concepts knowledge and skills (median = 75), indicated that the teachers were *mostly confident* towards the group's understanding of that subsection when planning and teaching CT.

Table 72 and Table 73 present the findings using the teacher participant's interview data to further explain the group medians. Observation data was not used in this section because the teachers were observed individually. The findings for group technology collaboration and communication (Table 72) and group effort (Table 73) are presented to show the difference between the teacher's collective efficacy beliefs for the subscale sections, contributing to the overall median for collective efficacy in CS3. For brevity, the remaining results for the other four categories are presented as Appendices 47 – 50.

Table 71

Teacher Participants' Collective Efficacy and Group Technology Collaboration and Communication

ID	Pseudonym	Group technology collaboration and communication (median)	Interview evidence
P1	Linda	100 Totally confident	"I would say the biggest factor for me is having people to talk to. So, I have the other two fourth grade teachers who also took the CT training. So Daryl is kind of my counterpart in another building who also teaches in the program in fourth grade. So we do a lot of planning together as well and try to think about it" (Interview – CS3P1Q10).
P2	Daryl	83 Totally confident	"If I wasn't communicating with Linda who's over at Explorer or [a teacher not involved in the PD] on Fridays. I think that would be something that would be harder" (Interview – CS3P2Q12).
P3	Addison	100 Totally confident	"I think you put all those pieces together, and it really helps us to be able to bounce ideas off of one another. I think that pairing of the four of us has really been key in making it successful, because it definitely is not something that you can sit back and wait until you have figured out to perfection before you can start it (Interview – CS3P3Q11).
P4	Maria	88 Totally confident	"I think that it's been really nice to have Addison and Linda in the class with us, because we bounce ideas off each other. We get to plan with each other. We share things with each other" (Interview – CS3P4Q8).
P5	Jessica	100 Totally confident	"We don't necessarily like to plan in sync like but we always make sure we're kind of on the same page" (Interview – CS3P5Q11).
P6	Ted	68 Mostly confident	"I explain in the staff lounge, so that the other teachers know what type of class I have this year, and how it helps, so I think they're interested. But I think for most of us the first time they've ever heard of CT" (Interview – CS3P6Q7).

ID	Pseudonym	Group technology collaboration and communication (median)	Interview evidence
P7	Susan	100 Totally confident	"I think collaboration. As I was planning my lessons and how to start, I really leaned on Christina, because she had started earlier in the school year than I did, and so I think that collaboration piece is really important to bounce ideas off of, and to get feedback" (Interview – CS3P7Q10).
P8	Christina	52 Moderately confident	"Not much of a role. They are interested in it. So I kind of like if they ask, I can answer questions for them. But, otherwise it's just me pretty much doing it by myself when there's time" (Interview – CS3P8Q11).
P9	Kelly	55 Moderately confident	"I think that everything is easier with peers. So that's - with Holly and I that's been great for us that we did it together, because so much of the projects that we did, in the work that we did, we were able to collaborate" (Interview – CS3P9Q11).
P10	Holly	51 Moderately confident	"If I didn't have someone that was encouraging me and excited about this at the same time it would be really difficult" (Interview – CS3P10Q11).
Group median		**85** **Totally confident**	

The teachers in CS3 reported they were *totally confident* (median = 85) toward the capability of the group when collaborating and communicatng using technology. For example, Linda (median = 100) was *totally confident* in the capabilities of the group. Linda commented that the most important factor was having colleagues to discuss strategies for how to plan and teach CT, which in turn, strengthened her collective efficacy beliefs. She stated:

> I have the other two fourth grade teachers who also took the CT training. Daryl is kind of my counterpart in another building who also teaches in the program in fourth grade. So, we do a lot of planning together as well and try to think about it (Interview – CS3P1Q10).

Similarly, Susan (median = 100) provided evidence how important collaboration was in supporting her *totally confident* efficacy beliefs. She was confident in the group's abilities after having collaborated on CT planning. Susan spoke of how when she:

> Was planning my lessons and how to start, I really leaned on Christina, because she had started earlier in the school year than I did, and so I think that collaboration piece is really important to bounce ideas off of, and to get feedback (Interview – CS3P7Q10).

Addison too (median = 100) was buoyed from collaborating with her peers, which aligned with her *totally confident* collective efficacy beliefs. Addison said:

> It really helps us to be able to bounce ideas off of one another. I think that pairing of the four of us has really been key in making it successful, because it definitely is not something that you can sit back and wait until

> you have figured out to perfection before you can start it (Interview – CS3P3Q11).

On the other hand, several teachers reflected how if they didn't have support from other teachers, particularly from their own school, their collective efficacy beliefs decreased. An example was from Holly (median = 51) who said that, *"if I didn't have someone that was encouraging me and excited about this at the same time it would be really difficult* [to plan and teach CT]" (Interview – CS3P10Q11). Holly's lack of support contributed to her *moderately confident* collective efficacy beliefs. Similarly, Christina (median = 52), was the only teacher in her school involved in the PD. Because she was somewhat isolated, Christina had *moderately confident* collective efficacy beliefs towards her groups' abilities when collaborating and communicating with technology when planning and teaching CT. Christina commented that if other teachers ask about what she is doing, *"I can answer questions for them. But otherwise, it's just me pretty much doing it by myself when there's time"* (Interview – CS3P8Q11). This meant Christina couldn't collaborate using technology, and she wondered if the rest of her group also lacked that opportunity.

To further understand collective efficacy and the planning and teaching of CT, the focus turns to the survey subscale category, group effort. The group median for group effort was 83 and suggested the teachers were *totally* confident in the groups' effort when planning and teaching CT. Table 73 presents CS3 interview findings which provide insight into the group median for CS3 teacher participants' collective efficacy beliefs and group effort.

Table 72

Teacher Participants' Collective Efficacy and Group Effort

ID	Pseudonym	Group effort (median)	Interview evidence
P1	Linda	80 Mostly confident	"We try to stay together, try to do some of the same CT things. So it's really nice to have somebody to be able to bounce ideas off of, or like they're doing [things] that they found, and then they share that with us, and we share things with them" (interview – CS3P1Q10).
P2	Daryl	77 Mostly confident	"PD, I think, has to be coupled with teammates who also are participating in that PD. I think that I've done PD where I didn't have teaching partners that were interested in and focused on doing it. And so that it goes more to the wayside when I'm not equally encouraged by someone else who's also trying to figure it out" (Interview – CS3P2Q11).
P3	Addison	100 Totally confident	"I think that pairing of the four of us has really been key in making it successful" (Interview – CS3P3Q11).
P4	Maria	90 Totally confident	"We share the different prep that's required, and I would say, we are a close team, just because of the nature of our building. Those are the people that I talk to every day. Our [University] interns are really supportive and interested in it" (Interview – CS3P4Q11).
P5	Jessica	100 Totally confident	"But if I'm incorporating CT and she doesn't feel comfortable with it or doesn't want to do it, she doesn't" (Interview – CS3P5Q11).
P6	Ted	43 Moderately confident	"Well, so far there's just Jessica, and I think she's kind of using it the same way that I am, just applying it to, you know, any type of problem that comes up" (Interview – CS3P6Q11).

ID	Pseudonym	Group effort (median)	Interview evidence
P7	Susan	100 Totally confident	"They do a Friday stem activity together in the cafeteria, where they introduced all the concepts, and then they work with Sphero. And so I've been in there to observe, and just kind of seen… How did you get here?" (Interview – CS3P7Q8).
P8	Christina	81 Totally confident	No evidence.
	Kelly	85 Totally confident	"We were able to talk about how we could integrate it with our students. How we could do across grade level collaboration. So it's just great for the ideas, and having someone there as a support to help" (Interview – CS3P9Q11).
	Holly	57 Moderately confident	"But the rest of my staff know Kelly and I are on our tech team for the district, and this is just an additional thing that we're part of. But you know, for all they consider it's just kind of our requirement through the tech team" (Interview – CS3P10Q11).
Group median		**83 Totally confident**	

The group median for teacher participants' collective efficacy beliefs was 83 and indicated the teachers were *totally confident* in the group's effort to plan and teach CT. Specifically, collaborative planning, and sharing of resources assisted the teacher's collective efficacy beliefs for group effort and many teachers commented how they had observed members of their group planning and teaching CT. For example, Addison (median = 100) stated how she worked alongside her team of teachers when they collaboratively taught CT and witnessed the effort they put into the content, thus contributing to her *totally confident* collective efficacy median. Addison said, *"I think that pairing of the four of us has really been key in making it successful"* (Interview – CS3P3Q11). Similarly, Susan (median = 100) observed group members teaching CT and noted their efforts, which aligned with her *totally confident* collective efficacy median. Susan commented, *"they do a Friday STEM activity together in the cafeteria, where they introduced all the concepts, and then they work with Sphero. And so, I've been in there to observe, and just kind of seen… How did you get here?"* (Interview – CS3P7Q8).

In contrast, two teachers provided evidence that without members of the group putting in the effort to complete PD for planning and teaching CT, their own efficacy beliefs for group effort might decrease. One of these teachers, Daryl (median = 77) was *mostly confident*, and said:

> PD, I think, has to be coupled with teammates who also are participating in that PD. I think that I've done PD where I didn't have teaching partners that were interested in and focused on doing it. And so that it goes more to the wayside when I'm not equally encouraged by someone else who's also trying to figure it out (Interview – CS3P2Q11).

Similarly, Holly (median = 57) was *moderately confident* and believed that her colleagues thought she was mandated to complete the PD therefore required to put in the effort to plan and teach CT. Because of this, Holly was unsure whether her group would put in their own effort because they were not required to complete the PD. She commented:

> The rest of my staff know [colleague] and I are on our tech team for the district, and this is just an additional thing that we're part of. But you know, for all they consider, it's just kind of our requirement through the tech team (Interview – CS3P10Q11).

The findings presented in this section describe how CS3 teacher's beliefs towards both group technology collaboration and communication, and group effort contributed to the group median for their collective efficacy beleifs (median = 87).

For group computing concepts knowledge and skills (median = 75), the CS3 teachers had *mostly confident* collective efficacy beliefs. This meant that the teachers were *mostly confident* in the group's abilities understanding computing concepts to plan and teach CT. For example, while Maria (median = 84) and Holly (median = 85) were both *totally confident*, neither provided evidence from the interview to support their medians. Addison (median = 80) and Linda (median = 80) were *mostly confident*, and Addison provided interview evidence that highlighted Linda's advanced approach to problem solving and CT in her classroom, thus giving Addison the confidence in Linda's computing knowledge and skills. Addison commented that Linda was, *"constantly looking for those extensions, and she's always had a bit more freedom than we have when it comes to content, because her goal in her classroom is more of this problem solving, outside the box, computational thinking"* (Interview – CS3P3Q11). Similarly, Susan (median =

70) had interview evidence which suggested she had support from a member of the group, who she viewed as *"a lot better at technology than I am"* (Interview – CS3P7Q8). This supported her *mostly confident* collective efficacy beliefs towards group computing concepts knowledge and skills. In contrast, Ted (median = 14) was *not confident at all*, and Daryl (median = 35) was *somewhat confident*, however both lacked interview evidence to elaborate on their positions. A reason behind the teachers' lack of evidence towards their group's computing concepts knowledge and skills, may be because most of the teachers worked at different schools, and were not privy to the group members' CT knowledge and skills when they planned and taught CT.

The CS3 teacher's reported *totally confident* collective efficacy beliefs for group capability (median = 87). The teachers with *totally confident* beliefs were Linda (median = 100), Addison (median = 100), Jessica (median = 100), and Susan (median = 100). These four teachers provided evidence for their collective efficacy medians and group capability. For example, Linda described her involvement in a smaller program at her school, where she and other teachers worked to integrate CT across different grade levels. She mentioned that while the third and fourth grade teachers were engaged with CT, the fifth grade teacher had not participated. To address this, they all made effort to include the fifth grade teacher and explored ways to incorporate CT into the curriculum for all grades. The engagement from the third and fourth grades teachers supported Linda's *totally confident* collective efficacy beliefs for group capability. Similarly, Addison reflected that everything done in their group had been very helpful. She found the articles they read during the PD useful and appreciated having them as references. However, she particularly valued the hands-on experiences from the PD, which allowed the group to experience the engagement from the students' perspective. Addison witnessed the group learning how to plan and teach CT, and this experience supported her *totally confident* collective efficacy beliefs for group capability. Susan too had high efficacy in the groups' capability because she had observed members of the group teach CT. Susan said she had:

> Gone into other teachers' rooms that have done the CT and observed them before. I felt more confident when I didn't have students in my classroom, and I wanted to see how they were doing it. I went into their classroom, so I went into Christina's classroom, and then Daryl's (Interview – CS3P7Q8).

Maria (median = 91) also mentioned that she was fortunate to have three co-teachers in her class and another supportive colleague when implementing their CT lessons. She believed that planning and teaching CT lessons would have been much more challenging without her groups' collaborative support, as they shared the workload. The trust in Maria's group indicated she had high beliefs in their capability and aligned with her *totally confident* collective efficacy beliefs. Other teachers in CS3 were *mostly confident.* For example, Holly (median = 79) noted the positive impact of raising awareness about CT and stated that the group was, *"curious. So, I guess awareness and just talking about it is a positive thing"* (Interview – CS3P10Q11). Although Holly said the group was interested in learning about CT, she did not explicitly provide evidence on her beliefs in her groups' capability. Ted (median = 65) was also *mostly confident* but provided no supporting evidence. While most teachers in CS3 had *totally confident* beliefs about their group's capability, this high median likely stemmed from their consideration of the capabilities of the teachers who participated in the PD. Teachers who lacked evidence may have been reflecting on their colleagues within their own schools, who they had less insight into their capabilities when planning and teaching CT, rather than the group who completed the PD.

The CS3 teacher participants reported *totally confident* collective efficacy beliefs for group quality of outcomes (median = 84). Addison (median = 100), Jessica (median = 100), and Kelly (median = 100) were all *totally confident*, though they did not provide supporting evidence. Maria (median = 91) and Christina (median = 86) also expressed *total* confidence without additional evidence. These teachers held high collective efficacy beliefs for the survey items yet may not have had opportunities to witness their groups' CT planning and teaching outcomes. Linda however (median = 75), was *mostly confident* in the capabilities of the group. Linda said that it would be valuable to see how others incorporated CT, especially members of the group who might be isolated in their schools. She commented that teachers in the group without peers to collaborate with might struggle to find resources and support on their own, which aligned with her collective efficacy median; Linda was unsure whether her group had support, and therefore could not assume the level of their CT capabilities. At the other end of the spectrum, Holly (median = 0) was *not confident at all* in the groups' capability. While she did not provide additional evidence, Holly may have been referring to the group in her own school, as opposed to the group who completed the PD.

For general group satisfaction, the teacher's in CS3 reported a *totally confident* group median score of 97. This group median was highlighted by Linda (median = 100), Addison (median = 100), Jessica (median = 100), and Kelly (median = 100) who were all *totally confident*. For example, Jessica valued the PD sessions for learning about CT, experimenting, and creating lessons with the group. These experiences were important for her to understand CT, and learn with the group how to incorporate CT, as well as receive reassurance that she was on the right track. Similarly, Susan found that working with others during the PD made CT *"come alive"* and enhanced her learning experience and confidence in the group. Maria had high collective efficacy beliefs for group satisfaction because she was supported by her superintendent's strong interest in CT. Maria had invited the superintendent to her class and his positive attitude made her excited to share their work in the collaboration centre (larger teaching space) with him. In addition, Daryl (median = 88) identified the importance of accountability in his group which supported his *totally confident* collective efficacy beliefs. Daryl said he was satisfied in the group planning and teaching CT and stated there was a level of accountability, *"that's really valuable and important"* (Interview – CS3P2Q12). Christina (median = 93) was also *totally* satisfied in the group and saw the group's potential for improving CT understanding. Christina said that although she was satisfied the group were planning and teaching CT, she wished it were more widespread amongst other teachers.

While individual teacher medians varied across the collective efficacy subsections, which suggested differences in confidence levels among participants, overall, the teachers in CS3 were *totally confident* in the group when planning and teaching CT.

6.6 Teachers' Collective Efficacy Beliefs and the School Strategy

CS3 was different to CS1 and CS2 in that the teachers were mostly from different schools within the same school district. Therefore, an individual school strategy was not utilised to present findings, the state-wide curriculum documents for CT was used instead (Figure 6). At the time of the study, the computing standards (which includes CT) were not compulsory for teachers in the state. The following section presents findings from CS3 teacher participants as evidence of the relationship between the state curriculum documents and their *totally confident* group collective efficacy beliefs (median = 87).

Figure 6

State Computing Standards for Elementary Students

CONCEPT: ALGORITHMS & PROGRAMMING

Subconcept	Level 1A: Lower Elementary (Grades K-2) By the end of Grade 2, students will be able to...	Level 1B: Upper Elementary (Grades 3-5) By the end of Grade 5, students will be able to...
Algorithms	1A-AP-08 Model daily processes by creating and following algorithms (sets of step-by-step instructions) to complete tasks. (P4.4)	1B-AP-08 Compare and refine multiple algorithms forthe same task and determine which is the most appropriate. (P6.3, P3.3)
Variables	1A-AP-09 Model the way programs store and manipulate data by using numbers or other symbols to represent information. (P4.4)	1B-AP-09 Create programs that use variables to store and modify data. (P5.2)
Control	1A-AP-10 Develop programs with sequences and simple loops, to express ideas or address a problem. (P5.2)	1B-AP-10 Create programs that include sequences, events, loops, and conditionals. (P5.2)
Modularity	1A-AP-11 Decompose (break down) the steps needed to solve a problem into a precise sequence of instructions. (P3.2)	1B-AP-11 Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. (P3.2) 1B-AP-12 Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. (P5.3)

Subconcept	Level 1A: Lower Elementary (Grades K-2) By the end of Grade 2, students will be able to...	Level 1B: Upper Elementary (Grades 3-5) By the end of Grade 5, students will be able to...
Program Development	1A-AP-12 Develop plans that describe a program's sequence of events, goals, and expected outcomes. (P5.1, P7.2) 1A-AP-13 Give attribution when using the ideas and creations of others while developing programs. (P7.3) 1A-AP-14 Debug (identify and fix) errors in an algorithm or program that includes sequences and simple loops. (P6.2) 1A-AP-15 Using correct terminology, describe steps taken and choices made during the iterative process of program development. (P7.2)	1B-AP-13 Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences. (P1.1, P5.1) 1B-AP-14 Observe intellectual property rights and give appropriate attribution when creating or remixing programs. (P7.3) 1B-AP-15 Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. (P6.1, P6.2) 1B-AP-16 Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development. (P2.2) 1B-AP-17 Describe choices made during program development using code comments, presentations, and demonstrations. (P7.2)

The teachers in CS3 reflected on the state strategy document and how the lack of compulsory CT standards, and the effect of standardised testing in other curriculum areas influenced their collective efficacy beliefs for planning and teaching CT. For example, Doug (median = 81) had *totally confident* collective efficacy beliefs towards his group who completed the PD. Despite his high median, Doug noted that his collective efficacy beliefs were influenced because CT state standards were not mandatory. Doug said:

> [CT] needs to be supplemented and supported with technology standards which are absolute, but no one does them right. And so that's something that needs to be nationally, [and] at the state level, they need to be pushed more as being part of an and included into the curriculum. [Presently] if you don't do it [teach CT], no one cares, and no one says anything, and it's not something that's necessarily, teachers are being held accountable for. And if you want actual change, you need to have those national or state standards to be pushing and holding teachers accountable (Interview - CS3P2Q13).

Similarly, Susan (median = 100) also had *totally confident* collective efficacy beliefs towards the group who completed the PD, and other teachers in her school. However, she questioned whether teachers across the district were teaching CT and cited the lack of compulsory CT standards as a reason for her doubt. Susan reported:

> I don't think it's been a big push in all districts yet. There was an isolated amount of teachers that went to the training, so it's not district wide. And I also think that it still is viewed as this isolated type of activity that you kind of box up and put away. And so I think that, like the knowledge about CT has to change, and then integrated into the curriculum, has to change. And then just the ability to allow, the freedom for students to be able to grapple with the content where it is not just playing with robots. There's a lot of thinking changes that happen (Interview - CS3P7Q13).

In contrast, Holly (median = 55) was more understanding of how non-compulsory CT standards in the state affected how a wider range of teachers taught (or did not teach) CT in the district, therefore affecting her *moderately confident* collective efficacy beliefs. Holly commented that she would, *"love them* [policy makers] *to regulate something like CT in similar ways that they regulate* [other subjects] (Interview - CS3P10Q13).

In addition, while the teachers were aware of the CT state standards, several teacher participants provided evidence about how standardised testing requirements for other subjects (mathematics and literacy) impacted their own ability to teach CT. This meant that if some teachers were pressured from other tested curriculum areas, they assumed that others experienced similar pressures, therefore influencing their collective efficacy beliefs that others were planning and teaching CT. For example, while Linda (median = 85) held *totally confident* collective efficacy beliefs, she recognised that her colleagues involved in the PD were more likely to plan and teach CT. She believed the group had pressure to teach other content that would be tested rather than focusing on CT. Linda said:

> The fact that we have all these other standards that we do have to teach that takes precedence over the CT, so the more that I can incorporate it into what I'm doing, the better that would be. Then it wouldn't feel like another thing. It would just feel like it's just a part of what we do (Interview - CS3P1Q13).

Similarly, Maria (median = 89) reiterated how standardised testing in other subject areas, impacted her ability to teach CT to her students, and likely her colleagues. Despite a *totally confident* collective efficacy median, Maria stated:

> Standardised testing is going to be tough because we are constantly feeling all the pressure. If we take that forty-five minutes to do CT. Or we have to do something that's based on state testing. I think that in a perfect world we could implement CT and our main lessons and still be doing it. But that's going to take work in time, too (Interview – CS3P4Q13).

The findings present how the teacher's in this study were aware of the CT state strategy documents, yet believed the lack of CT being compulsory, and the pressure of standardised testing in numeracy and literacy influenced their belief that other teachers in the wider school-district were planning and teaching CT. In turn, this influenced their collective efficacy beliefs. Although the survey indicated that the teacher participants had total confidence in their group's collective efficacy, this confidence likely stemmed from their experiences with other teachers in the PD program. The interview responses, however, revealed lower collective efficacy beliefs regarding the wider teaching community's planning and teaching of CT.

6.6.1 Collective Efficacy Summary

In summary, the teacher participants' group median of 87 indicated that those who completed the PD were *totally confident* in their groups' ability to plan and teach CT. Contributing to this group median was the teachers' beliefs in how the group understood computing concepts, knowledge, and skills (median = 75), used technology for collaboration and communication (median = 85), the group's capability (median = 87), the group's effort (median = 83), the group's quality of outcomes (median = 84), and general group satisfaction (median = 97). In addition, most teachers viewed the state strategy as supportive of their CT planning and teaching but did wonder how other teachers in the wider school district would implement CT when it was not a requirement. Combined, these factors provided evidence for the relationship between teacher's collective efficacy beliefs, and the planning and teaching of CT.

Part One Summary

Part one has presented CS3 teacher participants' group medians for self-efficacy, teaching efficacy, and collective efficacy beliefs as well as interview and observational findings to support the medians. The group median for self-efficacy of the teacher participants was 57 and interpreted as the teachers in CS3 having *moderately can do* self-efficacy beliefs towards understanding foundational CT concepts and planning CT. The group median for teacher efficacy was 63 and suggested these teachers had *mostly can do* teacher efficacy beliefs when teaching CT concepts and integrating CT across curriculum areas. Finally, the group median for collective efficacy of the teacher participants was 87 and suggested *totally confident* collective efficacy beliefs, as discussed under the framing of their professional network. The following part now turns to the self-efficacy and collective efficacy beliefs of the school leaders from CS3. Teacher efficacy is not reported as the school leaders did not teach CT themselves. Please note that the school leaders in CS3 were called coaches.

PART TWO

6.7 Self-Efficacy Beliefs and the Conceptual Foundations of CT

What are the relationships between school leaders' efficacy beliefs (self, and collective) and the implementation of CT?

This section presents findings from survey and interview data from school leader participants in case study three (CS3). The school leaders completed the same survey as the teachers (please see Appendix *). The school leaders for CS3 were technology coaches for the school district, and their role was to support the teachers when planning and teaching CT. They are referred to as 'coaches' from here on. Table 74 presents the group self-efficacy beliefs for coaches in CS3 (median = 41) and suggested that the school leaders held *moderately* can do self-efficacy beliefs towards understanding and planning CT concepts. The overall IQR was 37 which meant that the coaches held vastly different self-efficacy beliefs for the survey subsections.

Table 73

Coach Participants' Self-Efficacy

		Self-efficacy		
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P11	Ruth	20	85	Somewhat can do
P12	Beth	61	12	Moderately can do
Group median		**41**	**37**	**Moderately can do**

The coaches in CS3 were asked to define their understanding of CT in both the survey, and interview. Table 75 presents the aggregated data for the coaches' survey scale responses for the five CT concepts (and general problem-solving) as explained in section 3.7.1

Table 74

Coach Participants' Self-Efficacy Subscale Medians

ID	Pseudonym	Decomposition	Abstraction	Pattern Recognition	Algorithmic thinking	Debugging	General Problem-solving
P11	Ruth	50	20	100	20	0	73
P12	Beth	64	62	73	52	61	67
Group median		**57 Moderately can do**	**41 Moderately can do**	**87 Totally can do**	**36 Somewhat can do**	**79 Mostly can do**	**70 Mostly can do**

The coaches in CS3 were *moderately* self-efficacious in their understanding of decomposition (median = 57) and abstraction (median = 41), however, were *somewhat* self-efficacious in their understanding of algorithmic thinking (median = 36). For debugging (median = 79) and general problem-solving (median = 70), the coaches were *mostly* self-efficacious in their understanding. Lastly, pattern recognition (median = 87) had the highest median which suggested the coaches were *totally* self-efficacious in understanding that particular CT concept.

Table 76 and Table 77 presents findings using the coaches' interview data to explain the group medians. The coaches were not observed because they do not teach CT in a classroom environment. The findings for abstraction (Table 76) and pattern recognition (Table 77) are used to identify the difference between the coaches' self-efficacy beliefs for the two CT concepts. The remaining joint displays for decomposition, algorithmic thinking, debugging, and general problem-solving are presented as Appendices 51 – 54.

Table 75

Coach Participants' Understanding of Abstraction

ID	Pseudonym	Abstraction (median)	Interview evidence
P11	Ruth	20 Somewhat can do	"Abstraction would be sort of like a bird's eye view over the whole thing. How does this fit, and what are some of the like? The key pieces? The key parts that I can pull out to help me understand this problem better" (Interview – CS3P11Q1).
P12	Beth	62 Mostly can do	"Abstraction would be, when you look at a problem really trying to pull out the specific things that you're trying to solve" (Interview – CS3P12Q1).
Group median		**41 Moderately can do**	

The two coaches in CS3 were *moderately* self-efficacious in their understanding of abstraction as a conceptual foundation of CT. Despite having *somewhat can do* self-efficacy beliefs towards abstraction, Ruth (median = 20) described abstraction clearly in the interview. Ruth commented on her understanding of abstraction as, *"what are some of the like? The key pieces? The key parts that I can pull out to help me understand this problem better"* (Interview – CS3P11Q1). This may indicate that Ruth could recognise abstraction in non-digital environments but struggled to identify abstraction in technological contexts, as reflected in the survey questions.

The other coach, Beth (median = 62), was *mostly* self-efficacious in her understanding of abstraction and commented that she understood abstraction as, *"when you look at a problem - really trying to pull out the specific things that you're trying to solve"* (Interview – CS3P12Q1). The findings presented illustrate how the coaches explicitly defined abstraction yet were *moderately* self-efficacious towards their understanding of this CT concept in relation to the survey questions.

Attention now turns to the coaches' self-efficacy beliefs towards their understanding of pattern recognition as a foundation CT concept. Table 77 presents findings using interview data to further explain the coaches' group median for pattern recognition.

Table 76

Coach Participants' Understanding of Pattern Recognition

ID	Pseudonym	Pattern Recognition (median)	Interview evidence
P11	Ruth	100 Totally can do	"Can I use this way to solve the problem in a different scenario? So it is, you know. Am I able to find success with this sort of way that I solve this problem, or what are the parts that I could repeat here in order to make that problem solving simpler and more efficient in the future" (Interview – CS3P11Q1).
P12	Beth	73 Mostly can do	"Pattern recognition would be simply to look for patterns in the findings" (Interview – CS3P12Q1).
Group median		**87 Totally can do**	

The coaches' medians suggested they were more familiar with pattern recognition as a foundational concept of CT than abstraction. This may be because pattern recognition was seen as a concept that spans many curriculum areas, particularly mathematics. The coaches had prior experiences that involved identifying similarities and differences across various problems. For example, Ruth (median = 100) *totally can* recognise patterns in a range of scenarios, and commented, *"am I able to find success with this sort of way that I solve this problem? Or what are the parts that I could repeat here in order to make that problem solving simpler and more efficient in the future?"* (Interview – CS3P11Q1). In addition, Beth (median = 73) was *mostly* self-efficacious towards her understanding of pattern recognition, and although did not explain it in detail during the interview, Beth described pattern recognition as, *"simply to look for patterns in the findings"* (Interview – CS3P12Q1).

The coach participants had *moderately can do* group self-efficacy beliefs towards their understanding of decomposition as a foundation CT concept (median = 57). Contributing to the group median, Ruth (median = 50) *moderately can do*, and described decomposition as breaking down a problem into smaller steps, such as determining the first step in a word problem (Interview – CS3P11Q1). Beth (median = 64) *mostly can do* decomposition, and summarised it as, *"really to break that information down into manageable steps"* (Interview – CS3P12Q1). She further elaborated on the process of decomposition, and considered it as asking, *"what's the problem? What are we trying to fix? How can we break that down?"* (Interview – CS3P12Q8).

In terms of algorithmic thinking, the group median was 36 and suggested *somewhat can do* self-efficacy beliefs. Ruth (median = 20) and Beth (median = 52) both showed varying levels of understanding. Ruth's understanding suggested she had *somewhat can do* self-efficacy beliefs, and Beth's understanding meant she *moderately can do* algorithmic thinking. Despite this, neither coach provided interview evidence to support their medians. This suggested that the coaches identified algorithmic thinking in the survey questions, yet needed more support to explicitly describe it for their planning of CT.

For debugging, the group median was 31 and indicated the coaches were *somewhat* self-efficacious towards this CT concept. For example, while Ruth (median = 0) reported a *cannot do at all* median, she defined debugging as finding and fixing problems, and stated, *"well, where is the problem in this, which is the part that we could fix? So that's exactly that, debugging right? You're trying to find it"* (Interview – CS3P11Q1). Ruth's description of debugging in the interview was at odds with her survey median, suggesting she was more comfortable with debugging in non-digital environments than in the programming contexts covered by the survey questions. Beth (median = 61) reported she *mostly can* debug, and described it as part of the troubleshooting process involved when trying new solutions (Interview – CS3P12Q1).

The group median of 70 indicated a similar level of competence between the coaches when generally problem-solving. Ruth (median = 73) and Beth (median = 67) both reported *mostly can do* medians for general problem-solving. However, there was no specific interview evidence to further support or detail their problem-solving abilities. A reason behind this may stem from the survey's focus on general problem-solving abilities, while the interview concentrated on foundational CT concepts, and led the coaches to provide more targeted responses.

6.7.1 Self-Efficacy Summary

Findings suggested that the coaches' self-efficacy beliefs towards foundational CT concepts range from *somewhat can do*, to *totally can do*, and indicated that they were more efficacious with some CT concepts than others. For example, despite *somewhat can do* self-efficacy beliefs for algorithmic thinking (median = 36), the coaches did not explicitly provide any interview evidence of their understanding. Both coaches considered that with more time and working to support the teachers in the district, their understanding of conceptual CT concepts would become clearer.

6.8 School Leaders' Collective Efficacy Beliefs, their Professional Network, and the Planning of CT

Collective efficacy beliefs are held by an individual in relation to how they perceive others as successful when working together on a collective endeavour. The CS3 coach participants' group collective efficacy median was 95 (see Table 78) and interpreted as *totally confident* efficacy beliefs in the group who completed the PD when planning and teaching CT. The IQR was 4 and suggested that the coaches held very similar collective efficacy beliefs across the collective efficacy survey questions.

Table 77
Coach Participants' Collective Efficacy Scores

Collective Efficacy				
ID	**Pseudonym**	**Median**	**IQR**	**Interpretation**
P11	Ruth	100	0	Totally confident
P12	Beth	89	8	Totally confident
Group median		**95**	**4**	**Totally confident**

This section discusses findings how CS3 coaches' collective efficacy beliefs related to their planning of CT. Professional network (from 3.9) describes the collaboration between teachers and coaches and was used as a structure for understanding collective efficacy beliefs of the school district in CS3. To support the results, Table 79 presents the collective efficacy subscale results for each coach in each category, as well as the group median. Rationale for the categories of Table 79 is described in Section 3.7.1.

Table 78

Coach Participants' Collective Efficacy Subscale Medians

ID	Pseudonym	Group computing concepts knowledge & skills	Group technology collaboration & communication	Group capability	Group effort	Group quality of outcomes	General group satisfaction
P11	Ruth	31	100	100	100	100	100
P12	Beth	91	92	91	84	83	87
Group median		**61 Mostly confident**	**96 Totally confident**	**96 Totally confident**	**92 Totally confident**	**91 Totally confident**	**94 Totally confident**

Group technology collaboration and communication, and group capability had the highest overall median for the coaches (both medians = 96). This suggested that the coaches were *totally confident* in their collective efficacy beliefs for how the teachers in the school district collaborated and communicated using technology, as well as the groups' capability when planning and teaching CT. Both Ruth and Beth were also *totally confident* in their collective efficacy beliefs towards group effort (median = 92), group quality of outcomes (median = 91), and general group satisfaction (median = 94). Group understanding of computing concepts knowledge and skills (median = 61) indicated that the coaches were *mostly confident* in their collective efficacy beliefs when reflecting on how the teachers at the school district understand computing concepts.

From here, Table 80 and Table 81 present findings using interview data from the coaches to further explain the group medians. The findings for group technology collaboration and communication (Table 80) and general group satisfaction (Table 81) are used to display the similarities and differences between the coaches' collective efficacy beliefs for the two subscale categories. The remaining joint displays for are presented as Appendices 55 – 58.

Table 79
Coach Participants' Collective Efficacy Beliefs and Group Technology Collaboration and Communication

ID	Pseudonym	Group technology collaboration and communication (median)	Interview evidence
P11	Ruth	100 Totally confident	"I feel like that collaboration is when the ideas happen. So if we had a grade level that sat together and or we were able to meet again as a [school district] cohort and talk about it" (Interview – CS3P11Q10).
P12	Beth	92 Totally confident	"I think, collaborating with peers plays a huge role to be able to bounce the ideas that you have off of peers and see what things that they're doing in their classroom" (Interview – CS3P12Q11).
Group median		**96** **Totally confident**	

Both Ruth (median = 100), and Beth (median = 92) were *totally confident* in their collective efficacy beliefs for how the group in their school district could collaborate and communicate using technology when planning and teaching CT. For example, Beth discussed the importance of collaborating online with peers when planning and teaching CT which contributed to her high collective efficacy median. Beth commented, *"I think, collaborating with peers plays a huge role to be able to bounce the ideas that you have off of peers"* (Interview – CS3P12Q11). Similarly, Ruth was *totally confident* in the group when collaborating online and offline, and said, *"I feel like that collaboration is when the ideas happen"* (Interview – CS3P11Q10). Both interview answers provided evidence in support of the coaches *totally confident* collective efficacy beliefs for group technology collaboration and communication. In addition, to further understand the coaches collective efficacy beliefs towards the planning and teaching of CT, group capability is analysed next. Table 81 presents findings using the coaches interview data to further explain the overall median for collective efficacy beliefs and group capability.

Table 80

Coach Participants' Collective Efficacy and Group Capability

ID	Pseudonym	Group capability (median)	Interview evidence
P11	Ruth	100 Totally confident	"We've got a number of key players from different schools who were those early adopters, and ready to try it out and dedicate a couple of days over the summer, and some asynchronous learning opportunities to learn more about it, and I think that as more people find out about it, they're going to be totally on board with using CT" (Interview – CS3P11Q7).
P12	Beth	91 Totally confident	"Some just want me to provide them with the technology, and then they can develop things on their own" (Interview – CS3P12Q5).
Group median		**96 Totally confident**	

Both coaches were *totally confident* (median = 96) in the capability of the group in the school district when planning and teaching CT. For example, Ruth (median = 100) believed the group members were 'on board' with using CT in their classrooms which increased as they found more information/resources about how to teach CT, thus supporting her *totally confident* efficacy median. In addition, Beth (median = 91) mentioned how members of the group were independently teaching CT, and she believed they had capability to plan and teach CT. Beth commented that most often, the group wanted her to provide the resources, and then they used the tools to develop their own CT plans (Interview – CS3P12Q5). Interview data provided evidence to support the coaches *totally confident* collective efficacy beliefs for group capability.

In terms of collective efficacy beliefs and group computing concepts knowledge, and skills, the coaches held *mostly confident* beliefs (median = 61). Beth (median = 91) was *totally confident* in the group and highlighted how assisting the group when incorporating CT concepts meant she built confidence in their knowledge and abilities when planning and teaching CT. On the other hand, Rith (median = 31) had *somewhat confident* collective efficacy beliefs for the groups' understanding of computing concepts and skills. Ruth said she had experience asking the group to show her what teaching CT looked like in their classes. While some had provided demonstrated their understanding, it appeared that others had not, thus aligning with Ruth's *somewhat confident* collective efficacy beliefs for group computing concepts knowledge, and skills.

The coaches in CS3 had *totally confident* collective efficacy beliefs for group capability (median = 96). For example, Ruth (median = 100) was reassured by the capability of 'key players' in the group from various schools within the district when planning and teaching CT. Ruth said that those members had enthusiastically engaged in learning and implementing CT, and believed that as the group shared their knowledge, more teachers in the district would be encouraged to plan and teach CT. Similarly, Beth (median = 91) was also *totally confident* and commented that that some people in the group preferred to receive the technology and then independently develop their own solutions. Beth's evidence indicated that she had high collective efficacy beliefs in the group's capability to plan and teach CT.

For collective efficacy and group effort, the coaches in CS3 also had *totally confident* beliefs and a group median of 92. Ruth (median = 100) knew the group members were putting in the effort to plan and teach CT. She commented that, *"the teachers that I've worked with have all kind of done it on their own. And I've found out after the fact, like, 'Okay, wait, you're doing something.*

Can I come in and watch?'" (Interview – CS3P11Q3). Ruth's evidence supported her *totally confident* efficacy beliefs. Beth, however, (median = 84) was also *totally confident* with her top score for collective efficacy and group effort, yet there was still room for her collective efficacy to increase as she had not worked with all the group at the time of the interview. Beth had a lower collective efficacy median compared to Ruth because she believed the group was already incorporating CT without explicit awareness. As a result, she believed the group was naturally putting in the effort to plan and teach CT.

The group median for collective efficacy and quality of outcomes was 91. This suggested the coaches had *totally confident* efficacy beliefs. Despite *total confidence* in quality of outcomes, Ruth (median = 100) provided evidence that one of the group members did not have a specific goal when she had observed them teaching CT. However, Ruth was still confident, and said that the teacher was teaching students about CT and *"how they were applying the components of computational thinking throughout that exploration process"* (Interview – CS3P11Q3). Beth (median = 83) was also *totally confident* and her median was supported by evidence of working with the group when integrating mice robots to introduce CT vocabulary in English language lessons with lower grade students.

The findings presented in this section demonstrate how collective efficacy related to the coaches belief in their groups' understanding of group technology collaboration and communication, general group satisfaction, group capability and effort, and group computing concepts knowledge, and skills. The subsections were used to explain the coach's collective efficacy beliefs, contributing to the overall group collective efficacy median of 95 (*totally confident).*

6.9 School Leaders' Collective Efficacy Beliefs and the State Strategy

The state-wide curriculum documents for CT were used to understand the coaches' collective efficacy beliefs (Figure 6 in section 6.6). Currently, the computing standards (which included CT) are not compulsory for teachers. The following section presents findings from coach participants who discussed the relationship between the state curriculum documents and their overall collective efficacy beliefs (median = 95, *totally confident*).

One coach, Beth (median = 89) believed it was important for CT to be prioritised at a state level, to ensure teachers were planning and teaching it. Although Beth had *totally confident* collective efficacy beliefs towards how the group involved in the PD were planning and teaching CT, she was not sure the wider teaching community were planning and teaching CT. Beth commented:

> If it is a priority at the national and state level, it is more likely to be a priority in our classrooms. It's important that they understand and see the importance and keep that in mind as they're identifying what we need to prioritize, so that we can have time to teach it throughout the day (Interview – CS3P12Q13).

Similarly, Ruth (median = 100) was *totally confident* in her collective efficacy beliefs that the group from the PD would plan and teach CT, despite the curriculum not being compulsory. Ruth also commented how she believed CT would be planned and taught significantly more if it was a mandated part of the state curriculum. Ruth said:

> I mean if the state or the federal government says it needs to happen, it will happen. Then we have to do it, we'll find ways to make it work. But

> that oftentimes comes with time, resources, and money that we can use in order to implement or roll out some of those things (Interview – CS3P11Q13).

The findings presented how the state curriculum documents for CT strategy supported the coaches' collective efficacy beliefs with regards to the group who participated in the PD, yet there remained doubts regarding the wider teaching community when planning and teaching CT.

6.9.1. Collective Efficacy Summary

In summary, in CS3 the coach participants' median of 95 indicated *totally confident* collective efficacy beliefs in the group's ability to plan and teach CT. Contributing to this overall group median were the coaches beliefs in how the group utilised computing concepts, knowledge, and skills (median = 61), group technology use for collaboration and communication (median = 96), group capability (median = 96), group effort (median = 92), group quality of outcomes (median = 91), and general group satisfaction (median = 94). While the coaches commented that they held very high collective efficacy beliefs when it was in relation to the teachers completing the PD (who they coached within their district) they did wonder whether other teachers were motivated to plan and teach CT without state compulsory standards.

Part Two Summary

Part two has presented the CS3 coach participants' medians for self-efficacy, and collective efficacy beliefs as well as interview findings help to understand the medians. The overall group median for self-efficacy of the coaches was 41 and suggested they *moderately can* understand and plan CT foundation concepts. In addition, the overall group median for collective efficacy of CS3 coaches was 95 and indicated *totally confident* collective efficacy beliefs towards how the group involved in the PD planned and taught CT, as discussed as part of their professional network.

Part three of the chapter now turns to the factors that support or undermine sources of efficacy judgements for both teachers and coaches of CS3 when planning and teaching CT.

PART THREE

6.10 Factors that Support or Undermine Efficacy Judgements

What factors support or undermine sources of efficacy judgements when planning and teaching CT?

This section discusses the group median for each efficacy type, the four sources of information on which efficacy judgements are made, and the factors that supported and/or undermined self, teacher and collective efficacy beliefs when planning and teaching CT. Both teacher and coach participants' findings are reported together because the results were not different between the two groups (see Table 82).

Table 81

Overall Efficacy Medians and IQR for Case Study Three

Efficacy Type	n	Median	IQR	Interpretation
Self-efficacy	12	57	17	Moderately can do
Teacher Efficacy	10	72	21	Mostly can do
Collective Efficacy	12	89	20	Totally confident

The school district-wide self-efficacy median for both teacher and coach participants (collectively called participants in this section) was 57 (*moderately can do*) with an IQR of 17. The school district-wide collective efficacy median for participants was 89 (*totally confident*) with an IQR of 21. The teacher efficacy median of 72, (*mostly can do*) did not change, nor did the IQR of 20, because the coaches did not have teacher efficacy measured as they are not teaching CT to students.

In addition, Table 83 presents the factors that were identified to either support or undermine self, teacher, and collective efficacy beliefs. Table 83 shows whether the four sources of efficacy judgements are supported (S) or undermined (U) for all participants in CS3. The four sources of efficacy judgements are enactive mastery, vicarious experiences, social/verbal persuasion, and physiological states (Bandura, 1997) (as described in Chapter 2). The factors identified that supported efficacy judgements of participants in CS3 were professional development, resources, teacher collaboration, and leadership. The factors that undermined efficacy judgements were a lack of time, and collaboration. Both supporting and undermining sources of efficacy judgements are described under each factor.

Table 82

Factors Supporting/Undermining Sources of Efficacy Judgements of CS3 Participants

Sources of efficacy judgements	**Enactive mastery**			**Vicarious Experiences**			**Verbal Persuasion**			**Physiological States**		
Type of efficacy	SE	TE	CE	SE	TE	CE	SE	TE	CE	SE	TE	CE
PD	S			S			S			S		
Resources	S	S	S					S				
Time	U	U										
Collaboration	S	S		S			S			S	S	
Leadership		S	U				S		S	S		

SE – self efficacy, TE – teacher efficacy, CE – collective efficacy.
S supported, U undermined.

6.10.1 Professional Development

All teacher and coach participants discussed PD as a factor that supported their efficacy judgements (enactive mastery (i.e. success), vicarious experiences, and verbal persuasion) or undermined their efficacy judgements (enactive mastery (i.e., failure), and verbal dissuasion) for planning and teaching CT (Table 83). PD was a factor that, depending on the situation, supported or undermined efficacy judgements which contributed to the school district-wide self-efficacy median of 57 (*moderately can do*). There was no evidence towards how PD either supported or undermined efficacy judgements in relation to teacher efficacy and collective efficacy beliefs.

PD Supporting Enactive Mastery. The following findings are evidence of how PD (through the University-lead initiative) contributed to school district-wide enactive mastery when planning CT. When asked about experiences the teachers believed were supportive in developing enactive mastery of CT contributing to their self-efficacy beliefs, several teachers mentioned PD providing them with the opportunity to practice the content themselves and see how CT fit into planning their curriculum. For example, Linda (median = 70) commented that PD provided time to gain practical experience which was a support for her mostly can do self-efficacy median. Linda said that PD was, "the biggest thing in how I gained my understanding, and learned about different activities that I could do with my students" (Interview – CS3P1Q11). Similarly, Jessica (median = 50) appreciated the PD time to learn how to plan and teach CT and the introductory PD sessions supported her moderately can do efficacy median. Jessica commented that, "having those days to kind of experiment and talk and make lessons, and just kind of get us thinking - that was my big thing" (Interview – CS3P5Q11). Holly also appreciated having time to learn the content, and create her own materials for planning CT, which contributed to her mostly can do self-efficacy median of 69. She said it was good to have PD so she could, "play and get our hands in it to kind of work through things and what we want us to do with our kids" (Interview – CS3P10Q10). Interestingly, despite lower self-efficacy beliefs (median = 20) coach Ruth commented:

> Not only was it [the PD] hands on, it feels like the direction that we should be moving education in, but also without knowing it, it's how I thought about solving problems. So, it was really cool and affirming to figure out like, 'Hey, I do that'" (Interview – CS3P11Q2).

Although she stated how the PD provided her with enactive mastery experiences, Ruth still believed she only had *somewhat can do* self-efficacy beliefs towards her understanding and planning of CT. This suggested that Ruth may benefit from ongoing PD.

These findings indicated that PD CS3 participants' enactive mastery experiences when planning CT, which contributed to the school district-wide self-efficacy median.

PD Supporting Vicarious Experiences. The second most influential source of efficacy judgements are vicarious experiences (Bandura, 1997). The following findings are evidence of how PD (through the University-lead initiative, or internal PD) supported the vicarious experiences of teachers and coaches, contributing to the school district-wide self-efficacy beliefs for planning CT.

PD was cited as an opportunity for participants in CS3 to learn vicariously from the University facilitators or other teachers from the group. This learning contributed to the school district's self-efficacy median of 57 (*moderately can do*). Two teachers spoke of PD providing opportunities for vicarious experiences that supported their self-efficacy beliefs. For example, Addison (median = 65) stated that during the summer face-to-face PD, she learned from the facilitators how to plan and teach CT which supported her *mostly can do* self-efficacy beliefs. Addison commented that the learning involved observations from the facilitators which acted as a positive, *"hands-on experience that we did in our professional development because it put us in the seats of the kids"* (Interview – CS3P3Q10).

In addition, Susan (median = 55) discussed how she had visited other teacher's classes as internal PD to learn how they were teaching CT, and this experience supported her *moderately can do* self-efficacy beliefs. Susan commented that she had, *"gone into other teacher's rooms that have done the CT and observed them before. I felt more confident when I didn't have students in my classroom, and I wanted to see how they were doing it"* (Interview – CS3P7Q8). While Susan had the opportunity to observe others plan and teach CT, Linda (median = 80) had not. Despite a *mostly can do* self-efficacy median, other than the PD with the facilitators, Linda had not had the chance to observe other teachers as part of internal PD. Linda stated that:

> We used to do something in the district where you could go in and watch; we had a group of teachers, and you do like some professional development and learning together, and then you'd go in and watch everybody's class a little bit, and I would love to be able to do something like that for this (Interview – CS3P1Q11).

Similarly, one of the coaches, Beth (median = 61) viewed internal PD as opportunities to observe CT implementation. Beth's *mostly can do* self-efficacy median was supported by evidence that she had the chance to go, *"see what things that they're doing in their classroom* [with CT]*"* (Interview – CS3P11Q11). These examples demonstrated how PD supported CS3 participants vicarious experiences, contributing to the school district-wide median of 57, indicating *moderately can do* self-efficacy beliefs.

PD Supporting Verbal Persuasion. Verbal persuasion involves encouragement from people whom an individual respects and values, which can boost their self-efficacy beliefs. Conversely, if these valued individuals offer negative feedback or discouragement, it can undermine the person's self-efficacy (Bandura, 1997). The following findings are evidence of how PD supported verbal persuasion for participants in CS3, and therefore contributed to the school district-wide self-efficacy median of 57 (*moderately can do).*

During internal school PD verbal persuasion was evident in the support provided for planning for teachers and coaches, positively contributing to the group's self-efficacy median. For example, Maria (median = 52) said that discussing successful approaches to planning CT with her teaching colleagues helped her believe in her own abilities. Maria believed this discussion supported her *moderately can do* self-efficacy because she understood the content better after each discussion. She had, *"shared good news before, like we were successful doing this with the staff and our staff meetings"* (Interview – CS3P4Q7). Furthermore, Maria mentioned how she enjoyed speaking to colleagues about planning CT, and this gave her more confidence. She said, *"I also like talking to other people about it, because not many people know a lot about it, planning, sharing all those pieces kind of go into that PD aspect"* (Interview – CS3P4Q11). Similarly, Kelly (median = 72) stated that she had allocated time in staff meetings to discuss what was happening in her school towards planning CT. The opportunity for internal PD discussions supported her *mostly can do* self-efficacy beliefs. Kelly commented that, "*we get time at staff meetings to be able to talk about and share different technology and things available in the district"* (Interview – CS3P9Q7). Discussing CT concepts and strategies for planning, suggested that the teachers understood CT planning well enough to share with their colleagues, thus supporting the school district-wide self-efficacy median.

PD Supporting Physiological States. PD was also discussed in relation to teachers' positive physiological states when planning CT, therefore impacting their self-efficacy beliefs. In particular, as a coach, Beth (median = 61) reflected that she felt excited about modelling CT to other teachers as internal PD. She stated, *"I'm excited to model that. But I think it's something that we've been doing, I've been doing for a very long time"* (Interview – CS3P12Q8). Beth's excitement towards CT reiterated her *mostly can do* self-efficacy beliefs when planning CT. Internal PD was the only aspect of PD that was mentioned during the interviews as a factor supporting physiological states when planning CT and the school district-wide *moderately can do* self-efficacy beliefs.

The previous sections provided insight into how PD affected teachers' enactive mastery (i.e. success), vicarious experiences, verbal persuasion and physiological states for planning. The efficacy judgements supported during PD contributed to the school district-wide self-efficacy median of 57 (*moderately can do*).

6.10.2 Resources (Digital & Non-Digital)

Non-digital resources included activities using pen and paper or physical tools (such as blocks, Lego etc), while digital resources encompassed technology devices such as laptops, robotics, and online software. The following findings help to provide insight into how resources supported CS3 participants' enactive mastery, and verbal persuasion when planning and teaching CT, contributing to the school district-wide self-efficacy median of 57 (*moderately can do*), the teacher participant median for teacher efficacy (median = 72, *mostly can do*) and the school district-wide collective efficacy median of 89 (*totally confident*). There was no evidence if resources either supported or undermined vicarious experiences or physiological states of the participants.

Resources Supporting Enactive Mastery. Several teachers provided evidence for how resources supported their enactive mastery when planning CT which contributed to their self-efficacy beliefs. For example, Linda (median = 80) had built up available resources over the years, and this meant she was more confident in her planning, which supported her *mostly can do* efficacy median. Linda said she had, *"been teaching this same class and grade level, for this is my eighth year. So now I've built up these lessons that I've been using"* (Interview – CS3P1Q12). Similarly, Addison (median = 65) had access to the resources needed to integrate CT into her planning which supported her *mostly can do* self-efficacy beliefs. Addison commented, *"I think there are some levels of resources needed, but so far we've been really happy with the fact that most things we can access"* (Interview – CS3P3Q10). No participants in CS3 mentioned that resources undermined their enactive mastery when planning CT, which would have lowered their self-efficacy median. Although this might have been the case, the individual medians indicated variations in self-efficacy beliefs related to resource availability. This suggested that the participants might have realised the benefits of having more resources for planning CT.

In terms of teacher efficacy, Daryl (median = 40) also had access to resources which supported his *moderately can do* efficacy beliefs when teaching CT. He said having the equipment in class meant he could teach CT easily and stated, "*I feel like every technology that I would want is* [there], *they all have Chromebooks. They all have things I need. So, I don't feel like there are any factors that they, or I don't have for* [CT] (Interview – CS3P2Q10). Although Daryl reported a lower teacher efficacy median, he was aware he had the necessary equipment required to teach

CT, so his teaching efficacy beliefs may have been influenced by the fact that he was at the beginning stages of teaching CT.

For coach Ruth (median = 100), resource availability supported her *totally confident* collective efficacy beliefs. She reflected that having resources available to the group would assist them when planning and teaching CT because they could practice with the tools. Ruth believed there was value in the CT posters that were provided as part of the PD, and commented how, *"the posters, just having those materials for that, so that teachers and students could see them, I think, is huge. Teachers are more apt to use them if it's right at their fingertips"* (Interview – CS3P11Q10).

The discussion with the researcher about both digital and non-digital resources highlighted how the enactive mastery was supported. Access contributed to CS3 participants school district-wide *moderately can do* self-efficacy median when planning CT, their *mostly can do* teacher efficacy median when teaching CT, and the school district-wide collective efficacy beliefs (median = 89, *totally confident*).

Resources Supporting Verbal Persuasion. Digital and non-digital resources emerged as a factor that was related to opportunities for verbal persuasion when teaching CT. One teacher had discussed resource availability which supported their *mostly can do* teacher efficacy beliefs. Linda (median = 80) commented how she valued sharing resources with other teachers, and the time pressure was lessened when other people spoke of finding relevant CT resources that she could also use. Linda commented:

I think the biggest thing is having people to talk to who can share resources, because sometimes it can be difficult to take the time, or to find things that really would work well for your classroom, because you also want to be kind of picky (Interview – CS3P1Q10).

Non-digital resources were supported by verbal persuasion between the teachers was evidence as a contributing factor towards the CS3 teachers' *mostly can do* teacher efficacy median when teaching CT.

The previous section provided insight into how both digital and non-digital resources influenced teachers' enactive mastery and verbal persuasion sources of efficacy judgements, contributing to the school district's overall group self-efficacy median of 57 (*moderately can do*), the teacher participant median for teacher efficacy (median = 72, *mostly can do*) and the overall group collective efficacy median of 89 (*totally confident*).

6.10.3 Time

A factor which undermined CS3 participants' enactive mastery when planning and teaching CT was time. The perceived lack of time contributed to the school district-wide self-efficacy median of 57 (*moderately can do*), and the teacher group efficacy median of 72 (*mostly can do*).

Lack of Time Undermining Enactive Mastery. The participants in CS3 cited a lack of time as a challenge when planning and teaching CT. A lack of time meant participants did not have sufficient experience to understand, plan, and practice CT effectively, which impeded their ability to build efficacy. In terms of a lack of time undermining self-efficacy beliefs, Jessica (median = 50) commented that she did not have the time to learn about CT concepts in a deep way to help her have experiences of success when planning CT lessons. She mentioned that if was difficult to, *"have the time to really understand the words. Understand what computational* *thinking is"* (Interview – CS3P5Q10). Jessica further discussed time as a factor for her *moderately can do* self-efficacy beliefs when planning CT lessons. She commented, *"I think it's just time. I don't think it takes a lot of time, but it does take some thinking like I can't just… I'm not just going to go off the cuff"* (Interview – CS3P5Q10). Similarly, Christina (median = 45) reiterated that a lack of time was a factor for her enactive mastery when planning CT, and this contributed to her *moderately can do* self-efficacy beliefs. She reflected that, *"the biggest one is time, just to even sit down with the concepts and the non-digital activities, and just do a little research on how it could be implemented into different lessons. The time is just not there to even do that"* (Interview – CS3P8Q12). In addition, Holly (median = 69) provided evidence for how a lack of time impacted her enactive mastery when planning CT, and this contributed to her *mostly can do* self-efficacy median. Holly commented that, *"we don't have any common planning time. We're teaching, you know, six subjects. So plan for six different things, and then add a new thing into it, it's just time management"* (Interview – CS3P10Q12).

Time was also a factor for some teachers' enactive mastery contributing to their teacher efficacy beliefs. For example, Daryl (median = 40) recognised that time was needed in the classroom to teach the students CT, regardless of whether CT was integrated throughout other subject areas. A lack of time meant that Daryl was not regularly teaching CT, which contributed to his *moderately can do* teacher efficacy beliefs. He said:

> I think time in the actual classroom itself and figure out trying to fit everything in. I think that's also a piece that can get in the way. And so, an understanding, and knowing exactly when it should be integrated, and when it should be taught on its own, is something that I think I didn't necessarily understand the importance of until I got into it. And now, I

kind of understand more. I understand it better [how to integrate CT in classroom teaching] (Interview – CS3P2Q12).

A lack of time undermined CS3 participants' self, and teacher efficacy beliefs because they did not have the time to practice what was needed for planning and teaching CT. While enactive mastery was undermined due to a lack of time, the participants in CS3 did not provide evidence of a connection between either time availability, or a lack of time and how this influenced their vicarious experiences, verbal persuasion, or physiological state sources of efficacy judgements.

6.10.4 Collaboration

An additional factor supporting/undermining CS3 sources of efficacy judgements was teacher collaboration. Collaboration meant CS3 participants were able to work with each other to practice planning and teaching CT, supporting all four sources of efficacy judgements which helps to explain the school district-wide self, and teacher belief medians. Teacher collaboration supported all sources of efficacy judgements, and undermined verbal persuasion, contributing to the school district-wide self-efficacy median of 57 (*moderately can do*), and the teacher participant median for teacher efficacy (median = 72, *mostly can do*). There was no evidence from participants in how teacher collaboration supported or undermined the efficacy judgements contributing to collective efficacy beliefs.

Teacher Collaboration Supporting Enactive Mastery. The CS3 participants acknowledged that collaboration was supportive of their efficacy beliefs when planning and teaching CT. Several teachers discussed how modelling to others was a factor that supported their high teacher self-efficacy medians when planning CT. This meant that collaborating in a group enabled the teachers to experience success when planning CT. For example, Maria (median = 89) commented that she had worked alongside a colleague and had spent time modelling CT plans, which aligned with her *totally can do* self-efficacy median. Maria said she had to, *"teach her* [a colleague] *and coach through that* [CT planning]. *So that's been helpful, modelling that for her"* (Interview – CS3P4Q8). Similarly, Holly (median = 92) had worked with other teachers demonstrating how to plan with CT tools, and this provided opportunities for her own experiences of success. Holly held *totally can do* self-efficacy beliefs, and said, *"I have walked through using the different programs, Scratch, hour of code and different things to show them what it looks like from the student standpoint. And then how can I translate that into CT"* (Interview – CS3P3Q8).

The participants also identified how collaboration supported their enactive mastery experiences contributing to teacher efficacy beliefs. Some teachers had the opportunity to teach pre-service teachers from the local university. One teacher with *mostly can do* self-efficacy beliefs mentioned how she was more comfortable in her own ability because she could demonstrate CT teaching while pre-service teachers were in her class, observing the lesson. Addison (median = 75) stated that:

> We have our student teachers that are working with us this year. They've been able to hear how we are talking to students in the Collaboration Centre, how we're encouraging, how we're describing CT to kids and putting it in kid friendly terms (Interview – CS3P3Q8).

Findings presented here suggest that collaboration between teachers was supportive of enactive mastery experiences, therefore contributing to the school-district wide group self-efficacy median of 57 (*moderately can do*), and the teacher participant median for teacher efficacy (median - 72, *mostly can do*). There were no examples of how collaboration supported or undermined enactive mastery, and therefore influencing collective efficacy beliefs of the participants.

Collaboration Supporting Vicarious Experiences. Collaborative planning was also identified as a factor that supported vicarious experiences contributing to the school-district wide group self-efficacy median of 57 (*moderately can do*). Several participants detailed how when planning as a team and sharing resources they had positive vicarious experiences. For example, Susan (median = 55) relied on her colleague when planning CT lessons, and this vicarious learning experience supported her *moderately can do* self-efficacy beliefs. Susan commented how she, *"really leaned on Christina, because she had started earlier in the school year than I did, and so I think that collaboration piece is really important to bounce ideas off of, and to get feedback"* (Interview – CS3P7Q10). In addition, as a coach, Beth (median = 61) planned with other coaches and learning from them supported her own *mostly can do* self-efficacy beliefs for planning CT. Beth stated how, *"collaborating with peers plays a huge role to be able to, you know, bounce the ideas that you have off of peers and see what things that they're doing in their classroom. So, I think it plays a large role"* (Interview – CS3P12Q11).

Findings presented here suggest that collaborative planning can support vicarious experiences when planning CT, contributing to self-efficacy beliefs. Working collaboratively was not discussed as either supporting or undermining vicarious experiences contributing to either teacher efficacy, or collective efficacy beliefs.

Collaboration Supporting Verbal Persuasion. Collaboration amongst CS3 participants also provided opportunities for verbal persuasion which contributed to their self-efficacy beliefs when planning CT. One teacher, Linda (median = 70 reflected on how she needed others to talk to about CT planning and this influenced her *mostly can do* self-efficacy median. Linda said, *"the biggest factor for me is having people to talk to. We do a lot of planning together as well and try to think about it"* (Interview – CS3P1Q10). Furthermore, Linda commented how she thought planning CT would be difficult if teachers were unable to collaborate. Linda reflected how some teachers might, *"feel like a little bit of an island right now, and they're not maybe like… It's a lot harder to find resources on your own. If you don't have anyone to talk to"* (Interview – CS3P1Q11). Addison (median = 65) too, had discussed CT with her colleagues which supported her *mostly can do* self-efficacy beliefs. Addison said, *"we work very closely together, and I think just being able to bounce ideas off of each other* [helps]" (Interview – CS3P3Q11). Interestingly, Daryl (median = 59) mentioned that if he didn't have verbal persuasion while collaborating with others, he might not be as comfortable planning CT. Daryl's comment aligned with his *moderately can do* self-efficacy median, suggesting that he may have had fewer people to discuss successful CT planning with. He commented how:

> If I didn't have someone that was encouraging me and excited about this at the same time it would be really difficult. If I wasn't communicating with Linda I think that would be something that would be harder (Interview – CS3P2Q12).

Furthermore, Maria (median = 52) mentioned how she enjoyed speaking to colleagues about planning CT, and this gave her more confidence in her own abilities when planning CT. She said, *"I also like talking to other people about it, because not many people know a lot about it, planning, sharing all those pieces kind of go into that PD aspect"* (Interview – CS3P4Q11).

These participants provided evidence for how collaborating with others meant they had opportunities to discuss successful CT planning, which contributed to the school-district wide self-efficacy median. However, working collaboratively was not mentioned as either a support for verbal persuasion or a means of verbal dissuasion, and thus did not influence the teacher efficacy or collective efficacy beliefs of CS3 participants.

Collaboration Supporting Physiological States. Some participants also gave evidence of how excited they were to work with other teachers and discuss CT practices in class, which contributed to the school district-wide self, and teacher efficacy medians. For example, although Ruth (median = 20) had a lower *somewhat can do* self-efficacy median, she was excited to plan with others when integrating CT within English Language Arts (ELA). Ruth said she was, *"definitely happy with it all. But my kind of preferred content area is ELA. So, I'm super jazzed to start thinking about that more, and working with teachers on integrating CT"* (Interview – CS3P11Q5). Despite Ruth having a lower self-efficacy median, she still felt positive, and acknowledged that she was at the beginning stage of planning with other teachers in CT in her coaching role.

There was another participant who thought collaboration supported his positive physiological state, contributing to his teacher efficacy beliefs. Daryl (median = 59) held *moderately can do* teacher efficacy beliefs and when working alongside his colleagues stated how, *"it's kind of a rad experience and just kind of the engagement level, and that like perfect buzz, super fun"* (Interview – CS3P2Q8). While a few participants believed teacher collaboration supported their physiological state when planning and teaching CT, there were no examples of how physiological states regarding collective efficacy beliefs were either supported or undermined.

6.10.5 Leadership

The teachers and coaches from CS3 discussed how both school leadership and school district leadership was a factor that supported enactive mastery, verbal persuasion, and physiological states for planning and teaching CT, which contributed to the school district-wide group self-efficacy median of 57 (*moderately can do*), the teacher efficacy median of 72 (*mostly can do*), and the school district-wide group collective efficacy median of 89 (*totally confident*). Enactive mastery was also undermined by leadership and will be discussed further.

Leadership Supporting/Undermining Enactive Mastery. Some participants in CS3 viewed leadership as supportive of their enactive mastery, which contributed to their teacher efficacy beliefs. For example, Maria (median = 89) had been observed by school leaders when she taught CT to her students. Maria was encouraged to showcase her CT teaching, and this experience supported her *totally can do* teacher efficacy median. She commented about, *"having our principal come and see. I know our assistant principal, our dean, has been a couple of times to stop in and watch us"* (Interview – CS3P4Q7). Maria's evidence suggested that leadership visiting her class increased her efficacy in her ability to teach CT. Similarly, Daryl (median = 40) had planned to invite school district leaders to observe him teaching CT and stated, *"we're hoping to invite them to come and see some of the stuff that we are doing and know that that supports happening"* (Interview – CS3P2Q9). While Daryl's *moderately can do* teacher efficacy median was lower than Maria's, it was likely because he had not had the enactive mastery experience demonstrating CT to leadership at the time of interview, yet he was comfortable to do so in future.

In contrast, although Linda had high efficacy for teaching CT herself, she was concerned that other teachers who had not completed the PD might not be as inclined to teach CT without leadership support and leaders following-up with staff who were not yet incorporating CT. Linda (median = 85) was unsure whether leadership supported the groups' enactive mastery experiences, and this slightly undermined her *totally confident* collective efficacy beliefs. Linda reflected that teaching CT was:

> Definitely a choice for us to do. I think it's definitely possible for someone to say, 'Oh, not really my thing, and then not do it', and not really be held accountable for it. So, I don't think right now that I feel like there's any administrative accountability for it (Interview – CS1P1Q9).

Some participants also mentioned that leadership provided opportunities for CS3 participants to demonstrate their ability to teach CT, while others believed a lack of leadership support might result in some members of the group not teaching CT to their students. Both examples were provided as evidence for the CS3 median for teacher efficacy (median = 72, *mostly can do*) and the school district-wide collective efficacy median of 89 (*totally confident*). There were no examples of how leadership supported enactive mastery when planning CT, contributing to self-efficacy beliefs.

Leadership Supporting Verbal Persuasion. Leadership providing opportunities for verbal persuasion was also a supporting factor for several teachers' self, and collective efficacy beliefs. One teacher in particular, Addison (median = 65), mentioned that after talking with one of the coaches, and the superintendent of the school district, she was more efficacious when planning CT lessons, thus contributing to her *mostly can do* self-efficacy beliefs. Addison commented that if she is, *"going to take valuable class time to really focus on CT then I know that I'm going to be supported by the district in doing so"* (Interview – CS3P3Q9).

In terms of collective efficacy beliefs, Addison discussed that the school principal was supportive, and trusted the teachers to do a capable job planning and teaching CT. Addison's support from leadership via verbal persuasion, contributed to her 100 (*totally confident*) collective efficacy median. She stated:

> My principal is very supportive in what we do. She values our judgment and our opinions and sees us as capable people who can discern what's best for students. And so, when we got really excited about this, she got really excited about it. She looks for opportunities where she can support us if we need something (Interview – CS3P3Q9).

The participants in CS3 provided evidence for how leadership positively discussing CT with them contributed to the school district-wide self-efficacy, and collective efficacy medians. There were no examples of how leadership was either a support for verbal persuasion or a means of verbal dissuasion, and therefore did not influence teacher efficacy beliefs.

Leadership Supporting Physiological Experiences. Leadership was also discussed in relation to teachers' positive physiological states when planning CT lessons, contributing to the school district-wide self-efficacy median. For example, Addison (median = 65), thought leadership support contributed to her mostly can do self-efficacy median. Addison said the leaders knowing and supporting her teaching CT, "makes me feel less nervous" (Interview – CS3P3Q9) when she was taking class time to implement CT. In addition, Maria (median = 50) was assured her school leadership was positive about CT plans in class, which positively influenced her moderately can do self-efficacy beliefs. Maria reflected that, "if the leadership were to come in and see us in the Collaboration Centre, I would be excited to share that with him, just because I know he has a positive mindset about it" (Interview – CS3P4Q9).

Some participants in CS3 provided evidence that leadership supported their physiological experiences, contributing to the school-district wide self-efficacy median. There were no examples of how leadership either supported or undermined their physiological state, influencing teacher efficacy, or collective efficacy beliefs.

Part Three Summary

Part three presented the factors influencing the four sources of efficacy judgments and assessed whether these factors supported or undermined self-efficacy, teacher efficacy, and collective efficacy beliefs in the context of planning and teaching CT. For CS3, the school district-wide self-efficacy median was 57 (*moderately can do*), the teacher participant median for teacher efficacy was 72 (*mostly can do*) and the school-district wide collective efficacy median was 89 (*totally confident*). The factors that either support or undermined self, teacher, and collective efficacy beliefs were also presented and indicated whether the four sources of efficacy judgements were supported (+) or undermined (-) for all participants in CS3. The factors that supported efficacy judgements were PD, resources, teacher collaboration, and leadership. The factors that undermined efficacy judgements were a lack of time, and leadership.

PD played a dual role in influencing CS3 participants' efficacy judgements for planning and teaching CT. PD supported enactive mastery by allowing participants to practice and learn how to integrate CT into their curricula, which boosted self-efficacy beliefs. Vicarious experiences were also facilitated by PD as teachers observed and learned from others, enhancing their self-efficacy beliefs. Verbal persuasion, through positive reinforcement and peer discussions during PD, further strengthened participants' self-efficacy. However, PD could undermine self-efficacy beliefs when it involved failure or negative feedback. Digital and non-digital resources supported enactive mastery and verbal persuasion, positively affecting self-efficacy and collective efficacy beliefs of the CS3 participants. There was also evidence how a lack of time significantly undermined participants' enactive mastery when planning and teaching CT, reflected in a school-district wide median of 57 for self-efficacy and a teacher efficacy median of 72. Time constraints prevented effective learning, planning, and practicing of CT. Despite these challenges, collaboration among participants supported enactive mastery, vicarious experiences, verbal persuasion, and positive physiological states, contributing to higher school district-wide self-efficacy and collective efficacy medians. In addition, leadership further influenced efficacy beliefs by offering support but also presented challenges, therefore influencing school district-wide self, teacher, and collective efficacy beliefs when planning and teaching CT.

6.11 Summary of Case Study Three

This chapter has presented the findings from Case Study Three. In particular, results were presented to understand the relationships between efficacy beliefs and teachers' and coaches' understanding and confidence when planning and teaching CT.

Part One presented CS3 teacher participants' efficacy beliefs, with self-efficacy at a median of 57 (*moderately can do*) in planning and understanding CT, teacher efficacy at 72 (*mostly can do*) when teaching and integrating CT, and collective efficacy at 87 (*totally confident*) in the group when planning and teaching CT. Part Two covered CS3 coaches, and identified a self-efficacy median of 41 (*moderately can do*) when understanding and planning CT, and a collective efficacy median of 95 (*totally confident*) in the group to CT plan and teach CT. Furthermore, using self-efficacy theory as a framework (Bandura, 1977), Part Three identified factors that supported or undermined teachers' and coach's efficacy judgments when planning and teaching CT. The school district-wide self-efficacy median was 57 (*moderately can do*), teacher efficacy remained at 72 (*mostly can do*), and school district-wide collective efficacy was 89 (*totally confident*). The factors identified that supported efficacy judgements were PD, resources, teacher collaboration, and leadership. The factors that undermined efficacy judgements were a lack of time, and collaboration.

In the next chapter, a cross-case analysis and discussion is presented, synthesising the findings from the previous sections to draw broader insights into the relationships between efficacy beliefs and the planning and teaching of CT.

Chapter Seven: Cross-Case Analysis and Discussion

Having presented key findings from CS1 (Chapter 4), CS2 (Chapter 5) and CS3 (Chapter 6) this chapter focuses on bringing the multiple cases together via a cross-case analysis and discussion. Multi-case studies highlight how various components and constraints interact, including how common and unusual factors are portrayed - all situated in complex interactions within each case (Stake, 2013). In other words, the cross-case analysis examines and compares multiple cases to uncover common patterns, differences, and provide a more comprehensive view and deeper insights. The purpose of this cross-case analysis and discussion is to provide answers to all three research questions situated within as much context as possible (Stake, 2013), and identify recurring themes, compare different contexts, and increase understanding of the relationships between efficacy beliefs and the planning and teaching of CT.

In this cross-case analysis chapter, all participants' data were analysed together within each case. The justification for analysing all participants together within the case (i.e., school leaders and teachers in CS1 and CS2, and coaches and teachers in CS3) is found within social cognitive theory. Bandura (1997) argued that social cognitive theory encompasses several factors that regulate and motivate established cognitive, social, and behavioural skills. According to Bandura (1986), this theory is grounded in the concept of 'triadic reciprocity,' which means that personal, behavioural, and environmental factors interact and affect each other. In this study, the cases have multiple factors influencing both teachers and school leaders/coaches within their given contexts.

7.1 Efficacy Beliefs Across the Cases

To understand the similarities and differences between cases, the analysis is separated into the following sections. The first section focuses on the quantitative findings which are compared to highlight commonalities and differences between the three cases. Following this, is an analysis and discussion of the factors that either supported or undermined the four sources of efficacy beliefs of the participants. For example, within self-efficacy, first the summary statistics are presented for each case, and then there is an analysis and discussion of the factors that either supported or undermined enactive mastery, vicarious experiences, verbal persuasion, and physiological states within each case. This is followed by statistical analysis and discussion of participants' teacher efficacy beliefs in each case, and finally, participants' collective efficacy beliefs of each case.

Self-efficacy was analysed by examining how teachers and school leaders articulated CT concepts and defined and identified CT practices for their own planning purposes. Teacher efficacy was analysed both through planning and facilitating CT (teachers only, as school leaders did not teach CT). For example, planning integrated CT was how the teachers linked CT-related learning goals to other disciplinary goals, and how they designed CT-integrated learning experiences. With regards to facilitating CT, teacher efficacy was analysed by focusing on how the teachers reported how they used CT strategies to guide and engage their students. Lastly, for collective efficacy, the teachers and school leaders/coaches were asked to report on their understanding of CT collaboration with the group and their perceptions of how the group planned and taught CT. Table 84 presents the summary statistics for participants' self, teacher, and collective efficacy beliefs for each case. For self, and collective efficacy, please note that for

CS1 and CS2, the group median is presented as ‘school-wide’ whereas for CS3, the group median is presented as ‘school district-wide'. Teacher efficacy remains as group median.

Table 83

Efficacy Summary Statistics across Cases

Case	Efficacy Type	n	Median	IQR	Interpretation
CS1	Self-efficacy	8	62	23	Mostly can do
	Teacher Efficacy	6	67	41	Mostly can do
	Collective Efficacy	8	90	22	Totally confident
CS2	Self-efficacy	6	52	13	Moderately can do
	Teacher Efficacy	5	47	36	Moderately can do
	Collective Efficacy	6	65	16	Mostly confident
CS3	Self-efficacy	12	57	17	Moderately can do
	Teacher Efficacy	10	72	21	Mostly can do
	Collective Efficacy	12	89	20	Totally confident

Self, and Teacher Efficacy (0-20 ‘cannot do at all’, 21- 40 ‘somewhat can do’, 41-60 ‘moderately can do’, 61-80 ‘mostly can do’, 81-100 ‘totally can do’).
Collective efficacy (0-20 ‘not confident’, 21-40 ‘somewhat confident’, 41-60 ‘moderately confident’, 61-80 ‘mostly confident’, 81-100 ‘totally confident’).

CS1 participants had a school-wide median score of 62 which indicated *mostly can do* self-efficacy beliefs for planning CT. The IQR was 23 and suggested that while there was a noticeable spread, it was not extreme, relative to the range of the self-efficacy beliefs dataset. CS2 had a school-wide median of 52, which suggested the participants had *moderately can do* self-efficacy beliefs. The IQR for CS2 was 13 and this level of spread indicated a moderate concentration of data points around the self-efficacy median, showing some variability, but not extreme variability. Finally, the participants in CS3 had a school district-wide median of 57, which indicated *moderately can do* self-efficacy beliefs when understanding and planning CT. The IQR for CS3 and the spread suggested a moderate variability in how participants perceived their self-efficacy, with the majority of participants' medians falling within this range. Further analysis of self-efficacy findings across the cases is explored in section 7.2.

In terms of teacher efficacy beliefs, the group median for CS1 participants was 67. This median suggested that the teachers were *mostly* efficacious towards their teaching of CT. CS1 had a large IQR of 41 and meant that the central 50% of participants' beliefs were distributed over a 41-point range. This level of spread demonstrated a substantial degree of variability in how teachers perceived their teaching efficacy. The group median for teacher participants in CS2 was 47, and indicated *moderately can do* teacher efficacy beliefs when teaching CT. The IQR for CS2 was 36. This substantial range indicated a moderate to high degree of variability in teachers' efficacy beliefs, reflecting diverse perceptions among the participants in CS2 in their teaching of CT. CS3 had the highest overall median, and at 72, indicated *mostly can do* teacher efficacy beliefs for the teacher participants. The IQR for CS3 was 21. This range suggested a moderate level of variability in participants' teacher efficacy beliefs. Teacher efficacy findings across the three cases are discussed further in section 7.3.

Collective efficacy beliefs had the largest difference in medians across the three cases. CS1 had *totally confident* collective efficacy beliefs when planning and teaching CT, as indicated by the school-wide median score of 90. In addition, the IQR for CS1 was 22, and suggested that while there was some variation in collective efficacy scores among the central 50% of participants, this spread was not excessively wide. In other words, an IQR of 22 in collective efficacy scores suggested that there was a moderate degree of variation in how different individuals perceived their collective efficacy beliefs. CS2 had the lowest collective efficacy beliefs of the cases with the school-wide median score of 65 and showed *mostly confident* collective efficacy beliefs when planning and teaching CT. CS2 had an IQR of 16, and this range suggested that most CS2 participants had a moderate level of variability in their perceptions of their group's collective efficacy, showing that there were differences in how individuals viewed their collective capabilities. While there was some variation in collective efficacy beliefs for CS2, the spread was not excessively wide. Lastly, CS3 had a school district-wide median score of 93 which reflected *totally confident* collective efficacy beliefs. The IQR was 20 and indicated that the central 50% of participants' scores were distributed over a 20-point interval. This showed a moderate level of variation in how participants assess their group's collective efficacy, demonstrating a range of differing opinions about how the group planned and taught CT. Collective efficacy findings across the three cases are explored further in section 7.4.

7.2 Self-Efficacy Across the Cases

This section presents cross-case analysis and discussion of teachers' and school leaders/coaches self-efficacy beliefs efficacy beliefs when planning CT across the cases. Furthermore, self-efficacy beliefs are compared to highlight the commonalities and differences between the three cases.

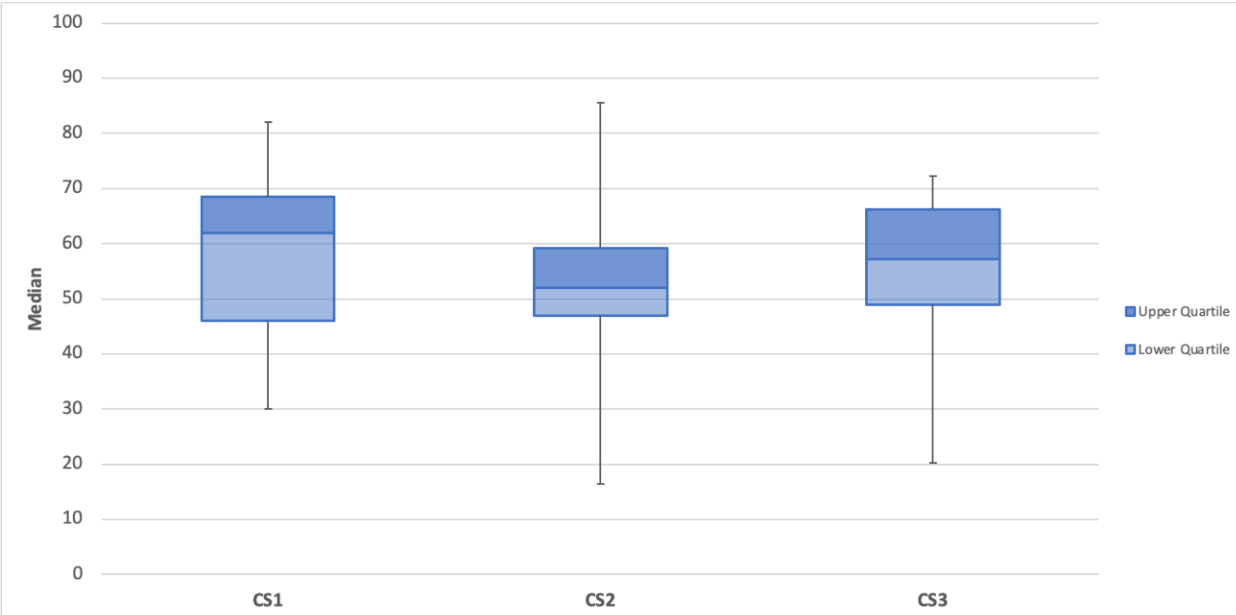
7.2.1 Self-Efficacy Scale Results

The three cases shared similar medians for self-efficacy beliefs, yet the IQR ranged from 13 to 23. In CS1, the IQR of 23 spanned a range of 23 units in which the middle 50% of the data falls. For CS2 an IQR of 13 spanned a range of 13 units of measurement which the middle 50% of the data falls. For CS3, the IQR of 17 for self-efficacy beliefs indicated that the central 50% of participants' beliefs were distributed over a 17-point range (see Table 85). The overlapping nature of results in the box plot (see Figure 7) suggested a similarity in medians between the cases. A subsequent analysis was performed via Kruskal-Wallis (1952) test on the school-wide or school district-wide self-efficacy median scores of the three cases. The differences between the medians of 62, *mostly can do* (CS1), 52, *moderately can do* (CS2) and 57, *moderately can do* (CS3) were not statistically significant, H (2) = .574, p = .750. Therefore, there were no statistically significant differences in self-efficacy scores between the three cases. In addition, a range of factors were identified as either supporting or undermining the sources of efficacy judgements contributing to self-efficacy beliefs across the cases. These are discussed next.

Table 85
Self-Efficacy Summary Statistics across Cases

Case	Efficacy Type	n	Median	IQR	Interpretation
CS1	Self	8	62	23	Mostly can do
CS2	Self	6	52	13	Moderately can do
CS3	Self	12	57	17	Moderately can do

Figure 7
Self-Efficacy Median by Case



7.2.2 Factors Contributing to Self-Efficacy Across Cases

Five factors were identified across the three cases as either supporting or undermining the sources of self-efficacy beliefs of participants. To determine which factors were most influential, this analysis focused on the sources of efficacy judgements that either supported or undermined self-efficacy beliefs which involved frequency counts for how often each factor was mentioned by participants. By aggregating these counts, it became possible to identify which factors were most frequently cited as influential. This approach provided a clear, quantitative measure of the relative importance of each factor in shaping self-efficacy beliefs, but further analysis was needed to assess their salience and significance in the context of the overall findings. The analysis of the three cases shows that they were not statistically different from each other primarily due to participants' similar experiences with PD, which was the most influential factor for supporting self-efficacy beliefs across all cases. The second most influential factor was collaboration, followed by resources, and leadership. A lack of time undermined enactive mastery judgements for all three cases, which also likely contributed to their similar overall medians (see Table 86).

Table 86

Sources of Self-Efficacy Judgements either Supported (S) or Undermined (U) by Case

Factor	**CS1**				**CS2**				**CS3**				**Results per Case**			**Overall Results**
	EM	VE	VP	PS	EM	VE	VP	PS	EM	VE	VP	PS	CS1	CS2	CS3	All Cases
Professional Development	S/U	S	S		S/U	S			S	S	S	S	3S 1U	2S 1U	4S	9S 2U
Resources					S	U		U	S		S			1S 2U	2S	3S 2U
Time	U				U				U				1U	1U	1U	3U
Collaboration	S								S	S	S	S	1S		4S	5S
Leadership											S	S			2S	2S

EM means enactive mastery or failure, VE is vicarious experiences, VP is verbal persuasion or dissuasion, and PS is physiological states

S supported, U undermined

Blue - CS1 Red - CS2 Green – CS3

Professional Development Supporting/Undermining Self-Efficacy Beliefs. PD was the most supportive factor for building self-efficacy of participants across all cases and had nine instances of supporting the sources of efficacy judgements. The overall result of nine instances reflects the accumulation of evidence from participants about how PD supported the sources of efficacy judgements. Each instance represents a different source of efficacy judgement, per case about how PD contributed to their self-efficacy beliefs.

The majority of participants from all cases shared their experiences regarding PD and its positive influence on their sources of efficacy judgements, contributing to their self-efficacy beliefs. Most participants found the PD particularly beneficial through experiences of success and observing others. Fewer participants benefited from PD providing opportunities for verbal persuasion, and only participants in CS3 mentioned PD being enjoyable. PD opportunities via a facilitator, internal PD within a school, or off-site PD contributed to the CS1 school-wide self-efficacy median of 62 (*mostly can do*), the CS2 school-wide self-efficacy median of 52 (*moderately can do*), and the CS3 school district-wide self-efficacy median of 57 (*moderately can do*).
Most participants (n = 17) in all three cases commented how PD supported their enactive mastery judgements when planning CT; the teachers got to practice planning CT with support from the facilitator, and these experiences likely contributed to their self-efficacy beliefs. The participants across the cases had time during the PD sessions to ask questions, and unpack the curriculum/state requirements for planning CT. The PD experiences also provided opportunities for participants to develop their competence when planning CT, and many teachers believed they were 'on the right track' after the PD sessions. This finding is similar to prior research which highlights the positive impact of PD incorporating mastery experiences, suggesting that learning the skills and the opportunity to apply them in an authentic setting during PD sessions may

increase self-efficacy (Bruce et al., 2010; Morris & Usher, 2011; Tschannen-Moran & McMaster, 2009). More specifically, Arslan (2019) found that mastery experiences were the most powerful predictor of self-efficacy beliefs where learning in courses, in-school training, and microteaching all contributed to the self-efficacy beliefs of the teachers. In addition, Gale et al. (2021) found that active participation in various PD experiences was important in developing participants' self-efficacy beliefs. In other words, learning new content and skills by practicing planning during PD is vital for teachers to develop self-efficacy beliefs. However, there was also evidence how PD undermined sources of efficacy judgements, specifically how PD had undermined enactive mastery in both CS1 and CS2. There were also few participants in CS1 (n =1) and CS2 (n = 2) who believed the PD content was initially confusing, or not sufficiently tailored to the age group they taught. This, in turn, undermined their enactive mastery for planning CT, and therefore lowered the self-efficacy medians of each case.

There were also participants (n = 12) from all three cases who identified how PD provided opportunities to learn vicariously from a facilitator or learn from another teacher. Across the cases, the teachers consistently perceived learning from a PD facilitator as highly beneficial for enhancing their self-efficacy beliefs. This positive influence stemmed from their ability to independently complete CT lessons by effectively following instructions provided by a recognised leader. Consequently, these vicarious experience judgements contributed to the school-wide or school district-wide self-efficacy medians in each case when understanding and planning CT. Despite participants in CS3 having a different PD model (less time with a facilitator), they still reflected how vicarious experiences supported their *moderately can do* self-efficacy median when understanding and planning CT. The findings of how vicarious experiences during PD supported the development of self-efficacy beliefs in this project are consistent with

Gale et al. (2021) who found that teachers reported positive vicarious experiences by observing colleagues or learning new strategies modelled during PD. This is consistent with the current study, as there were no instances where PD was perceived to lead to negative vicarious experiences which subsequently undermined the self-efficacy beliefs of the case participants. In other words, there were no examples of how PD might have resulted in negative observations or experiences from others that negatively influenced the participants' efficacy in their own abilities for planning and teaching CT. A possible explanation may be that during the PD, the teachers were supported when learning from the facilitator observing what to do, and the participants appreciated the time to learn and practice CT planning themselves. Teachers (n = 6) reported how they enjoyed learning 'as a student' which suggested how learning vicariously contributed positively to their self-efficacy beliefs.

While of less relative importance, some teachers in CS1 and CS3 discussed examples of PD opportunities as a supportive source of verbal persuasion judgements by positive discussions with colleagues and school leaders. Most teachers in CS1 believed that having the time to discuss CT learning during the PD contributed to their belief they could successfully plan CT lessons. For example, CS1 participants (n = 6) mentioned how discussions about CT during internal PD sessions also helped them believe they were supported. Although CS1 provided examples of how PD supported verbal persuasion and planning CT, these examples were considered less influential compared to those from CS3. This difference may have been due to CS3 participants having had more opportunities to discuss CT, whether during their PD, internally at their schools with colleagues who had also completed the PD, or via email with other teachers in the district. The findings from this study on how PD supported verbal persuasion judgements mirrors research by Arslan (2019), who found that verbal persuasion was a factor contributing to teachers' self-efficacy beliefs by positive communication with principals and colleagues, either through internal PD, or collaborative meetings where teachers were discussing curriculum content. In addition, when teachers receive positive feedback on their teaching performance and collaboration with their peers, their self-efficacy beliefs increased. Therefore, allowing teachers an opportunity to discuss their learning with each other during PD is an important factor contributing to self-efficacy beliefs. However, PD also undermined self-efficacy beliefs by verbal dissuasion for one participant. The participant from CS1 believed that the PD was not regularly discussed after completion, and this influenced the school-wide self-efficacy median. Similarly, work by Morris and Usher (2011) argued that teachers often perceive they are reaching their teaching goals when confirmed by the verbal persuasion of others. The teacher from CS1 may have lacked opportunities to discuss the PD and receive feedback from peers, which contributed to the absence of confirmation regarding their CT planning.

CS3 was the only case in which specific examples were identified of how PD supported the physiological states of the participants when they described the excitement they felt about planning CT. Learning about CT was new to many teachers in CS3 (n = 10), and was viewed as an exciting learning area, which may have contributed to their positive physiological states. In contrast, teachers from both CS1 and CS2 did not provide detail on how their physiological states were impacted during PD. A possible explanation was that the teachers from these cases only mentioned excitement or stress with regards to their teacher efficacy; they only discussed their feelings when putting CT into practice during PD, not when they were planning CT. Physiological states when planning CT was only analysed as a contribution towards self-efficacy beliefs.

Collaboration. Collaboration was the second most influential factor for building self-efficacy beliefs of participants by the sources of efficacy judgements (particularly enactive mastery) contributing to their school-wide and school district-wide self-efficacy medians. The overall result of five instances across the cases reflects the accumulation of evidence from participants about how collaboration supported the sources of efficacy judgements. Each instance represents a different source of efficacy judgement, per case, related to how collaboration contributed to their self-efficacy beliefs. There were no examples of how collaboration undermined participants' sources of efficacy judgements.

Teacher collaboration is viewed as joint activities with a common purpose, involving dialogue, inquiry, and mutual support when addressing challenging professional issues (Robutti et al., 2016). In the current study, participants in CS1 and CS3 (n = 15) acknowledged that opportunities to collaborate with other teachers supported their own planning of CT. Furthermore, collaborating with others, sharing resources, and receiving positive feedback supported the participants' own experience of success when planning CT. Previous research has also shown that it is imperative teachers have a professional network or collaborative opportunities to successfully integrate CT, and improve their CT knowledge and skills (Caskurlu, 2021; Haden et al., 2016; Pollock et al., 2017). While the participants from CS1 and CS3 believed collaboration supported their experiences of success, CS2 participants did not provide evidence how teacher collaboration either supported or undermined the development of their enactive mastery judgements when planning CT. A possible explanation for these findings was that planning was mostly done on an individual basis; the teachers in CS2 (n = 2) mentioned that they were more familiar with planning solo and needed time to understand CT themselves before being comfortable demonstrating to others how they planned CT.

Regarding how collaboration and vicarious experiences influenced self-efficacy beliefs in planning CT, only participants in CS3 reported receiving support. Participants in CS3 (n = 6) were supported by collaborative vicarious experiences when planning CT but may have needed more observation opportunities to achieve a higher school district-wide self-efficacy median. A possible reason behind the CS3 school district-wide *moderately can do* median for self-efficacy comes from Woolfolk-Hoy and Burke-Spero (2005) who argued that there was no influence on self-efficacy beliefs when teachers assessed their success against that of their colleagues, and this was likely due to the lack of observation opportunities. While CS3 participants reported on collaboration supporting vicarious experiences, the teachers in CS1 and CS2 provided no examples of how collaboration either supported or undermined their vicarious experiences contributing to their self-efficacy beliefs. For the teachers in CS1, although they discussed planning CT collaboratively, they did not specify how they learned from each other during planning sessions. The teachers in CS1 also commented how they discussed CT planning but did not provide examples of when they had observed another teacher modelling CT planning. Likewise, teachers in CS2, who predominantly planned individually, had limited opportunities to observe their colleagues' CT planning.

Only participants in CS3 reported how collaboration supported verbal persuasion and contributed to their self-efficacy beliefs when planning CT. Most of the participants (n = 10) viewed discussing CT concepts and activities, coupled with sharing CT resources between colleagues as helpful for their self-efficacy when planning CT instruction. Two teachers in CS3 also noted that not having the opportunity to collaborate and discuss CT together might lessen the likelihood of planning CT lessons.

Collaboration and physiological states may have also contributed to the school district-wide self-efficacy median for CS3. For example, one teacher commented how excited he was when collaborating with other teachers when planning CT, which increased his self-efficacy beliefs. Despite the teacher in CS3 commenting positively about his physiological state when collaborating with other teachers, there is less research about how physiological states support self-efficacy beliefs; rather, the focus is on how physiological states undermine self-efficacy beliefs (Gale et al. 2021). In comparison, the teachers from CS1 and CS2 did not discuss how teacher collaboration affected their physiological states. Although the teachers from CS1 often planned CT collaboratively, they may not have shared their positive or negative affective states. Conversely, participants in CS2 as individuals, and this may be a reason why they did not mention examples of either excitement or stress when planning CT with their colleagues.

Resources Supporting/Undermining Self-Efficacy Beliefs. While less influential than PD and collaboration, resources were supportive of building self-efficacy beliefs of participants across two cases (CS2 and CS3). There were three instances across the cases where the accumulation of evidence from participants showed how resources supported the sources of efficacy judgements (specifically enactive mastery, and vicarious experiences). Each instance represents a different source of efficacy judgement, per case, related to how resources contributed to their self-efficacy beliefs. Many participants in CS2 and CS3 ($n = 17$) noted that having resources readily available allowed them to practice using them and consider how to integrate resources into their CT planning thereby building their self-efficacy when planning CT lessons. This finding is consistent with previous research which found that teachers want practical, usable resources with CT integrated into elementary subjects which are either unplugged or plugged, and already available to them in their classrooms (Ketelhut et al., 2020).

Interestingly, even though CS1 had the highest school-wide self-efficacy median, the participants did not report resources as a contributing factor (either supporting or undermining) their enactive mastery judgements when planning CT. This may be because discussions of resources supporting experiences of success typically occurred during PD sessions, and thus were included within the PD section.

There were also instances where resources undermined sources of self-efficacy judgements. In particular, resources undermined vicarious experiences of some participants in CS2. A couple of participants ($n = 2$) described how they had tried to learn vicariously from the facilitator while they were using digital tools, however, they believed that learning how to plan CT activities using these tools was initially quite daunting. Observing digital tools being modelled undermined their vicarious experiences judgements which in turn undermined their self-efficacy beliefs when planning CT in future. In contrast, the participants in CS1 and CS3 did not mention resources as either supporting or undermining their sources of efficacy judgements. There were no mentioned examples where a colleague or facilitator had demonstrated CT using a specific resource for them to learn from. The examples discussed by CS1 and CS2 participants where the use of a resource had been modelled, were identified as part of PD. This is an important finding as there is less research available discussing how vicarious experiences can be strengthened specifically by learning from another when using particular resources. While previous research has investigated vicarious experiences strengthening self-efficacy beliefs when teachers observe a knowledgeable colleague effectively teaching a particular skill (Gunning & Mensah, 2011; Siwatu, 2011) alongside observing the task's manageability (Marschall, 2023), there is a gap in the research specifically addressing how resources can support vicarious experiences.

In addition, only participants in CS2 believed digital and non-digital resources undermined their physiological state when planning CT. For example, a couple of teachers (n = 2) in CS2 found some resources unapproachable and 'daunting'. This finding suggested that physiological states are dependent on the context of resource use. The fact that only two participants across the three cases identified resources as undermining physiological states aligns with other research. In particular, physiological states and self-efficacy have been researched previously but found to be rarely discussed as increasing self-efficacy beliefs (Gale et al., 2021). In other words, teachers tend to focus more on the negative feelings they may experience when planning for CT, which undermined their self-efficacy beliefs. The participants in CS1 and CS3 did not comment on how resources influenced their physiological state. While many participants (n = 10) understood the resources were available for them to use, they did not provide detail on how the resources contributed to their feelings of excitement or doubt when planning CT.

Leadership Supporting Self-Efficacy Beliefs. Leadership was supportive of two sources of efficacy judgements (verbal persuasion, and physiological states), but only for participants in CS3. For example, some teachers (n = 3) mentioned how the school leaders let the staff know they were pleased that CT activities were planned and going ahead, and the leaders also made teachers aware they were confident in their abilities and skills for CT teaching and learning. In addition, one coach participant had also completed the PD with the teachers in CS3 therefore contributing to the school district-wide median for self-efficacy. Because the coach had completed the PD alongside teaching colleagues, the coach was able to verbally support others when planning CT. In line with these results, findings from Versland and Erikson (2017) found that when leadership leads by example and completes PD with the teachers, the leaders experience the same complexities involved with learning a new skill, and in turn, can offer advice (verbal persuasion). In contrast, the participants from CS1 and CS2 did not provide examples of how school leaders either supported or undermined their self-efficacy beliefs via verbal persuasion/dissuasion. This may be because the school leaders did not participate in CT PD and therefore lacked an understanding of what was involved to confidently discuss CT planning with their teachers.

In addition, only a couple of teachers in CS3 (n = 2) believed leadership supported their physiological states when planning CT. For example, one teacher believed support from leadership made them feel less nervous when taking the time to plan CT. Knowing the leaders supported CT planning, the teacher appreciated knowing she could use that time, despite additional pressure to complete curriculum requirements for state testing. Furthermore, another teacher was assured her school leadership was positive about CT in class and reflected that they felt excited when leadership came and observed them planning CT activities. The excitement some teachers in CS3 felt when planning CT is distinctive from previous research (Gale et al., 2021; Palmer, 2011). Often physiological states are reported as negative feelings which is a reminder that when things are going according to plan, we tend not to explicitly reflect on them, as there is no immediate need to adapt (Bandura, 1989; Bruner, 1990). Conversely, the participants in CS1 and CS2 did not provide evidence how school leaders supported or undermined their physiological states when planning CT. A likely reason was that teachers perceived the school leaders as somewhat unaware of what CT planning entailed. As a result, teachers did not verbalise experiencing strong emotions, such as excitement or anxiety, when planning CT; they were able to complete their CT planning either collaboratively with colleagues or individually, as opposed to planning with school leaders.

Lack of Time Undermining Self-Efficacy Beliefs. A lack of time was the most influential undermining factor specifically for enactive mastery of the participants in all three cases. Many of the participants (n = 16) mentioned a lack of time as an undermining factor for enactive mastery judgements when planning CT. All participants in the three cases commented on how time pressure was a key factor undermining their perceived ability to plan CT, contributing to an undermining influence on their self-efficacy beliefs. Many of the participants in the cases believed that the curriculum was already very full, and the teachers in CS3 had additional testing pressure for mathematics and literacy and meant they had even less time to plan CT. It is not surprising that the teachers in the current study had time pressure when planning CT, as previous research has also shown that teachers have difficulties finding time to teach everything within their curriculum requirements and do not believe they could prioritise additional hours per week for CT on its own (Barr & Stephenson, 2011; Israel et al., 2015; Yadav et al., 2018).

The analysis of the three cases shows that participants were not statistically different from each other primarily due to their similar experiences with PD, which was the most influential factor for supporting self-efficacy beliefs across all cases. All cases highlighted how PD provided opportunities for enactive mastery by allowing participants to practice and refine their planning skills, which contributed positively to their self-efficacy. This consistent experience across cases is reflected in the lack of statistical differences.

Collaboration was another factor that uniformly supported self-efficacy beliefs in two cases. Collaborating with colleagues and sharing resources contributed to experiences of success. Even though CS2 did not report on collaboration, the absence of negative reports about collaboration in any case supported the overall similarity in their medians.

While resources were less influential compared to PD and collaboration, the influence of resources on supporting self-efficacy was similar in CS2 and CS3. Participants noted that having resources readily available supported their planning. The lack of evidence about how resources influenced participants in CS1 may be attributed to their focus on resources within PD sessions. In addition, CS1 were more supported by collaboration than resources, whereas the opposite was true for participants in CS2.

While leadership support was only reported in CS3, there was limited evidence for how it supported sources of efficacy judgements. This limited but positive impact in CS3, compared to the absence of similar reports in CS1 and CS2, did not create a major difference in the overall medians for each case.

Time constraints were an undermining factor across all cases, influencing participants' enactive mastery judgments. This shared challenge also helps to account for the lack of statistical differences among the cases; the vast majority of participants shared that their main challenge when planning CT was lack of time.

The relatively uniform support from the PD, along with the common challenges related to time, contributed to the lack of statistical differences observed among the cases.

7.2.3 Summary

The analysis of self-efficacy beliefs across the cases showed they were not statistically significantly different. Further analysis revealed that participants’ self-efficacy beliefs were shaped by various factors that either supported or undermined all four sources of efficacy judgements.

Cross-case analysis highlighted that the participants cited PD opportunities as the most influential support for sources of efficacy judgements. PD was notably effective in supporting self-efficacy by offering experiences of success, observing others, and learning vicariously from a facilitator or peers. These experiences contributed to participants' self-efficacy when planning CT. However, some PD experiences undermined self-efficacy by confusing participants or not aligning well with their specific teaching needs, which negatively influenced their perceived mastery when planning CT.

Collaboration was the second most influential factor supporting sources of self-efficacy judgements. Collaboration provided support for all sources of efficacy judgements where participants could practice CT planning and observe and discuss CT planning. However, when there were no opportunities to collaborate the influence was minimal due to individual planning and limited opportunities for peer interaction.

Resources were generally supportive of building self-efficacy by aiding in enactive mastery and, to some extent, vicarious experiences. Specifically, the resources enabled the participants to practice planning and teaching CT. Overall, while resources contributed positively to self-efficacy, their influence varied, with some challenges noted in specific contexts of efficacy judgements.

In addition, leadership played a supportive role in self-efficacy development for some participants by supporting verbal persuasion and physiological states. Specifically, participants benefited from positive reinforcement and participation from school leaders in PD which boosted excitement and reduced anxiety.

It was not surprising that a lack of time was a consistent undermining factor for enactive mastery across all three cases. Participants frequently cited time pressure as a significant barrier to effectively planning CT which undermined their enactive mastery experiences. Teachers in all cases were overwhelmed by an already full curriculum, with some participants experiencing additional pressure from testing requirements.

In sum, various factors influenced the sources of efficacy judgements across the cases, therefore supporting or undermining participants' self-efficacy beliefs. Cross-case analysis revealed that each case demonstrated how all four sources of efficacy—enactive mastery, vicarious experiences, verbal persuasion, and physiological states—were either supported or undermined by different factors, therefore shaping school-wide and school district-wide self-efficacy beliefs.

7.3 Teacher Efficacy Across the Cases

This section presents cross-case analysis and discussion of teachers' efficacy beliefs when teaching CT across the cases. Teacher efficacy beliefs are compared to highlight the commonalities and differences between the three cases. School leaders did not answer the teacher efficacy survey questions, so have not been included in this analysis and discussion.

7.3.1 Teacher Efficacy Scale Results

CS1 and CS3 shared similar group median scores for teacher efficacy beliefs, and CS2 had a lower group median (see Table 87). The IQR for each case ranged from 21 to 41. The IQRs illustrated that CS1 participants experienced the greatest variability in their teacher efficacy beliefs, CS2 had moderate variability, and CS3 had the least variability. This suggests differing levels of consistency in teacher efficacy beliefs across the cases.

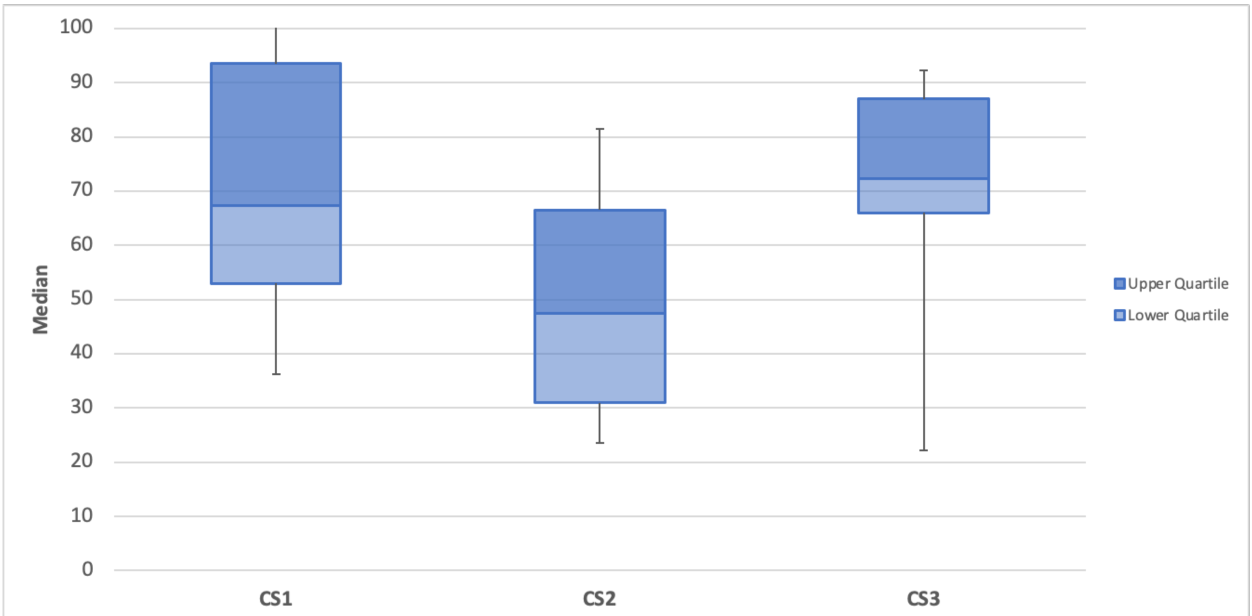
The overlapping nature of results in the box plot (see Figure 8) suggests a similarity between the cases. A subsequent analysis was performed via a Kruskal-Wallis test on the group median scores of the three cases. The differences between the medians of 67, *mostly can do* (CS1), 47, *moderately can do* (CS2), and 72, *mostly can do* (CS3) were not statistically significant, $H(2) = 1.880$, $p = .391$. This indicated that there was no statistically significant difference among the groups for teacher efficacy beliefs. In addition, a range of factors were identified as either supporting or undermining teacher efficacy beliefs across the cases. These are discussed next.

Table 87
Group Teacher Efficacy Medians and IQR per Case

Case	n	Median	IQR	Interpretation
CS1	6	67	41	Mostly can do
CS2	5	47	36	Moderately can do
CS3	10	72	21	Mostly can do

Figure 8

Teacher Efficacy Median by Case



7.3.2 Factors Contributing to Teacher Efficacy Across Cases

Five factors were perceived by participants as either supporting or undermining their teacher self-efficacy beliefs. To identify the most influential factors, an examination of the sources of efficacy judgements that either supported or undermined teacher efficacy beliefs was conducted. Analysis involved counting how often each factor was mentioned by participants during the interview. By summing up these, it was possible to determine which factors were cited most frequently as most or least influential for teacher efficacy beliefs. This approach offered a quantitative assessment of the relative significance of each factor in shaping teacher efficacy beliefs. Further analysis was also needed to assess their salience and significance in the context of the overall findings.

The analysis of the three cases shows that they were not statistically different from each other primarily due to their similarities in how resources were the most influential factor contributing to teacher efficacy. Resources highlighted accumulated evidence for two sources of efficacy judgements per case. Following this were collaboration, professional development (PD) and leadership. The most influential factor undermining teacher efficacy beliefs was a lack of time with accumulated evidence from participants citing how limited time undermined enactive mastery for teaching CT Table 88 presents which sources of efficacy judgements were either supported and/or undermined for each case.

Table ***88***

Sources of Teacher Efficacy Beliefs Either Supported (S) or Undermined (U) per Case

Factor	**CS1**				**CS2**				**CS3**				**Results per Case**			**Overall Results**
	EM	VE	VP	PS	EM	VE	VP	PS	EM	VE	VP	PS	CS1	CS2	CS3	All Cases
Professional Development	U	S			S								1S1U	1S		2S 1U
Resources	S/U			S/U	S	S			S		S		2S2U	2S	2S	6S 2U
Time	U				U				U				1U	1U	1U	3U
Collaboration	S								S			S	1S		2S	3S
Leadership									S			S			2S	2S

EM means enactive mastery or failure, VE is vicarious experiences, VP is verbal persuasion or dissuasion, and PS is physiological states
S supported, U undermined
Blue - CS1 Red – CS2 Green - CS3

Resources Supporting/Undermining Teacher Efficacy Beliefs. Resources were the most supportive factor for teacher efficacy beliefs of participants across all cases. The overall result of six instances reflects the accumulation of evidence from participants for how resources supported or undermined all four of the sources of efficacy judgements. Each instance represents a different source of efficacy judgement, per case, and was calculated as a cumulative measure how resources contributed to teacher efficacy beliefs. However, resources also undermined sources of efficacy judgements for some participants in CS1, particularly for enactive mastery and physiological states.

Having access to the necessary resources ensured that participants had opportunities for success. Many participants (n = 15) in all cases mentioned that they had all the resources they required to successfully teach CT. Furthermore, during the observations, most teachers from all three cases (n = 18) used appropriate resources when teaching CT. Not only had these teachers' created slides for the students to read, but also demonstrated enactive mastery with the resources available for the students to complete the task. There were also teachers in CS3 (n = 8) who knew they had support from the coaches, who were able to source the CT equipment for their classes as the school district was well resourced. However, a couple of teachers in CS1 (n = 2) believed they could be supported further with access to more physical resources (such as robotics). These teachers commented that they might need more equipment in future, and a lack of resourcing undermined their teacher efficacy beliefs. This finding is similar to Kale et al. (2018) who found that robotics kits were the least common resource available for teaching CT, with their study finding only 18% of the teachers reporting they had access to such kits. Although resources were cited as supportive for teaching CT, some teachers (n = 6) believed they were more capable teaching CT with non-digital resources compared to digital resources, which may help to explain the variation among teacher efficacy beliefs within each case. In terms of non-digital resources, some teachers in CS1 (n = 4) created their own materials, used them in class with students, and then shared these resources with colleagues. This suggested that those teachers had experiences of success because after using the resources with their own students, they were assured they had created supportive learning resources that could then be used by other teachers. While most participants in the cases were supported by resources, challenges remain. Previous research has shown that while there are plenty of resources available for teachers, they often have difficulty evaluating the quality of the resource, as well as encountering problems integrating the resource into their own classroom instruction (Pepin et al., 2017). Similarly, Kale et al. (2018) found that two-thirds (n= 54) of the teacher participants in their study reported limited skills for teaching CT and had difficulties understanding how to use appropriate tools to engage students in CT. These studies suggest that providing resources alone may not be sufficient; ongoing support and professional development are also important when using particular resources for effective CT implementation.

Resources also supported vicarious experiences contributing to teacher efficacy beliefs when teaching CT, but only for participants in CS2. The teachers in CS2 mentioned that observing others model how to use resources (both digital and non-digital) supported their teacher efficacy beliefs. A few teachers in CS2 (n = 3) had observed resources being demonstrated and were intrigued to delve deeper into effective methods for incorporating the resources into their teaching instruction. Learning vicariously by using the resources available to support teacher efficacy beliefs as noted in CS2, aligns with research by Mishra and Koehler (2006) who argued that teachers must understand the content, the technology they are using, and the pedagogy behind the content, technology, and students, to successfully teach with technology. In addition, although teachers in CS2 believed they could use the non-digital resources provided from the facilitator, they did not appear as efficacious when creating their own paper-based resources for teaching CT. Similarly, research from Marschall (2023), found that vicarious experiences went beyond teaching comparison by providing access to pedagogical knowledge in action in the form of pre-planned lessons. In Marschall's research, the pre-planned lessons provided vicarious experience support for novice teachers with limited classroom experience and appeared to support pedagogical knowledge development as opposed to content knowledge itself. It appeared that the teachers from CS2 were similar to those in previous research, in that, although they individually were efficacious in their teaching of CT, overall, as a case, they were not as efficacious – some teachers (n = 3) were only comfortable teaching using the lessons provided, and not comfortable creating their own CT teaching resources. In addition, there were no examples provided how using resources had either supported or undermined vicarious experiences for teachers' efficacy beliefs in CS1 and CS3. A likely reason was the teachers in CS1 and CS3 lacked CT modelling opportunities with resources. The teachers did not provide explicit details about when they had modelled CT resources to another teacher, and if they were not able to model to another teacher, they were unlikely to have CT resources modelled to them. Without CT resources modelled to the teachers, there were no vicarious learning experiences, either supportive or undermining.

In terms of resources supporting verbal persuasion judgements, only participants from CS3 (n = 5) provided examples where resources had been discussed. CS3 had the highest overall median for teacher efficacy, and although the teachers were from different schools, many (n = 8) were supported by sharing resources when they had the opportunity. Some teachers (n = 3) specifically mentioned they appreciated the communication between teachers via email after using a specific resource successfully. In contrast, the teachers from CS1 and CS2 did not discuss resources and the discussions around their use either persuading or dissuading them to teach CT. Despite this, a couple of teachers from CS2 (n = 2) noted that there was an implicit assumption among teachers that resources were readily available. As a result, they did not see the need to explicitly discuss CT resources with their colleagues, and assumed the teachers would find out about the resources themselves. The limited opportunities for teachers in CS1 and CS2 to discuss CT resources and receive feedback may have impacted how they believed these resources effectively supported CT teaching. According to Tschannen-Moran and McMaster (2009), feedback, as a form of verbal persuasion needs to be specific to be effective. Without sufficient discussion and targeted feedback on the use of resources, the teachers in CS1 and CS2 may not fully benefit from or effectively integrate these resources into their CT instruction, therefore undermining their teacher efficacy beliefs.

Resources also supported the physiological states of a few teachers in CS1 (n = 3). In particular, the availability of CT resources motivated and excited the teachers in CS1 and helped them feel more competent when practicing and teaching CT to their students. On the other hand, a couple of teachers in CS1 (n = 2) discussed how they felt they needed to upskill using resources, therefore undermining their physiological states. These teachers commented about feeling stressed learning the new digital resources required to teach CT, and these experiences influenced their teacher efficacy beliefs. The findings from teachers in CS1 are supported by previous research underlining how a person perceives their teacher efficacy when teaching, and it may not be affected by the physiological states they experience in class, but the meaning they attribute to those experiences (Bandura, 1989; Marschall & Watson, 2022; Morris et al., 2017). In this instance, the teachers in CS1 might have been less prepared in the classroom to teach CT, which caused them to feel worried; yet it was the overall attribution of stress that contributed to lower teacher efficacy beliefs.

Collaboration Supporting Teacher Efficacy Beliefs. While less influential than resources in supporting or undermining efficacy judgements, collaboration had three instances where it had supported efficacy judgements for participants (particularly for enactive mastery and physiological states). The three instances reflect the accumulation of evidence from participants about how collaboration supported the sources of efficacy judgements. Each instance represents a different source of efficacy judgement, per case, for how PD contributed to their teacher efficacy beliefs.

For example, some teachers in CS1 (n = 3) and CS3 (n = 3) identified how collaborating with other teachers supported their enactive mastery experiences, thus influencing the school-wide and school district-wide teacher efficacy beliefs. One teacher in CS1 explained how demonstrating to other teachers supported her own teacher efficacy beliefs. Similarly, another teacher in CS3 explained how she had modelled CT activities to other teachers, and this experience contributed to her high teacher efficacy beliefs. These findings from CS1 and CS3 align with research by Goddard et al. (2004) and Zhou (2019) who argued that staff can learn from direct mastery experiences with each other, where past success enhances teacher efficacy beliefs. On the other hand, some teachers in CS2 (n = 3) mentioned that they did not have sufficient opportunities to collaborate with other teachers, and therefore they needed to practice newly acquired CT teaching skills. Because of this restriction, the teachers from CS2 did not believe teacher collaboration either supported or undermined their enactive mastery when teaching CT, because they lacked collaborative opportunities to model CT teaching.

In addition, only one teacher from CS3 believed that collaborating with other teachers supported their physiological states when teaching CT and stated how they were motivated and excited when co-teaching CT in class. This may be a contributing factor as to why CS3 had the highest teacher efficacy median.

Professional Development Supporting/Undermining Teacher Efficacy Beliefs.

Professional development (PD) was recognised as supportive of teacher efficacy beliefs and had two instances across the cases of accumulated evidence from participants as support for enactive mastery (CS2) and vicarious experiences (CS1). PD also had a negative influence on some participants' enactive mastery in CS1. Therefore, it was less influential on teacher efficacy beliefs than the previous factors discussed.

PD provided enactive mastery experiences to prepare teachers for teaching CT in their classrooms which supported their teacher efficacy beliefs. For example, some teachers in CS2 (n = 3) believed that PD gave them hands-on experiences so they could practice the skills required to teach CT, therefore contributing to their school-wide *moderately can do* teacher efficacy median. In addition, when the teachers participated in PD, the enactive mastery experiences they had 'as students' led them to understand the instructional strategies required to teach CT. Other research supports this finding, for example, Bruce and Flynn (2013) found that teachers completing tasks as participants in PD encouraged them to carefully consider instructional strategies such as creating learning intentions, asking open-ended questions, and learning what success criteria were required for their own lessons. Furthermore, a couple of teachers in CS2 (n = 2) commented that completing higher level CT activities during PD (for example, learning how to use programming software) allowed them time to practice and understand the pedagogy required to teach CT using these tools. Similarly, in work by Rich et al. (2021), the authors found that PD can support teachers in learning how to teach programming and understand how to integrate programming into other areas of the curriculum via enactive mastery experiences. Moreover, Zhao et al. (2020) found a significant difference in teachers' efficacy beliefs for CT before and after PD. Their research showed that an online course improved teachers' abilities to integrate Scratch programming into their subject areas and provided valuable opportunities for teachers to learn and teach 'plugged' CT, thus enhancing their teacher efficacy beliefs.

On the other hand, there were also participants in CS1 who believed that PD undermined their enactive mastery for teaching CT because they did not continue the PD. For example, one teacher in CS1 was initially confident when learning CT with the facilitator because they had the time to practice the skills. However, the teacher reported they had not been able to continue developing their understanding of how to teach CT by creating their own resources and activities – leading to a lower sense of teacher efficacy. Other research has shown similar findings, in that teachers only reflected on their enactive mastery being supported by activities and lessons that the facilitators had provided during the PD, not through creating the content themselves (Ketelhut et al., 2020). Likewise, other research has shown that after PD, teachers had a significant improvement in their understanding of CT concepts, yet some participants demonstrated only surface CT understanding, and could not design lessons that meaningfully integrated CT concepts (Mouza et al., 2017). In sum, it is important to develop the skills and knowledge during and after PD to further develop teachers' teacher efficacy beliefs when teaching integrated CT lessons.

Although a couple of teachers in CS1 (n = 2) believed PD undermined their enactive mastery judgements, the analysis of their responses still resulted in a high school-wide median for teacher efficacy. This finding aligns with research by Gale et al., (2021) who found that teachers' negative enactive experiences were not indicative of lower teacher efficacy beliefs overall. Furthermore, research by Morris and Usher (2011) found that some teachers viewed failure as a learning experience that did not ultimately threaten their teacher efficacy beliefs. Similarly, findings from Tschannen-Moran et al. (1998) suggest that teacher efficacy can change through new challenges (for example, new curriculum, new grade level, new class setting) and this was the case for participants in CS1. While this was the situation for teachers in CS1 and CS2, the teachers in CS3 did not believe PD either supported or undermined their ability to successfully teach CT. A possible explanation is that CT was new to the teachers in CS3, and they were motivated and excited by the PD opportunity. Because CT was so new, the experiences during the PD helped them understand how to plan CT with their students and mainly provided evidence towards PD supporting efficacy judgements contributing to self, and collective efficacy beliefs.

Participants in CS1 (n = 6) also provided evidence how external PD from a facilitator, or internal PD learning from other teachers allowed opportunities to learn vicariously, and these experiences supported the school-wide teacher efficacy median. For example, when teaching CT to their students, a couple of CS1 teachers (n = 2) recalled the methods used by the PD facilitator. This recollection helped the teachers clarify CT concepts when teaching their own students. Additionally, CS1 teachers (n = 2) mentioned that after observing CT lessons demonstrated during PD, they recognised the need to be precise about certain CT concepts when teaching their students. This awareness of where additional clarification was needed helped improve their delivery of CT in the classroom. In this example, participants mentioned how the PD facilitator demonstrated CT teaching practices, which gave them as observers the chance to learn the skills and strategies needed. As a result, the teachers were more efficacious in their ability to teach CT themselves. According to Bandura (1997), when a task is modelled, it may reveal that the task is either more or less manageable than the observer initially expected, therefore altering their perception of task difficulty, and potentially changing their beliefs. In contrast, the teachers from CS2 and CS3 did not identify how PD either supported or undermined their vicarious experiences and influence their teacher efficacy beliefs. This is interesting to note, because the PD was primarily learning from a facilitator, but when the CS2 and CS3 teachers provided evidence of vicarious learning experiences, they commented that learning from others influenced their self-efficacy beliefs towards understanding and planning CT and vicarious learning did not contribute to their teacher efficacy beliefs.

Leadership Supporting Teacher Efficacy Beliefs. Leadership was another factor that supported participants' experiences of success when teaching CT. CS3 was the only case where participants explicitly discussed leadership as positively supporting their enactive mastery judgements for CT teaching. As CS3 was a school district as opposed to one school, leadership included school principals, assistant principals, coaches, and the school district superintendent. Participants in CS3 (n = 5) identified leadership as a supportive factor. The participants noted that their teacher efficacy beliefs increased when they received support from their school leaders, particularly during classroom observations. This support engaged the teacher participants in their experiences of success when teaching CT. Similarly, Versland and Erickson (2017), found that teachers were supported in implementing new content (and CT is new to many teachers) when principals provided feedback, monitored teaching practice, and gave encouragement and support. Furthermore, the teachers in CS3 believed that school leaders publicly gave them the 'green light' to learn and teach CT, and this support was reflected in their teacher efficacy beliefs about their own capability and capacity to plan and teach CT lessons. This also aligned with research by Versland and Erickson (2017), who found that when teachers believe school leaders share leadership roles, develop capacity, and publicly acknowledge strengths of the staff, efficacy increased.

Conversely, the teachers from CS1 and CS2 did not believe that leadership either supported or undermined their enactive mastery experiences when teaching CT. The teachers from CS1 (n = 6) believed that they garnered enough support from other teaching colleagues, and did not mention how leadership had specifically supported or undermined their efficacy beliefs for teaching CT. In addition, a few teachers in CS2 (n = 2) believed that the value of leadership support occurred at the beginning stages of CT awareness and commented that they were trusted to complete their CT teaching and learning on their own. These teachers believed they did not require the school leaders to observe them as a support for their experiences of successful CT teaching.

Lack of Time Undermining Teacher Efficacy Beliefs. The main factor undermining teachers' enactive mastery for teaching CT was a perceived lack of time, therefore influencing teacher efficacy beliefs. Participants from all the cases (n = 8) discussed a lack of time, in particular, a sense of insufficient time to both learn how to teach CT and less available class time to ensure they were teaching CT in a valuable way for students. This finding is supported by Rich et al. (2021) who found that unless teachers have time in their teaching schedule to teach CT, they are less likely to develop the efficacy needed to teach it successfully. Furthermore, the teachers in the Rich et al. (2021) study discussed how time needed to be allocated from school leaders who valued CT practices, provided the resources, and allowed teachers time to learn and teach CT, for them to feel confident in their teaching. When time was allocated to teachers, Rich et al. (2021) found an increase in the frequency of CT instruction in classrooms, specifically when teaching programming.

The analysis of teacher efficacy beliefs across the cases between the medians of 67, *mostly can do* (CS1), 47, *moderately can do* (CS2), and 72, *mostly can do* (CS3) were not statistically significantly different. This consistency is largely due to the shared supporting influence of resources, and the undermining influence of time constraints on teacher efficacy across the cases. The other factors played less of an influential role in either supporting or undermining the participants sources of efficacy judgements, and therefore influencing teacher efficacy beliefs.

Resources were identified as the most supportive factor for sources of efficacy judgements contributing to teacher efficacy in all cases. The majority of teachers noted that having access to necessary resources generally facilitated their teaching of CT. However, there were variations within cases, where some teachers believed they were under-resourced compared to their counterparts in other cases. Despite these variations, the overall influence of resources on teacher efficacy judgements was consistent across the cases.

A lack of time was a common challenge across all cases, affecting teachers' ability to fully engage with CT instruction, and explains the lack of significant difference across case medians. The consistency of limited time across cases points to a widespread need for better time management and scheduling to effectively support CT instruction.

The lack of statistically significant differences between medians can be explained by how each case was supported by resources, and a lack of time undermined teacher efficacy in each case. While individual experiences varied, the overarching factors influencing teacher efficacy remained similar across diverse settings.

7.3.3 Summary

The analysis of teacher efficacy beliefs across the cases showed they were not statistically significantly different. Further analysis showed that the participants in the three cases provided evidence for all four sources of efficacy judgements being either supported or undermined by a variety of factors, which contributed to their teacher efficacy beliefs. The evidence revealed both similarities and differences in how teacher efficacy beliefs were supported by various factors across CS1, CS2, and CS3.

A common thread among all three cases was the positive influence of resources, which were frequently used to support teaching CT and contributed to teacher efficacy beliefs. However, despite this shared reliance on resources, there were notable differences. For instance, some faced challenges due to a lack of specific resources which negatively influenced their teacher efficacy beliefs.

Collaboration also emerged as a factor influencing teacher efficacy in distinct ways across the cases. While collaboration supported enactive mastery, as teachers shared successful teaching strategies and modelled CT activities, some teachers also reported limited opportunities to work with others and practice new skills. While collaboration was beneficial in some contexts, its effectiveness in supporting teacher efficacy varied depending on the extent and nature of collaborative interactions within each case.

Leadership support was a less influential factor enhancing teacher efficacy beliefs. While encouragement and direct observation from school leaders supported teachers' efficacy, some participants relied more on peer support. This variation underscored that while strong leadership could influence teacher efficacy, its effect often depended on the specific context and support structures in place.

Professional development had a mixed influence on teacher efficacy beliefs. While PD was mostly beneficial, providing teachers with hands-on experience and a deeper understanding of teaching, PD also undermined efficacy when there was a lack of ongoing support. The varying influence of PD demonstrated that while it could support teacher efficacy, its influence depended on the opportunities to practice CT teaching alongside continued support.

A lack of time was the most influential factor undermining teacher efficacy across all cases. Teachers reported that insufficient time was a significant barrier to effectively teaching CT, influencing their ability to both prepare and deliver high-quality CT instruction. Despite variations in other supporting factors, the pervasive challenge of time limitations underscored a universal issue that affects teachers' perceived effectiveness and their ability to engage fully when planning and teaching CT.

7.4 Collective Efficacy Across the Cases

This section presents cross-case analysis and discussion of teachers' and school leaders/coaches collective efficacy beliefs efficacy beliefs when planning and teaching CT across the cases. Furthermore, collective efficacy beliefs are compared to highlight the commonalities and differences between the three cases.

7.4.1 Collective Efficacy Scale Results

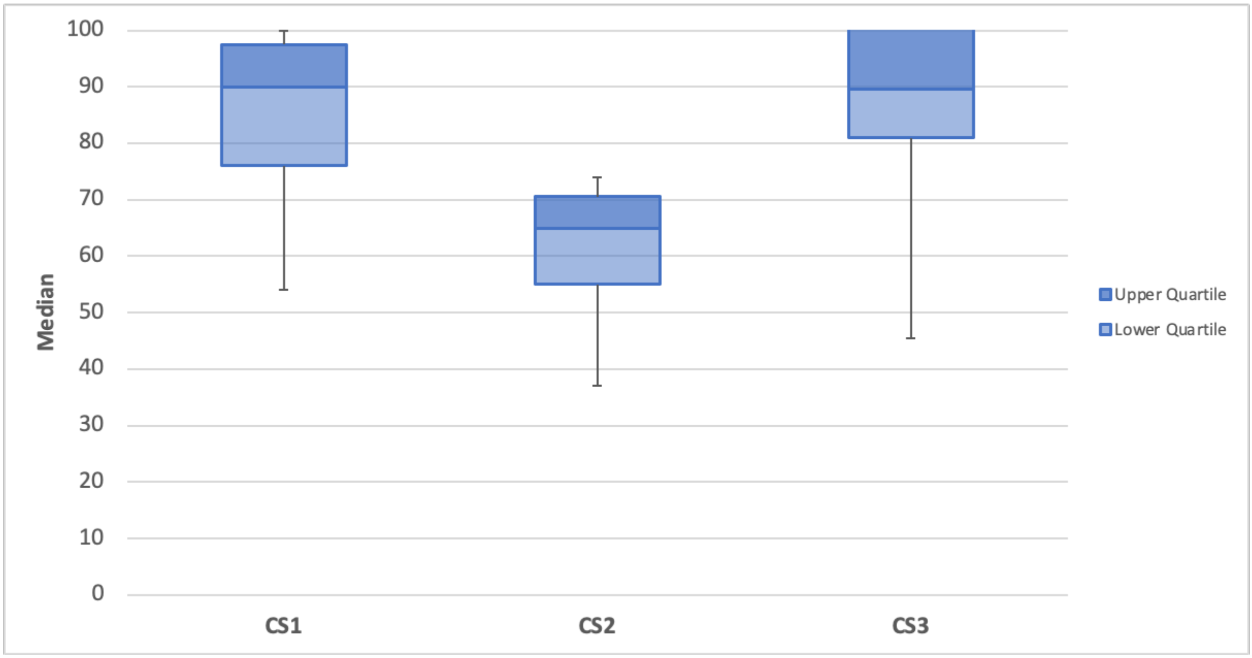
CS1 and CS3 shared similar medians for collective efficacy beliefs, and CS2 had a lower median (see Table 89). The IQR between the three cases ranged from 16 to 22 which indicated there was moderate variation between all participants' medians for collective efficacy when planning and teaching CT. The data was analysed first using box plots, then a Kruskal-Wallis test was performed using the medians from each case. The lack of overlap in the box plots (see Figure 9) suggests differences between CS2 and the other two cases. The differences between the medians of 90, *totally confident* (CS1), 65, *mostly confident* (CS2) and 89, *totally confident* (CS3) were statistically significant, H (2) = 7.243, p = .027. Further exploration of the findings identified a range of factors involved in either supporting or undermining sources of efficacy judgements for collective efficacy beliefs. These factors will be discussed to further understand the statistically significant difference between CS2 and the other cases.

Table 89
Group Collective Efficacy Medians and IQR per case

Case	**n**	**Median**	**IQR**	**Interpretation**
CS1	8	90	22	Totally confident
CS2	6	65	16	Mostly confident
CS3	12	89	20	Totally confident

Figure 9

Collective Efficacy Median by Case



7.4.2 Factors Contributing to Collective Efficacy across Cases

Across all efficacy measures, five factors either supported or undermined the sources of efficacy judgements for the collective efficacy beliefs of participants from the three cases and contributed to the significant difference identified above (see Table 90). To determine which factors were most influential, this section analysed the sources of efficacy judgements that either supported or undermined collective efficacy beliefs. This analysis was based on frequency counts of how many participants reported each factor and offered a quantitative assessment of the relative significance of each factor in shaping teacher efficacy beliefs. Further analysis was also needed to assess the factor's salience and significance in the context of the overall findings.

The most influential factor that contributed to sources of efficacy judgements contributing to collective efficacy was professional development. Following this was collaboration, resources, and leadership. A lack of time was a factor which undermined collective efficacy beliefs. All factors either supported or undermined sources of efficacy judgements of the participants in each case, therefore contributing to the statistically significant difference in collective efficacy beliefs between the cases. A possible reason for the statistically significant difference between CS2 (*mostly confident*) and CS1, and CS3 (both *totally confident*) is that CS2 participants identified four factors which undermined their sources of efficacy judgements. Conversely, participants in CS1 and CS3 identified one factor which undermined their source of efficacy judgements. Consequently, the greater number of undermining factors in CS2 had a more significant influence on collective efficacy beliefs, leading to a lower overall median for collective efficacy compared to the other cases.

Table 90

Sources of Collective Efficacy Beliefs Either Supported (S) or Undermined (U) per Case

Factor	**CS1**				**CS2**				**CS3**				**Results per Case**			**Overall Results**
	EM	VE	VP	PS	EM	VE	VP	PS	EM	VE	VP	PS	CS1	CS2	CS3	All Cases
Professional Development	S	S	U		S/U		S/U						2S 1U	2S 2U		6S 3U
Resources					S/U				S					1S 1U	1S	2S 1U
Time					U									1U		1U
Collaboration	S	S					S						2S	1S		3S
Leadership									U		S				1S 1U	1S 1U

EM means enactive mastery or failure, VE is vicarious experiences, VP is verbal persuasion or dissuasion, and PS is physiological states

S supported, U undermined

Blue - CS1 Red - CS2 Green - CS3

Professional Development Supporting/Undermining Collective Efficacy Beliefs. Professional development (PD) was the most influential factor for CS1 and CS2 participants' sources of efficacy judgements (enactive mastery, vicarious experiences, and verbal persuasion), contributing to school-wide collective efficacy beliefs. Overall, there were six instances across the cases where participants had provided accumulated evidence within each source of efficacy judgement. With regards to how PD supported efficacy judgements, some participants in CS1 (n = 4) and CS2 (n = 3) believed that PD provided the opportunity for enactive mastery experiences. The participants highlighted that PD allowed opportunities for the group to learn, practice, and plan for CT, contributing to the school-wide collective efficacy medians (CS1, *totally confident,* CS2, *mostly confident*). Furthermore, participants in CS1 (n = 4) mentioned that the school had committed to ensuring CT was a priority in their school, via ongoing professional development. Ongoing support meant the group had time to learn and practice CT concepts and skills, thus providing enactive mastery experiences. Similarly, the school leaders from CS1 (n = 2) witnessed ongoing internal PD as a support system for the teachers when planning and teaching CT. By observing the teachers during internal PD, the school leaders were assured that the teachers understood CT and were teaching it well. In addition, in CS1, collaborative planning as a form of internal PD was a factor that supported the teachers' collective efficacy beliefs. Some CS1 teachers (n = 4) identified how these sessions ensured the group understood they all had the opportunity to experience success planning and teaching the CT skills and concepts their students required. These findings align with the research conducted by Loughland and Nguyen (2020), which demonstrated that mastery experiences contributed to collective efficacy beliefs. Their study found that when teachers observed their colleagues successfully practicing a skill, it led them to believe that their peers would also be capable of performing that skill in the future. Conversely, during internal PD sessions, some teachers in CS2 (n = 2) realised that their colleagues had misunderstandings about CT (i.e., potential failure experiences). This led the participants to contemplate whether their group were effectively planning and teaching CT (if at all), thus undermining their experiences of success for the group, contributing to the school-wide *mostly confident* collective efficacy median. According to Bandura, (1986) within a school context, mastery is seen through faculty experience which could enhance and sustain collective efficacy beliefs of the staff. For CS2, the group experience influenced and shaped collective efficacy, as teachers' expectations were significantly influenced by the shared challenges they encountered. Despite having *totally confident* collective efficacy beliefs, the participants in CS3 did not mention PD as either a supportive or undermining factor for their enactive mastery when planning and teaching CT. A reason behind this may be that they had less time for PD, resulting in less opportunities to observe and understand how the group was planning and teaching CT. Another explanation might be that the teachers in CS3 were predominately from different schools; they did not have internal PD sessions together, or as many opportunities to share and recognise planning and teaching CT success from their group.

Only participants from CS1 discussed how PD provided opportunities for others to learn vicariously from a facilitator/colleague, and this experience contributed to the case's *totally confident* collective efficacy beliefs. For example, some participants in CS1 (n = 3) believed that conducting internal PD with their group was a way to provide vicarious learning experiences for others. The teachers leading internal PD knew their group had used the lessons/knowledge to teach CT in their own classes and this understanding increased their own collective efficacy beliefs. Comparatively, previous research found that collective efficacy can be bolstered when teachers observe effective skills and strategies from others and equate those learning experiences to their own performance, and the performance of their colleagues (de Carvalho et al., 2023). In addition, Bruce and Flynn (2013) found that peer observation of challenging instructional strategies and teachers achieving success, contributed to the overall collective efficacy beliefs of the teachers. While CS1 participants were supported by PD providing vicarious learning experiences, the participants from CS2 and CS3 did not discuss how PD provided vicarious experiences. In both cases, it appeared that the teachers had less opportunities to learn from each other, which meant that they were less aware of the confidence level of their group when planning and teaching CT.

Participants in CS1 and CS2 also described how PD opportunities and discussions as a group were a supportive or undermining source of collective efficacy judgements. For example, in CS2, there was evidence how verbal persuasion during and after PD positively influenced how teachers were planning and teaching CT. Some participants in CS2 (n = 3) reported having discussed CT with the group and were reassured that everyone was interested to start and were open-minded toward CT. However, the participants did not explicitly reflect on their efficacy in the group's ability to apply CT learning with their students after those discussions. This suggested that although the participants in CS2 had talked about CT and the discussion had supported their collective efficacy beliefs, they did not know whether members of their group had gone on to plan or teach CT, which in turn lowered collective efficacy beliefs. Similarly, there were participants in CS1 (n = 2) who believed that PD was a factor that undermined collective efficacy beliefs due to verbal dissuasion. One teacher explained that while the school had completed the PD, there was no further formal discussion around it. A potential reason for this finding is that participants in CS1 may have missed the opportunity to discuss CT teaching and learning, possibly due to their absence from meetings where these discussions took place. In addition, another participant from CS1 believed that the size of the school might hinder positive discussions of PD, thus impacting group collective efficacy beliefs. Because the school had a small staff, the participant questioned whether negative comments about planning and teaching CT by one staff member might discourage the group from engaging with CT. While participants from CS1 and CS2 had varied views on how PD influenced verbal persuasion, those from CS3 did not report any influence of PD on verbal persuasion/dissuasion contributing to their collective efficacy beliefs. This was likely because the participants were mostly from individual schools and lacked the opportunity to discuss CT planning and teaching with a wider audience of educators. Without the opportunity to discuss CT, the participants in CS3 could not explicitly say whether their group were planning and teaching CT. In addition, with a lack of observation opportunities and follow up discussion, it appeared that verbal persuasion as a source of collective efficacy beliefs was difficult to analyse without enactive mastery. These findings are consistent with Morris and Usher (2011), who found that enactive mastery experiences and verbal persuasion are closely linked. They noted that while teachers often gauge their own efficacy based on the verbal encouragement of others, this is connected more to individual efficacy beliefs. There is limited evidence supporting verbal persuasion as a sole source of collective efficacy beliefs (Loughland & Nguyen, 2020).

Collaboration Supporting Collective Efficacy Beliefs. The second most influential factor for collective efficacy beliefs was collaboration. Participants across the cases provided evidence which accumulated into three supportive influences for sources of efficacy judgements particularly for enactive mastery, vicarious experiences, and verbal persuasion. For example, opportunities to collaborate supported participants' in CS1 understanding their groups' ability and confidence when planning and teaching CT, contributing to the school-wide *totally confident* collective efficacy beliefs. Collaboration is viewed as joint activities with a common purpose, involving dialogue, inquiry, and mutual support when addressing challenging professional issues (Robutti et al., 2016). With this in mind, some participants from CS1 (n = 4) witnessed others' efficacy towards CT, and this gave them the belief their group was capable of planning and teaching it. Similarly, Carvalho et al. (2023) found that teachers gained individual and collective expertise through collaboration on the content. The authors argued that through collaborative creation of content, the teachers had to reason, challenge, and confirm their understanding as a team. Furthermore, discussing content collaboratively could enhance mutual understanding and increase the understanding of others' content knowledge.

Collaboration also supported vicarious experiences for participants in CS1. For example, the school leaders (n = 2) believed that working collaboratively enabled the teachers to vicariously experience the learning involved in planning and teaching CT. Furthermore, the teachers in CS1 (n = 4) who were confident and capable planning and teaching CT were able to highlight their understanding when working in teams, and were confident that their group was well supported, thereby strengthening school-wide *totally confident* collective efficacy beliefs. The teachers in CS1 believed their group understood CT and considered their insights were worth learning. This aligns with findings from de Carvalho et al. (2023) who indicated that when teachers collaboratively design lessons, they engage in deeper discussions about content and pedagogy, thereby enhancing each other's knowledge and understanding. Moreover, alongside other credible teachers who modelled, guided, and challenged colleagues, knowledge and practice was supported, resulting in an increase of collective efficacy (de Carvalho et al. 2023). Conversely, teacher collaboration was not a factor that either supported or undermined vicarious experiences of the participants in both CS2 and CS3. Once more, this was likely due to the lack of collaborative planning opportunities where CS2 participants primary planned individually. If participants did not have the opportunity to collaborate, they were unlikely to witness their group planning and teaching CT, which led to a lower collective efficacy median for CS2.

A couple of participants in CS2 (n = 2) also identified collaboration as a support for verbal persuasion which contributed to their *mostly confident* collective efficacy beliefs. The participants discussed CT with the group which served as a way for them to 'give back' to other teachers who had supported them in various curriculum areas in the past. By sharing knowledge and collaborating on CT planning and teaching, the participants believed those teachers would then be capable to implement CT. In support of CS2 participant findings, prior work has shown evidence that verbal persuasion during workshops and on-site team meetings may encourage engagement in quality collaborative and reflective activities that support new instructional practice (Darling-Hammond et al., 2017). In addition, Goddard et al. (2015) and Goddard and Kim, (2018) argued that social interactions allow teachers opportunity to work together towards aligned goals and acquire ideas about the entire group potential. In contrast, participants from CS1 and CS3 (both *totally confident*) did not provide evidence on how teacher collaboration either supported or undermined verbal persuasion. For CS1 participants, this was likely because when discussing teacher collaboration, the participants reflected on how verbal persuasion/dissuasion related to their own practice, and did not discuss their beliefs about how this related to their group planning and teaching CT. While participants in CS1 believed that collaboration supported self-efficacy as opposed to collective efficacy, CS3 participants believed collaboration supported their self, and teacher efficacy beliefs, as opposed to collective efficacy beliefs.

Resources supporting/undermining collective efficacy beliefs. Resources were less influential than PD or collaboration in supporting or undermining sources of efficacy judgements contributing to collective efficacy beliefs.

For participants in CS2 and CS3, resources supported their enactive mastery judgements. However, for CS2 specifically, resources also undermined enactive mastery. Despite having the lowest group median for collective efficacy beliefs (*mostly confident*) some participants in CS2 (n = 4) believed there were enough resources available and assumed that others in their group also had access to those resources in their school to practice CT planning and teaching. Similarly, participants in CS3 (n = 6) reflected on their beliefs that because their group had access to particular resources, they were capable of planning and teaching CT. However, other participants in CS2 (n = 2) considered the possibility that their group may not have enough access to CT resources, therefore limiting their ability to master planning and teaching of CT. This in turn lowered the school-wide collective efficacy beliefs of how their group were effectively planning and teaching CT. No participants from CS1 (*totally confident*) detailed how resource availability supported or undermined their understanding of their colleague's enactive mastery for planning and teaching CT.

Leadership Supporting/Undermining Collective Efficacy Beliefs. For participants in CS3, leadership had instances of supporting efficacy judgements (verbal persuasion) and one instance where it had undermined efficacy judgements (enactive mastery) contributing to collective efficacy beliefs.

Leadership undermined experiences of success contributing to the school district-wide collective efficacy beliefs. For example, a couple of teachers in CS3 (n = 2) did not believe other teachers were as supported by leadership to master planning and teaching CT. They wondered if other teachers were actually supported by leadership, or if anyone in their schools were even aware of CT, thus decreasing their collective efficacy beliefs. Conversely, the participants in CS1 and CS2 did not explicitly describe how the school leaders either supported or undermined their enactive mastery. Participants in both CS1 and CS2 did not mention that the principal/school leaders had observed the group planning and teaching CT. Despite participants in CS1 having *totally confident* collective efficacy beliefs, the participants did not provide evidence that school leaders were an influential factor contributing to this median. In addition, CS2 participants did not provide evidence of planning or teaching examples when the school leader had observed or supported the group. This in turn, perhaps led them to believe the school leader may not have as deep an understanding or interest in CT, which aligned with their significantly different collective efficacy belief median (*mostly confident*). The current findings reiterate prior research that has shown inconsistency in the relationship between principal leadership and teacher collective efficacy beliefs (Meyer et al., 2022). Some studies, such as Çalik et al. (2012) and Zheng et al. (2017), found statistically significant relationships in leadership supporting collective efficacy, while others, like Fancera and Bliss (2011), did not observe a connection between principal leadership support and teacher collective efficacy. The findings from this study, along with previous research, highlight the nuanced role of leadership in supporting collective efficacy beliefs.

While leadership undermined enactive mastery for participants in CS3, it positively supported verbal persuasion judgements for the same group. An example was when participants (n = 3) had supportive CT discussions with their own school principal gave them the impression that the principal was readily available for other members of the group as well. This finding was consistent with other research that found when a school leader discusses a challenge in a calm and optimistic manner it is more likely to positively influence teacher's confidence in their ability to work together to solve a problem (Goddard et al., 2021). Similarly, the perceptions from the teachers on how their leadership used verbal persuasion, created an environment that encouraged the team to persevere and overcome challenges when teaching CT (Goddard et al., 2004). Conversely, participants in CS1 and CS2 did not explicitly address how leadership either supported or undermined verbal efficacy judgments, which likely influenced their collective efficacy beliefs. For CS1, this was possibly because the teachers only discussed their collective efficacy beliefs in relation to their teaching colleagues, and not the school leadership. Participants in CS2 also did not comment on leadership supporting the collective efficacy beliefs via verbal persuasion. The likely explanation is because the teachers were independent in their planning and teaching of CT; they did not refer to specific incidents where school leaders had modelled or promoted CT planning and teaching, and therefore did not know whether their group was persuaded or dissuaded to plan and teach CT, thus resulting in a lower collective efficacy median. Similarly, research by Goddard et al. (2004) argued that when verbal persuasion is used alongside past models of success and positive experiences, it may increase the collective efficacy beliefs of a school staff. This may look like external encouragement from leadership when the school has adapted to changes in the past, but if this does not occur, collective efficacy beliefs remain unchanged. Through discussions in staff meetings, workshops, and casual talks in the staffroom, verbal persuasion may not increase organisational change on its own, but combined with positive vicarious experiences, verbal persuasion can be a powerful influence on a school's collective efficacy beliefs (Zhou, 2019). Overall, however, other research related to how verbal persuasion from leadership contributes to collective efficacy beliefs is somewhat lacking.

Lack of time undermining collective efficacy beliefs. A lack of time was a factor which undermined the enactive mastery for CS2 participants, therefore influencing their *mostly confident* collective efficacy beliefs. CS2 participants (n = 4) mentioned that a lack of time might influence the group's planning and teaching of CT. While they believed that the group's CT planning and teaching might be influenced by insufficient time, the participants still believed CT would be taught, but perhaps not as often as it could be. The CS2 participants also provided evidence about their students being out of class more often for other tasks, which meant the participants understood the group had less class time with their core group of students. Students out of class resulted in the group knowing there was less time to teach CT, and this evidence aligned with the significantly different collective efficacy median for CS2. In contrast, no participants from CS1 or CS3 explicitly discussed how time either supported or undermined their group's sources of efficacy judgements therefore contributing to collectively efficacy beliefs. A possible reason is that participants in CS1 and CS3 were teaching in a school where the students were younger than those in CS2. There was no evidence provided from participants in these cases that the younger students were likely to have time out of class for other activities. In addition, for participants in CS1 and CS3, a lack of time was often discussed as an undermining factor for self, and teacher efficacy beliefs, and the participants did not mention how they perceived a lack of time as influential on their group as a whole.

There was no evidence for any of the factors either supporting or undermining the case participants' physiological states contributing to the school-wide and school district-wide collective efficacy beliefs. This finding aligns with research by Loughland and Nguyen, (2020) who found limited evidence of physiological states negatively impacting teachers during PD sessions in particular, therefore influencing their sense of collective efficacy. Overall, it appears there is a significant lack of research focused on factors supporting or undermining physiological states of teachers, especially when planning and teaching CT.

The differences between the medians of 90, *totally confident* (CS1), 65, *mostly confident* (CS2) and 89, *totally confident* (CS3) were statistically significant. The difference between CS2 and the other cases (CS1 and CS3) for collective efficacy beliefs can be attributed to how participants in each case experienced the factors influencing the sources of efficacy judgements. The main difference between the cases, was that the participants in CS2 identified four sources of efficacy judgements across three factors that undermined their collective efficacy beliefs, while CS1 and CS3 each identified only one factor undermining one source of efficacy judgement. This difference indicated that CS2 faced more significant challenges that influenced their collective efficacy. Some teachers in CS2 found that PD sessions undermined enactive mastery because it revealed misunderstandings about CT understanding among their group. In turn, this led to participants having doubts about the group's ability to effectively plan and teach CT. Furthermore, while some participants in CS2 were reassured by discussions about CT during PD, and believed that the group seemed interested and open-minded, after the discussions some participants were not clear and believed some of their group members were dissuaded. As a result, from these discussions, some CS2 participants did not have confidence that their group could plan or teach CT in future. Both undermining experiences with PD resulted in a lower school-wide collective efficacy median.

Another undermining factor for CS2 was resources. Although resources were cited as available for some participants in CS2,the majority of participants in CS2 believed there was a shortage, which undermined their belief in the group's ability to experience success when planning and teaching CT. In contrast, CS1 and CS3 did not report issues with resources, therefore supporting their higher collective efficacy medians.

Time constraints were also identified by CS2 participants as a factor that undermined their sources of efficacy judgements, thus undermining their collective efficacy beliefs. The participants in CS2 cited limited time for planning and teaching CT, coupled with students being out of class for other tasks, as a likely undermining influence on their group's planning and teaching of CT, further diminishing their collective efficacy.

In contrast, participants in CS1 and CS3 experienced fewer undermining factors. In CS1, despite participants experiencing a lack of ongoing support after initial PD and believing the small size of the school might influence the group, the participants maintained *totally confident school-wide* collective efficacy beliefs. Even with PD as an undermining factor, it was less influential than for CS2. This was likely due to the overall strong influence of PD and the collaborative environment for participants in CS1 that reinforced their confidence in the group when planning and teaching CT.

In CS3, despite the perception that leadership was an undermining factor, specifically that some participants believed some of the group members were not sufficiently supported by school leaders, this did not significantly influence the school-district wide *totally confident* collective efficacy median. School leadership having less undermining influence was likely due to other positive influences, such as verbal encouragement from leadership, and many participants also cited how leaders had discussed available resources as supportive.

7.4.3 Summary

The differences between the medians of the three case studies were statistically significant. The differences in collective efficacy beliefs between CS1, CS2, and CS3, were primarily influenced by PD shaping participants' efficacy judgements. For participants in CS1 and CS2, PD provided structured opportunities for learning, practicing, and planning CT, which resulted in a boost to participants' beliefs in the group's capability when planning and teaching CT. PD also facilitated vicarious learning, where teachers observed peers or facilitators effectively teaching CT, which enhanced their confidence in the group's overall capability. However, the impact of PD varied across different contexts, with some participants in CS1 and several more participants in CS2 experiencing undermining influences based on their interactions and observations during PD sessions.

While less influential than PD, collaboration emerged as a factor which supported sources of efficacy judgements. It provided participants in CS1 and CS2 with opportunities to understand and assess their group's capabilities, which developed a shared sense of competence. Collaborative activities allowed participants to engage in joint planning and problem-solving, which reinforced their collective belief in their ability to teach CT effectively. Despite its benefits, the role of collaboration in supporting collective efficacy was less pronounced in some settings due (CS2) to limited opportunities for joint work.

Resources played a more limited role compared to PD and collaboration. While resources supported enactive mastery by enabling teachers to practice CT, their influence was not as pronounced. In some cases, inadequate resources were perceived as a barrier to effective CT teaching, negatively influencing sources of efficacy judgements (CS2), and therefore collective efficacy beliefs.

Leadership influence on collective efficacy was mixed for one case (CS3). It positively affected verbal persuasion by providing encouragement and support but had less influence on enactive mastery. In some instances, leadership was seen as a supportive force, while in others, leadership absence or perceived lack of engagement with CT (CS2) contributed to diminished collective efficacy beliefs.

A lack of time was identified as a factor that undermined collective efficacy for one case (CS2) Participants noted that insufficient time for planning and teaching CT, coupled with students being frequently out of class, limited their ability to effectively implement CT instruction, thus impacting their collective efficacy beliefs. For participants in CS1 and CS3, there was no evidence provided as to how a lack of time influenced their collective efficacy beliefs.

Overall, while PD and collaboration were most influential in supporting the sources of efficacy judgements for collective efficacy, resources, leadership, and time played more variable roles.

7.5 Chapter summary

The three cases shared similar medians for self-efficacy beliefs. The differences among these medians were not statistically significant. Five factors were identified across the cases as either supporting or undermining the sources of self-efficacy beliefs of participants. There were two key reasons as to why there were no statistically significant differences between the cases' self-efficacy medians. The participants were similar in their self-efficacy beliefs because the majority believed the main influence was PD and a lack of time to plan and teach CT. The participants in the three cases had all completed PD about how to plan and teach CT. This resulted in the majority of participants being supported in their sources of self-efficacy judgements, particularly having experiences of success and learning from a facilitator. Another reason was that most of the participants in the cases reported a lack of time as an undermining factor, particularly for enactive mastery, thus influencing their self-efficacy beliefs.

The three cases also shared similar medians for teacher efficacy beliefs. The medians did not show statistically significant differences. Further analysis revealed that participants' self-efficacy beliefs were shaped by various factors that either supported or undermined all four sources of efficacy judgments. Across all cases, access to resources consistently supported teacher efficacy. Teachers generally believed that having the necessary resources facilitated their teaching of CT. Despite these variations, the positive impact of resources was a common thread. The most significant factor undermining teacher efficacy across all cases was a lack of time. Teachers consistently reported that insufficient time was a major barrier to effective CT instruction, influencing their efficacy beliefs when preparing and delivering CT lessons. In sum, the consistent influence of resources and the challenge of time constraints were key factors in explaining the similar efficacy medians across the cases. These overarching factors influencing teacher efficacy remained consistent, despite differences in individual circumstances.

For collective efficacy, the differences between the cases were statistically significant. These differences were primarily influenced by the role of PD in shaping participants' efficacy judgments. In addition, the differences between CS2 and the other cases can be attributed to CS2 having more factors undermining sources of efficacy judgements. PD was the most significant factor influencing collective efficacy but only for some participants in CS1 and CS2. PD provided opportunities for learning, practicing, and planning CT, which led to an increase in participants' confidence in their group's ability to teach CT. PD also facilitated vicarious learning by allowing teachers to observe peers or facilitators effectively teaching CT, further supporting group. However, the impact of PD varied, with some participants in CS2 experiencing both supportive and undermining influences based on their interactions and observations during PD sessions, which led to a decrease in overall collective efficacy.

Resources and a lack of time also undermined sources of efficacy judgements, therefore reducing overall collective efficacy beliefs of CS2. Inadequate resources were seen as a barrier to effective CT teaching, negatively influencing collective efficacy beliefs. Participants also believed that insufficient time for planning and teaching CT, along with frequent student absences, limited their group's ability to implement effective CT instruction and influenced their collective efficacy beliefs.

Across the cases, self, teacher, and collective efficacy beliefs were influenced by several factors, with professional development and resources being most supportive, while time constraints were a common challenge. Variations in efficacy beliefs were primarily driven by the effectiveness and consistency of PD, collaborative opportunities, and resource availability, highlighting that while PD and resources generally supported efficacy, time limitations and varying leadership engagement were notable undermining factors.

Chapter Eight: Conclusions and Implications

The thesis was organised into eight chapters. Chapter one outlined the aim and rationale for the study and provided background information. Chapter two reviewed literature on computational thinking (CT) and efficacy theory (self, teacher, and collective) to support the study's aims. Chapter three discussed the case study methodology, including the methods for data collection and analysis. Chapters four, five, and six presented the findings for Case Study One (CS1), Case Study Two (CS2), and Case Study Three (CS3) respectfully. Chapter seven focused on the cross-case analysis and discussion of the three cases, supported by relevant literature.

This chapter provides a summary of the main conclusions from the research. It includes the key contributions of this research to wider research literature in self, teacher, and collective efficacy with a focus on the planning and teaching of CT. Following this, are the implications for practice this research has uncovered, and suggestions for future research. The chapter concludes with the limitations of the study and some final thoughts from the author.

8.1 Key Findings

This study examined how primary/elementary teachers' and school leaders' self, teacher, and collective efficacy beliefs influenced their planning and teaching of computational thinking (CT). The research was guided by the following questions:

1. What are the relationships between teachers' efficacy beliefs (self, teacher, and collective) and the planning and teaching of CT?
2. What are the relationships between senior leader's efficacy beliefs (self, and collective) and the planning of CT?

3. What factors support or undermine sources of efficacy judgements when planning and teaching CT?

The key research findings are highlighted in italics.

Self-efficacy beliefs were similar across the three cases, with professional development (PD) the most influential factor supporting sources of efficacy judgements when planning CT.

It was not surprising that PD was the most influential factor supporting teachers' self-efficacy beliefs when planning CT. PD was the most influential factor supporting participants' sources of self-efficacy judgements when planning CT. When the participants from each case practiced CT planning, learned how to plan CT from a facilitator or each other, discussed CT planning, and experienced emotions related to learning about CT planning, the understanding they gained from those experiences contributed to their school-wide and school district-wide self-efficacy beliefs for future CT planning. This underscores the critical role of PD in providing educators with the knowledge and skills they need to effectively teach a new subject. What was particularly noteworthy, however, were the specific circumstances under which PD was perceived as inadequate.

Time constraints emerged as the most significant undermining factor and meant the majority of participants believed they were pressured when trying to plan CT effectively, which influenced their self-efficacy beliefs. In particular, the participants across the three cases believed the curriculum was already very full, which added to the challenge of allocating sufficient time for CT integration. Most participants also believed they required additional time to understand CT fully, as well as time to understand how to integrate CT within their planning.

Together, the key findings highlighted the significance of each factor in shaping self-efficacy beliefs when planning CT. Understanding how each factor influenced the sources of efficacy judgements provided insight into strategies for increasing and sustaining self-efficacy for CT planning. This will be discussed in the implications section.

Teacher efficacy beliefs were similar across the three cases, with resources the most influential factor supporting sources of efficacy judgements when teaching CT.

It was also not surprising that resources were important for planning and teaching CT. CT often involves digital tools that are not typically part of traditional subject areas. These resources are essential for providing hands-on, interactive experiences that are fundamental to CT instruction. Without adequate resources, such as programming software, hardware, or relevant instructional materials, teachers may struggle to deliver engaging and effective lessons. Moreover, non-digital resources facilitated teachers' ability to practice and refine their CT teaching skills and create a supportive learning environment for younger students.

As with self-efficacy, time constraints emerged as the most influential factor undermining sources of teacher efficacy judgements. Most teachers across the cases expressed the need for sufficient time to learn and effectively teach CT. When participants did not believe they had allocated time for learning how to teach CT (either by mastering it themselves, or learning from others), they were less efficacious. In addition, the participants also needed time to practice teaching CT in class. The widespread challenge of time constraints highlighted a common issue influencing teachers' efficacy beliefs and their capacity to fully engage in planning and teaching curriculum content. The widespread issue of insufficient time helps explain why there were no statistically significant differences in teacher efficacy medians across the cases.

Collective efficacy beliefs were significantly different across the three cases. CS2 identified four sources of efficacy judgements across three factors that undermined their collective efficacy beliefs, resulting in lower school-wide collective efficacy beliefs. In comparison, CS1 and CS3 each identified only one factor undermining one source of efficacy judgement.

PD was an undermining factor for participants in CS2. The PD exposed gaps in the group understanding of CT, leading to doubts about their ability to plan and teach CT effectively. Despite some reassurance from PD discussions, many participants were unclear and discouraged, which contributed to a lower school-wide collective efficacy median in CS2. In addition, shortages in resources and time constraints further diminished participants' confidence in their group's success with CT.

In contrast, CS1 and CS3 reported fewer undermining factors. In CS1, despite challenges with ongoing support and school size, participants maintained high collective efficacy due to the collaborative environment and positive influence of PD. Similarly, in CS3, although there were concerns about school leadership, the overall impact on collective efficacy was mitigated by verbal encouragement and supportive discussions about resources.

The study demonstrated that while self, and teacher efficacy beliefs were consistent across the three cases due to similar contextual factors, collective efficacy beliefs showed significant differences. Professional development (PD) emerged as the most influential factor for all types of efficacy beliefs, supporting most efficacy judgements. It was not surprising that time constraints were a major undermining factor across all cases, for all efficacy types, highlighting the challenge of integrating CT into an already full curriculum. Despite these variations, the overall findings underscored the importance of context-specific factors in shaping self, teacher, and collective efficacy beliefs when planning and teaching CT.

8.2 Contributions to Knowledge

This research contributes to the field through a detailed analysis of how efficacy beliefs—self-efficacy, teacher efficacy, and collective efficacy—influenced the planning and teaching of CT in primary and elementary education. By situating the study within the broader context of research on teacher efficacy, professional development, and instructional practices (Bandura, 1997; Tschannen-Moran & Hoy, 2001; Guskey, 2002; Hattie, 2009), it became evident that the study's focus on how beliefs about one's capabilities influenced CT planning and teaching, contributed to ongoing discourse on effective educational strategies and frameworks.

CT stands out as distinctive compared to traditional subjects like mathematics or science due to its inherent characteristics and the unique challenges it presents (Barr & Stephenson, 2011; Grover, 2015). Not only is CT unfamiliar to many educators, but CT is also less about specific content knowledge and more about a set of problem-solving skills and processes that are applicable across various domains (Lye & Koh, 2014). The focus on cognitive processes and problem-solving techniques, rather than on mastering a set body of content, makes CT fundamentally different from subjects with well-defined curricula and traditional knowledge bases. However, from the findings, it appeared that CT’s focus on problem-solving and its interdisciplinary nature resonated with educators in a way that developed efficacy beliefs. The distinctiveness of CT, therefore, lies not only in its unique content and pedagogical approach but also in its ability to develop a sense of efficacy among teachers, despite their initial unfamiliarity with the subject. When CT resonated with educators, it suggested that the CT teaching approach aligned with their beliefs and experiences about effective teaching, which is different to prior research in other subject areas (Tschannen-Moran & Hoy, 2001; Pajares, 1992).

This study highlighted several factors which supported the participants' physiological states when planning and teaching CT. While there has been previous research on physiological states, they are often reported upon as negative feelings people experience. In other words, when things do not go to plan, teachers feel stressed and uncomfortable, and a failed experience is more likely to be reflected upon and adapted differently in future (Bandura, 1989; Bruner, 1990). The participants in this study however, mostly described their physiological states as positive. Many participants mentioned they felt excited and motivated to plan and teach CT and the excitement some teachers felt when planning CT is distinctive from previous research (Gale et al., 2021; Palmer, 2011). This study contributes to the existing body of research by shifting the focus from the predominantly negative portrayal of teachers' physiological states to a more nuanced understanding that encompasses positive feelings as well.

This study contributes to the research on educational leadership by highlighting the role that leadership plays in influencing teachers' self-efficacy and collective efficacy beliefs, particularly in the context of planning and teaching CT. Specifically, teachers reported that leaders communicated their approval of CT planning and demonstrated confidence in teachers' abilities, which developed a positive environment for learning and CT implementation. In contrast, some participants did not report significant leadership support, suggesting that when leaders do not actively engage with CT initiatives, teachers may feel isolated in their efforts, potentially undermining collective efficacy. The findings underscore the need for leaders to actively participate in professional development and communicate support to enhance teachers' efficacy beliefs. While the current research builds on existing studies that highlight the importance of leaders engaging in professional development alongside teachers to cultivate shared understanding and support (Versland & Erikson, 2017), it also adds a deeper layer to the understanding of effective leadership practices. This study highlights gaps in the literature regarding how leadership engaging in verbal persuasion/dissuasion can shape teachers' experiences and confidence in implementing innovative practices like CT. By examining these dynamics, the research suggests that supportive leadership an important role in developing a positive teaching environment, ultimately enhancing educators' efficacy and the overall success of new teaching initiatives.

8.3 Implications

This study has explored how self, teacher, and collective efficacy beliefs relate to the planning and teaching of CT, and which key factors supported or undermined participant's sources of efficacy beliefs. The research has contributed to a deeper understanding of the complex interplay of factors that influence efficacy beliefs when planning and teaching CT, providing valuable insights for improving teacher support, professional development practices, and educational policies related to CT integration in schools.

8.3.1 Self-Efficacy

Overall, most participants across all three cases demonstrated moderate to high levels of self-efficacy when planning CT. This consistent sense of self-efficacy suggested that, despite contextual factors and individual experiences, the participants in each case were generally efficacious in their ability to effectively integrate CT planning into their practice. This finding highlights the opportunity to capitalise on the overall high levels of self-efficacy beliefs observed among participants to further improve CT instruction. In particular, the generally high self-efficacy beliefs of the participants provide a strong basis for developing targeted PD programmes and supportive frameworks designed to reinforce and expand existing understanding and efficacy, ultimately contributing to more effective CT planning and teaching practices.

CT is a new and unfamiliar learning area for most teachers, and likely requires more PD than other subject areas. The current study has highlighted the importance of ongoing professional development (PD) for teachers for them to be efficacious in their planning of CT. In particular, providing teachers with ample opportunities to practice CT for their own understanding and learning how to plan CT lessons has provided evidence for the need of sustained PD. This means that schools / school districts need to provide their teachers with the opportunity to have experiences of CT success to build self-efficacy when learning how to plan CT, as well as learn vicariously from a facilitator (or valued colleague). These insights reveal that PD facilitators must focus on delivering well-structured programmes that include collaborative learning experiences and opportunities for teachers to engage with the content as learners themselves. This approach can significantly enhance the effectiveness of PD, thereby better supporting teachers in building their self-efficacy beliefs and ultimately improving their CT instruction practices. Furthermore, PD allows teachers to discuss CT planning and teaching with one another. While some PD experiences may not always be supportive of CT planning and teaching, providing teachers the opportunity to discuss their concerns has proven valuable. It appeared that a few teachers were overwhelmed during PD learning CT content and expressed their concerns. Based on these findings, PD needs to be ongoing, structured, and provide ample opportunities for teachers to learn how to plan CT – both as an individual activity and integrated within other subject areas.

8.3.2 Teacher Efficacy

The study highlighted the relationship between resources and teacher efficacy beliefs of teachers when planning and teaching CT. Specifically, resources had the most influence on teachers' efficacy beliefs when teaching CT. Teachers who had access to a wide range of resources, including digital and non-digital tools, believed they were more capable and prepared to integrate CT into their classroom instruction. Moreover, teachers who were able to create their own resources, share them with colleagues, and integrate them into their lessons demonstrated higher levels of teacher efficacy. This calls attention to the need for teacher support, not just with providing teacher's resources, but also with the training and guidance on how to create their own resources (and integrated resources) so they can plan and teach CT. In contrast, the current research has shown how resource limitations negatively influenced teacher efficacy beliefs. This finding highlights the importance that schools/school districts ensure that teachers have proper access to resources to support their CT planning and teaching. One suggestion could be providing teachers with a resource bank of non-digital resources they can easily access to use in their planning and teaching of CT. This would ensure the teachers become familiar with the resources and provide a common point for collaboration with other teachers. In addition, schools/school districts may need to acquire more digital resources and allocate time and support for teachers to learn how to use the digital tool in their CT teaching instruction. The emphasis on resource availability in CT is consistent with the understanding that effective teaching requires appropriate tools and materials.

8.3.3 Collective Efficacy

The findings of this study also have significant implications for building collective efficacy among educators when planning and teaching CT. The contrast between the experiences of participants in CS2 and those in CS1 and CS3 underscores the importance of addressing specific challenges that can undermine collective efficacy beliefs. In CS2, participants identified multiple factors, such as misunderstandings revealed during PD, resource shortages, and time constraints, that decreased their confidence in their group's ability to effectively plan and teach CT. This highlighted the need for tailored support; providing time, resources and PD sessions that facilitate clarity and alignment among teachers' understanding of CT.

In contrast, CS1 and CS3 exhibited higher collective efficacy despite facing some undermining factors. To enhance collective efficacy beliefs, leaders should prioritise effective communication and provide ample resources while also engaging in PD alongside teachers. By addressing these specific barriers and developing a supportive atmosphere, educational leaders can empower teachers, increase their confidence, and ultimately improve the implementation of practices like CT. These findings point to the need for school leaders to not only provide general support but also to develop a deeper understanding of CT and actively participate in its integration, thereby increasing their ability to effectively support their teaching staff.

A lack of time was the most influential undermining factor for the majority of participants which influenced their self, teacher, and collective efficacy beliefs when planning and teaching CT. A lack of time was consistently reported as a negative influence which affected the efficacy beliefs of the participants. This was primarily due to less opportunities to understand how to plan and teach CT, and no time to learn from others (or be observed). Given that CT is a complex subject area that often introduces novel concepts and technical skills, educators need time to develop, practice, and refine their instruction. Moreover, allocated time is vital for teachers to engage in PD, collaborate with peers, and adapt resources to fit the needs of their students. The challenge of fitting CT into already full curricula reflects broader issues in education where time limitations impact the ability to explore and implement new teaching approaches. Therefore, the significance of time constraints in the context of CT is consistent with the broader educational challenge of balancing various curricula demands within limited timeframes. The identification of time constraints as a factor undermining teacher efficacy emphasises the need for school leaders to allocate sufficient time for CT learning, and time to practice CT classroom instruction. An implication of this finding is the need for providing more support for teachers when learning how to integrate CT. This is because CT integration has the potential to reduce the time taken in class to incorporate CT concepts; when CT is embedded within other subject areas, the students can learn subject content, and CT. In addition, school leaders allowing teachers the time to collaborate (either when planning or teaching CT) can alleviate time pressure because they may be able to design lessons together, or share their learning.

8.4 Future Research

There are several avenues for future research based on the findings in this study. Firstly, as this study was cross-sectional, there is a need for longitudinal research. A longitudinal study would be valuable for exploring the long-term relationship between efficacy beliefs and the integration of CT. While this study provided a snapshot of efficacy beliefs at a specific point in time and with specific groups of participants, a broader longitudinal approach could track how efficacy beliefs evolve as educators gain more experience with CT planning and teaching. By examining how efficacy beliefs develop and change over time, researchers could gain deeper insights into the enduring impact of experience on educators' efficacy beliefs and the effectiveness in integrating CT into their practice. This would help in understanding the dynamic nature of efficacy beliefs and how sustained engagement with CT influences teachers' efficacy over a longer period of time.

In addition, examining the role of school leader's role in supporting/undermining efficacy beliefs of teachers when planning and teaching CT is an area that requires more research. Investigating how school leaders' own professional development might support CT can provide important insights into how leadership influences teachers' efficacy beliefs. Understanding this dynamic is of value because school leaders who are well-versed in CT may be better positioned to offer meaningful support, resources, and encouragement to their teaching staff. This could enhance teachers' efficacy and effectiveness in integrating CT into their curricula. Conversely, if school leaders lack adequate knowledge or training in CT, it may in advertently undermine their ability to foster a supportive environment for teachers. Thus, exploring this relationship could help in developing strategies to ensure that leaders not only supports but also actively contributes to building strong efficacy beliefs among teachers.

Another important area for future research is the development and evaluation of assessment methods for CT, an area still in its early stages (Cutumisu et al., 2019; Poulakis & Politis, 2021). Effective assessment of CT is important for several reasons: it helps identify the specific skills and competencies students need to develop, informs teachers om how to tailor their instructional strategies, supports the ongoing development of the curriculum, and tracks students' progress and growth. By focusing on CT assessment, future research can contribute to creating effective tools and strategies that enhance both teaching practices and student learning outcomes in this evolving field.

There is also a need to focus on the relationship between teacher CT efficacy, and student learning outcomes. Teacher beliefs in their ability to teach CT and positively influence student learning directly impact their instructional practices, classroom management, and the creation of a supportive learning environment (Bandura, 1997; Pajares, 1996; Guskey, 2002). By understanding the factors that contribute to teacher efficacy when planning and teaching CT, educators can develop targeted interventions to enhance teaching effectiveness, ultimately leading to improved student performance.

Finally, the role of students and the collective efficacy between teachers and students, not just in terms of student learning outcomes (LOs) is an area for further investigation. Understanding how students contribute to and influence collective efficacy within the classroom can offer valuable insights. For example, exploring how students' engagement, feedback, and collaboration influence both their own learning and the teachers' efficacy beliefs when delivering CT can reveal important aspects of the teaching and learning process. This approach could highlight how mutual support between teachers and students can develop a more effective learning environment and increase efficacy beliefs for both teacher and student.

8.5 Limitations

While there are contributions to knowledge and implications from this study, there are also limitations which must be addressed. For example, the use of case study methodology presents a limitation due to its inherent lack of generalisability. This approach focused specifically on primary and intermediate schools in New Zealand and an elementary school district in the United States. As a result, the findings are closely tied to these contexts and may not be easily transferable to teachers or school leaders in different schools or educational settings, and across other countries. This contextual specificity restricts the broader applicability of the research outcomes.

Furthermore, the small sample sizes across all three cases in this study also limit the generalisability and transferability of the findings. With a limited number of participants in each case, the results may not accurately represent the broader population of educators or schools. In other words, the small sample size constrains the ability to draw widespread conclusions or apply the findings to different contexts beyond the specific cases examined. Consequently, while the study provides valuable insights into the experiences and perceptions of the participants, the findings should be interpreted with caution when considering their applicability to other settings or larger groups.

Lastly, the fact that this was a cross-sectional study meant that the study did not examine how teachers' and school leaders' self, teacher, and collective efficacy beliefs changes over time. This approach limited the exploration of temporal variations and the long-term evolution of efficacy beliefs.

8.6 Final Thoughts

This study provided evidence of the important role of efficacy beliefs (self, teacher, and collective) in shaping the planning and teaching of computational thinking (CT) in primary/elementary education. The findings highlighted that while self-efficacy and teacher efficacy beliefs were generally robust across different contexts, they were influenced by key factors such as professional development, resource availability, and time constraints. Notably, the importance of ongoing and structured professional development emerged as a central theme, as it not only bolstered educators' efficacy when planning and teaching CT but PD also developed a collaborative environment which was and important support for collective efficacy beliefs. The overarching challenges posed by time limitations revealed a pressing need for systemic changes that allow educators the necessary space and time to engage with and integrate CT into their already packed curricula.

By highlighting the intricate relationships between efficacy beliefs and contextual factors, the current study serves as a guiding framework for educators, leaders, and policymakers aiming to enhance the teaching and learning of CT. Addressing the identified barriers, particularly in terms of time and resource allocation, is essential to develop a supportive environment where teachers can thrive and innovate. This study not only advocates for a shift in how we perceive teachers' efficacy beliefs but also highlights the potential of CT when adequately supported, reinforcing its relevance in contemporary education.

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Appendices

Appendix 1– Letter to Principal requesting access.

[Letterhead]

(Insert name here)
Principal of (insert name here)

Dear (insert name here)

My name is Victoria Macann and I am a part-time doctoral student within the Institute of Education at Massey University. My research supervisors are Dr. Maggie Hartnett and Dr. Lucila Carvalho. My research focus is on the relationships between efficacy beliefs and the implementation and teaching of computational thinking. I hope to conduct two case studies in primary/intermediate schools in New Zealand and two case studies in American elementary schools in 2022.

Project Description and Invitation

The technology learning area of the New Zealand curriculum recently underwent major consultation and review to include computational thinking (CT) as a key competency for year 1-8 students. The main justification behind the addition of CT into the New Zealand curriculum was the belief that all students need to be digitally capable to fully participate in modern society and these skills are integral to a range of occupations where people are creators of digital technologies rather than solely consumers. Because this content is new and unfamiliar for many teachers and school leaders, research is needed to develop a practical understanding of how to effectively teach computational thinking and the relationship between efficacy beliefs and their practical experiences associated with the implementation and teaching of computational thinking. Efficacy beliefs can influence our effort, choices made, our persistence when facing adverse situations and the level of stress experienced in response to adversity. Efficacy beliefs associated with computational thinking are likely to greatly influence the development of CT teaching practices, yet the relationship between these remains under-researched, especially at the primary school level. Expected contributions of this research include strategies that can be developed and utilised as supportive frameworks to encourage positive change in schools when teaching computational thinking and future digital technology competencies in New Zealand, and overseas.

I am kindly inviting your school to be a case study in this research.

Participant Identification and Recruitment

Your school has been identified as one of two schools where computational thinking is being implemented by school leaders and teachers and taught by teachers. While every effort will be made to ensure the confidentiality of participants, confidentiality cannot be guaranteed. Please understand that you and staff in your school are under no obligation to participate.

Consideration has gone into how this study may affect the participants. Psychological harm will be minimised to the best of the researcher's ability by providing an appropriate autonomous consent process which involves informing the participant at the beginning of what the study will involve but also continuing to monitor their progress throughout the interview/observations. Participants will be allowed to withdraw up until the data is analysed.

Project Procedures

1. If consent is granted by you, all staff (school leaders and teachers) will be invited to participate in an online survey that will take no more than 20 minutes to complete. This survey will ask questions about their self- efficacy, teacher-efficacy, and collective efficacy relating to computational thinking and the teaching of computational thinking.
2. As part of the survey, participants will be asked if they are willing to take part in a follow-up interview and classroom observation (teachers only). This will ideally involve 2-3 school leaders, and 10 teachers. The location for the interview will be agreed to between the participant and researcher. This location will be somewhere where the participant is comfortable, and the duration of the interview will be 1 hour and take place outside of work time. If the participant would prefer to be interviewed on the weekend, this will be accommodated while the researcher is in the local area. Interviews may also be conducted via zoom if this suits the participant. The interviews will also be audio recorded upon agreement with the participant. Participants are entitled to review their interview transcript and edit if necessary. If participants wish to review their transcript, this will take 30 minutes.
3. The observations will occur at a time agreed to upon between the researcher and teacher and will take between 30-45 minutes. Teachers will be observed once across the course of one week as agreed to between the principal, teacher and myself.
4. I also plan to gather data from school strategy and policy documents associated with the implementation and teaching of computational thinking. This will involve 15 mins from a school leader to provide access to these documents.

Data Management

Data will be managed with upmost care and no information will be given to any other person outside the researcher/supervisors. Data will be kept on the researchers' personal password protected laptop which is solely used by the researcher which ensures that data/information of participant's are kept private and confidential. Data will be stored confidentially for 5 years until it is destroyed appropriately by the researcher.

Once again, I am kindly inviting your school to be a case study in this research. I hope we can move forward with this research.

Please do not hesitate to contact me and/or supervisor if you have any questions about the project. Sincerely,
Victoria Macann
Project Contacts

- ● Victoria Macann - [redacted] [redacted] (Researcher)
- ● Dr. Maggie Hartnett - m.hartnett@massey.ac.nz (Supervisor)
- ● Dr. Lucila Carvalho - l.carvalho@massey.ac.nz (Supervisor)

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 20/62. If you have any concerns about the conduct of this research, please contact Dr Negar Partow, Chair, Massey University Human Ethics Committee: Southern A, telephone 04 801 5799 x 63363, email humanethicsoutha@massey.ac.nz.

Appendix 2 – Information Letter to potential participants (school leaders)

[Letterhead]

INFORMATION SHEET FOR SCHOOL LEADER PARTICIPANTS

Researcher(s) Introduction

My name is Victoria Macann and I am a part-time doctoral student within the Institute of Education at Massey University. My research supervisors are Dr. Maggie Hartnett and Dr. Lucila Carvalho. My research focus is on the relationships between efficacy beliefs and the implementation and teaching of computational thinking. I hope to conduct two case studies in primary/intermediate schools in New Zealand and two case studies in American elementary schools in 2022.

Project Description and Invitation

The technology learning area of the New Zealand curriculum recently underwent major consultation and review to include computational thinking (CT) as a key competency for year 1-8 students. The main justification behind the addition of CT into the New Zealand curriculum was the belief that all students need to be digitally capable to fully participate in modern society and these skills are integral to a range of occupations where people are creators of digital technologies rather than solely consumers. Because this content is new and unfamiliar for many teachers and school leaders, research is needed to develop a practical understanding of how to effectively teach computational thinking and the relationship between efficacy beliefs and their practical experiences associated with the implementation and teaching of computational thinking. Efficacy beliefs can influence our effort, choices made, our persistence when facing adverse situations and the level of stress experienced in response to adversity. Efficacy beliefs associated with computational thinking are likely to greatly influence the development of CT teaching practices, yet the relationship between these remains under-researched, especially at the primary school level. Expected contributions of this research include strategies that can be developed and utilised as supportive frameworks to encourage positive change in schools when teaching computational thinking and future digital technology competencies in New Zealand, and overseas.

I am kindly inviting you to participate in the doctoral research study that I am conducting involving your school as a case study.

What is involved?

If you agree to be part of this research project, it will require a maximum of two hours of your time should you choose to participate in the survey **and** the interview as well as review your interview transcript.

You are invited to participate in the following:

- - An anonymous online survey (15 mins) answering questions on your efficacy beliefs when implementing computational thinking (click here). Completion of the survey implies consent.
- - An interview (of one hour maximum) which involves answering questions about your experiences when implementing computational thinking. This may be conducted in person or via zoom. With your agreement the interview will be recorded. The original audio recording of the interview can also be returned to you if you wish.
- - Time to review your interview transcript (30 mins). If you choose, we can discuss the process and you may edit the transcription if you believe it to be a misrepresentation of the interview.
- - I will also ask one school leader to provide me with access to the school policy and strategy documents related to the teaching and implementation of computational thinking (10-15 mins).

  Please note:

  All information is confidential and will be stored and reported in such a way that participants identities remain confidential, however, while every effort will be made to ensure the confidentiality of participants, confidentiality cannot be guaranteed. The original interview recording, and signed consent form will be stored securely to ensure confidentiality and destroyed after 5 years.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- ● decline to answer any particular question;
- ● withdraw from the study (until the data is analysed);
- ● ask any questions about the study at any time during participation;
- ● provide information on the understanding that your name will not be used unless you give permission to the

  researcher;

- ● review your interview transcript;
- ● be given access to a summary of the project findings when it is concluded.
- ● ask for the recorder to be turned off at any time during the interview.

Please do not hesitate to contact me and/or supervisor if you have any questions about the project.

Sincerely, Victoria Macann

Project Contacts

- ● Victoria Macann - [redacted] (Researcher)
- ● Dr. Maggie Hartnett - m.hartnett@massey.ac.nz (Supervisor)
- ● Dr. Lucila Carvalho - l.carvalho@massey.ac.nz (Supervisor)

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 20/62. If you have any concerns about the conduct of this research, please contact Dr Negar Partow, Chair, Massey University Human Ethics Committee: Southern A, telephone 04 801 5799 x 63363, email humanethicsoutha@massey.ac.nz.

Appendix 3 – Information Letter to potential participants (teachers)

[Letterhead]

INFORMATION SHEET FOR TEACHER PARTICIPANTS

Researcher(s) Introduction

My name is Victoria Macann and I am a part-time doctoral student within the Institute of Education at Massey University. My research supervisors are Dr. Maggie Hartnett and Dr. Lucila Carvalho. My research focus is on the relationships between efficacy beliefs and the implementation and teaching of computational thinking. I hope to conduct two case studies in primary/intermediate schools in New Zealand and two case studies in American elementary schools in 2022.

Project Description and Invitation

The technology learning area of the New Zealand curriculum recently underwent major consultation and review to include computational thinking (CT) as a key competency for year 1-8 students. The main justification behind the addition of CT into the New Zealand curriculum was the belief that all students need to be digitally capable to fully participate in modern society and these skills are integral to a range of occupations where people are creators of digital technologies rather than solely consumers. Because this content is new and unfamiliar for many teachers and school leaders, research is needed to develop a practical understanding of how to effectively teach computational thinking and the relationship between efficacy beliefs and their practical experiences associated with the implementation and teaching of computational thinking. Efficacy beliefs can influence our effort, choices made, our persistence when facing adverse situations and the level of stress experienced in response to adversity. Efficacy beliefs associated with computational thinking are likely to greatly influence the development of CT teaching practices, yet the relationship between these remains under-researched, especially at the primary school level. Expected contributions of this research include strategies that can be developed and utilised as supportive frameworks to encourage positive change in schools when teaching computational thinking and future digital technology competencies in New Zealand, and overseas.

I am kindly inviting you to participate in the doctoral research study that I am conducting involving your school as a case study.

What is involved?

If you agree to be part of this research project, it will require a maximum of three hours of your time should you choose to participate in the survey, the interview and observation.

You are invited to participate in the following:

- - An anonymous online survey (15 mins) answering questions on your efficacy beliefs when implementing and teaching computational thinking (link here). Completion of the survey implies consent.
- - An interview (of one hour maximum) which involves answering questions about your experiences when implementing and teaching computational thinking. With your agreement the interview will be recorded. The original audio recording of the interview can also be returned to you if you wish.
- - Time to review your interview (30 mins). If you choose, we can discuss the process and you may edit the transcription if you believe it to be a misrepresentation of the interview.

You are then invited to participate in the following:

- A classroom observation (of 30 – 45 minutes maximum) which involves me observing you teaching computational thinking to your students. Observations will happen once per participant across a period of one week. Although students may be involved within your teaching/discussion, I will solely be focused on your teaching of computational thinking as you are the participant, not the student.

Please note:

All information is confidential and will be stored and reported in such a way that participants identities remain confidential, however, while every effort will be made to ensure the confidentiality of participants, confidentiality cannot be guaranteed. The original interview recording, and signed consent form will be stored securely to ensure confidentiality and destroyed after 5 years.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- ● decline to answer any particular question;
- ● withdraw from the study (until the data is analysed);
- ● ask any questions about the study at any time during participation;
- ● provide information on the understanding that your name will not be used unless you give permission to the

researcher;

- ● review your interview transcript;
- ● be given access to a summary of the project findings when it is concluded.
- ● ask for the recorder to be turned off at any time during the interview.
- ● ask to stop the observation.

Please do not hesitate to contact me and/or supervisor if you have any questions about the project.

Sincerely, Victoria Macann

Project Contacts

- ● Victoria Macann - [redacted] (Researcher)
- ● Dr. Maggie Hartnett - m.hartnett@massey.ac.nz (Supervisor)
- ● Dr. Lucila Carvalho - l.carvalho@massey.ac.nz (Supervisor)

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 20/62. If you have any concerns about the conduct of this research, please contact Dr Negar Partow, Chair, Massey University Human Ethics Committee: Southern A, telephone 04 801 5799 x 63363, email humanethicsoutha@massey.ac.nz.

Appendix 4– Consent form (teacher and school leader)

[Letterhead]

[Logo, name and address of Department/School/Institute/Section]

Relationships between efficacy beliefs and the planning and teaching of computational thinking in New Zealand and American primary schools

PARTICIPANT CONSENT FORM - INDIVIDUAL

I have read, or have had read to me in my first language, and I understand the Information Sheet attached as Appendix I. I have had the details of the study explained to me, any questions I had have been answered to my satisfaction, and I understand that I may ask further questions at any time. I have been given sufficient time to consider whether to participate in this study and I understand participation is voluntary and that I may withdraw from the study until the data is analysed. The researcher will contact me prior to analyzing the data to give me the opportunity to withdraw from the project if necessary.

1. I agree/do not agree to the interview being recorded.
2. I wish/do not wish to have my recordings returned to me.
3. I wish/do not wish to have data placed in an official archive.
4. I agree to participate in this study under the conditions set out in the Information Sheet.

Declaration by Participant:

I [print full name] ______________________ hereby consent to take part in this study.

Signature: ________________________ Date: _________________

Appendix 5 – Information Letter to Parents

[Letterhead]

INFORMATION SHEET FOR PARENTS

Researcher(s) Introduction

My name is Victoria Macann and I am a part-time doctoral student within the Institute of Education at Massey University. My research supervisors are Dr. Maggie Hartnett and Dr. Lucila Carvalho. My research focuses on the relationships between efficacy beliefs and the implementation and teaching of computational thinking. I hope to conduct two case studies in primary/intermediate schools in New Zealand and two case studies in elementary schools in America. I am an NZ registered teacher.

Project Description and Invitation

The technology learning area of the New Zealand curriculum recently underwent major consultation and review to include computational thinking (CT) as a key competency for year 1-8 students. CT is a way of thinking that allows students to express problems and solve them often with a computer. Through learning CT, students develop an understanding of computer science principles within all digital technology. Because this content is new and unfamiliar for many teachers and school leaders, research is needed to develop an understanding of how to effectively teach computational thinking. Expected contributions of this research include strategies that can be developed and utilised as supportive frameworks to encourage positive change in schools when teaching computational thinking and future digital technology competencies in New Zealand, and overseas.

The school where your child/children attends has kindly accepted my invitation to be one of my case studies. This letter is informing you that your child/children may be in a class where I am observing their teacher. My research focuses on the **teachers and school leaders** however, due to observations occurring, students will also be present and interacting with their teacher.

What is involved?

If you agree to your child/children being part of the research observations involving their **teacher**, I might be conducting observations while your child is participating in their normal class activity about computational thinking with their teacher and peers.

- - This will involve me observing the teacher teach an activity on computational thinking and interact with their students for between 30-45 minutes on one day. This day might be any day of one week (which has been agreed upon between the participant and myself).
- - All data collected will be strictly confidential and there will be no way your child/children may be identified in the research. If an interaction between the teacher and student has taken place, both will be recorded using pseudonyms.

Please note:

All information will be stored and reported in such a way that participants' identities remain confidential, however while every effort will be made to ensure the confidentiality of participants, confidentiality cannot be guaranteed.
The signed consent form will be stored securely to ensure confidentiality and destroyed after 5 years after completion of the PhD.

You are under no obligation to accept this invitation. If you decide to not allow your child/children to be involved in the observation, they will not be impacted in any way and will continue to be present learning in the classroom as normal, however they will not be observed or recorded in any way.

Please do not hesitate to contact me and/or supervisor if you have any questions about the project.

Sincerely, Victoria Macann

Project Contacts

- ● Victoria Macann - [redacted] (Researcher)
- ● Dr. Maggie Hartnett - m.hartnett@massey.ac.nz (Supervisor)
- ● Dr. Lucila Carvalho - l.carvalho@massey.ac.nz (Supervisor)

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 20/62. If you have any concerns about the conduct of this research, please contact Dr Negar Partow, Chair, Massey University Human Ethics Committee: Southern A, telephone 04 801 5799 x 63363, email humanethicsoutha@massey.ac.nz.

Appendix 6 – Transcript of Introductory Video for Parents

Kia ora, my name is Victoria Macann and I am a part-time doctoral student within the Institute of Education at Massey University. I am a registered secondary school teacher and taught in Rotorua for 8 years.

My research focuses on the relationships between teacher efficacy beliefs and the implementation and teaching of computational thinking.

Computational thinking is a way of thinking so students can express problems and solve them with or without technology. Through this learning, students develop an understanding of computer science principles within all digital technology. Because this content is new and unfamiliar for many teachers and school leaders, research is needed to develop an understanding of how to effectively teach computational thinking.

The school that your child attends has kindly accepted my invitation to be one of my case studies. This letter is informing you that your child is in a class where I am observing their teacher. I want to express that my research focuses on the teachers however, due to observations occurring, students will also be present and interacting with their teacher in a normal class environment. All data collected is strictly confidential, and there is no way your child will be identifiable in the research.

You are under no obligation to accept this invitation. If you decide to not allow your child to be involved in the observation, they will not be impacted in any way and will continue to be present learning in the classroom as normal, however they will not be observed or recorded in any way.

If you do decide you are happy for your child to be part of the teacher observation, please sign the consent form attached with this email.

I've also sent an information sheet with all the formal details of the research for you to have a read through and decide whether you are happy to consent your child being part of the teacher observation.

Please do not hesitate to contact me if you have any questions. My email and phone number are in the email too.

I appreciate your time and consideration of this request.

Thank you.

Appendix 7 – Parent / Student Consent Form

[Letterhead]

[Logo, name and address of Department/School/Institute/Section]

Relationships between efficacy beliefs and the implementation and teaching of computational thinking in New Zealand primary schools

PARENT AND CHILD CONSENT FORM

I have read, or have had read to me in my first language, and I understand the Information Sheet attached as Appendix I. I have had the details of the study explained to me, any questions I had have been answered to my satisfaction, and I understand that I may ask further questions at any time. I have been given sufficient time to consider whether to allow my child to be present during this study.

1. I agree/do not agree for my child to be present during this study under the conditions set out in the Information Sheet.
2. As the child, I agree / do not agree to be present during this study under the conditions set out in the Information Sheet.

Declaration by Parent:

I [print full name]______________________ hereby consent to allow my child

[print full name] _________________________ take part in this study.

Signature parent: ________________________ Date: _________________

Signature child: ________________________ Date: _________________

Appendix 8 – Survey for all participants

Kia ora koutou,

My name is Victoria Macann and I am a part-time doctoral student within the Institute of Education at Massey University. My research supervisors are Dr. Maggie Hartnett and Dr. Lucila Carvalho. My research focus is on the relationships between efficacy beliefs and the implementation and teaching of computational thinking. I hope to conduct two case studies in primary/intermediate schools in New Zealand and two case studies in elementary schools in the United States. I am writing to let you know your school has agreed to be a case study for my research project.

Project overview:

The technology learning area of the New Zealand curriculum recently underwent major consultation and review to include computational thinking (CT) as a key competency for year 1-8 students. The main justification behind the addition of CT into the New Zealand curriculum was the belief that all students need to be digitally capable to fully participate in modern society and these skills are integral to a range of occupations where people are creators of digital technologies rather than solely consumers. Because this content is new and unfamiliar for many teachers and school leaders, research is needed to develop a practical understanding of how to effectively teach computational thinking and the relationship between efficacy beliefs and their practical experiences associated with the implementation and teaching of computational thinking. Efficacy beliefs can influence our effort, choices made, our persistence when facing adverse situations and the level of stress experienced in response to adversity. Efficacy beliefs associated with computational thinking are likely to greatly influence the development of CT teaching practices, yet the relationship between these remains under-researched, especially at the primary school level. Expected contributions of this research include strategies that can be developed and utilised as supportive frameworks to encourage positive change in schools when teaching computational thinking and future digital technology competencies in New Zealand, and overseas.

Confidentiality:

You will not be asked for your name in this survey. All of your responses will be completely anonymous. If you provide your name for the interview and observation this will not be used to link your responses to your identity. The data from the survey will be combined together and reported as part of my doctoral research and after 5 years all original surveys will be destroyed.

Completing this survey:

This survey should take no more than **15 minutes** to complete. Completing the survey implies your consent to participate in the research. You may decline to answer any particular question simply by leaving it blank.

Research team:

This research is being conducted by Victoria Macann and supervised by Dr. Maggie Hartnett and Dr. Lucila Carvalho.

Queries:

If you need any further information or have any questions, please feel free to contact me via email at victoria.macann.1@uni.massey.ac.nz or phone me directly on [redacted]

THANK YOU FOR TAKING THE TIME TO RESPOND TO THIS SURVEY

To complete the questionnaire simply click on the following arrow: (insert link)

Survey information:

Hello and thank you for participating in this survey.

The questions here relate to your efficacy beliefs when implementing and teaching computational thinking. Please take your time and answer the questions as accurately as possible, so that the answers reflect your own attitudes and behaviours toward your implementation and teaching of computational thinking at your school.

Section 1: Personal information

1. Please indicate your age range:

   20-24

   25-30

   31-40

   41-50

   51 or over

   Other (please specify)

2. What ethnic group or groups do you identify with? (Please select all that apply)

   Māori

   NZ European

   Pasifika

   Asian

   Australian

   European

   Other (please specify)

3. Please indicate how long you have been in the teaching profession for:

   < 5 years

   Between 5 - 10 years

   Between 10 - 20 years

   > 20 years

4. Are you a teacher or school leader?

   Teacher

   School leader

   * Depending on the answer to this question, the participant will be directed to particular questions.

Section 2: Efficacy beliefs and computational thinking (for teachers)

1. What is your understanding of computational thinking? *Open-ended response*

Section 3: Self efficacy beliefs and computational thinking (for teachers)

There is ambiguity in terminology surrounding computing education. Please read the definitions provided that relate to the following questions:

- Computer programming: The act of developing instructions that a computer will read and execute. Programming may be expanded to include devices other than traditional computers (eg., robots, and small equipment).
- Coding: A synonym often used in place of "(computer) programming"
- Computing: Encompasses coding, but also refers to the thinking processes involved in solving problems with the use of machines.

In this next section please read each item carefully.

Rate your degree of confidence from 0 to 100 using the sliding scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all. Moderately can do Highly certain can do

1 I can describe fundamental computing concepts (eg., loops, variables, algorithms, conditional logic).
2 I can correct mistakes in the coding of a computer program on my own.
3 When I'm presented with a problem, I have difficulty breaking it down into smaller steps.
4 I can suggest different solutions in order to solve coding problems.
5 I struggle to generalise solutions that can be applied to many different problems
6 I can look at a computer program and explain the purpose of each command
7 I am good at finding patterns in data
8 I can apply Boolean logic (eg., IF, AND, NOT, OR) to solve problems with multiple conditions
9 I am NOT good at solving puzzles
10 I can read a formula (eg., algorithm, equation, input/output process) and explain what it should do
11 I struggle to identify where and how to use variables in the solution of a problem.

12 I can plan out the logic for a computer program even if I don’t know the specific programming language.

Section 4: Teacher efficacy beliefs and computational thinking (for teachers)

School leaders can answer if it’s relevant otherwise tick NA.

In this next section please read each item carefully.

Rate your degree of confidence from 0 to 100 using the sliding scale given below:

0 10 20 30 40 50 60 70 80 90 100

Cannot do at all Moderately can do Highly certain can do

13 I can explain basic computing concepts to children (eg., algorithms, loops, conditionals, functions, variables, debugging, pattern-finding).

14 I can help students debug their computer programs

15 I can find uses for computer programming that are relevant for students

16 I can integrate computer programming into my current curriculum

17 I know where to find the resources to help students learn to code

18 I believe that I have the requisite computer programming skills to integrate computing content into my class lessons.

19 I can recognise and appreciate computing concepts in all subject areas

20 I can create computing activities at the appropriate level for my students

21 I can explain computing how computing concepts are connected to daily life

22 I can develop and plan effective computing lessons.

Section 3: Collective efficacy beliefs and computational thinking

For the next set of questions, 'group' means the team of teachers you primarily work with. This may be a hub, year level or similar. In this next section please read each item carefully and answer according to this scale:

If yes, how confident are you?

10	20	30	40	50	60	70	80	90	100

Not confident Moderately confident Totally confident

23 I believe my group has the ability to understand terms/words relating to computer software.

24 I believe my group has the ability to troubleshoot computer problems.

25 I believe my group has the ability to explain why a program (software) will or will not run on a given computer.

26 My group has confidence in itself.

27 My group expects to be known as a high-performing team.

28 My group can get a lot done when it works hard.

29 I believe my group has the ability to use communications software to collaborate with remote group members.

30 I believe my group has the ability to do teamwork in a distributed environment if we have access to appropriate technology.

31 I believe my group has the ability to share information using technology with remote group members.

32 I believe my group has the ability to use communication technology to do work with people who cannot physically get together to meet.

In the next set of questions, 'project' relates to the implementation and teaching of computational thinking. In this next section please read each item carefully and answer according to this scale:

If yes, how confident are you?

10	20	30	40	50	60	70	80	90	100

Not confident Moderately confident Totally confident

33 My group worked hard on the project.

34 My group exerted substantial effort on the project.

35 My group did a significant amount of work on the project.

36 I am satisfied with the project outcome produced by my team.

37 I am pleased with the quality of work we did in my team.

38 I am satisfied with the final project deliverable submitted by my team.

39 I was satisfied with my group members.

40 I was pleased with the way my teammates and I worked together.

41 I was very satisfied working with this team.

42 The work produced by my team was high quality.

43 The project outcome produced by my team was excellent.

44 The deliverables of my team were outstanding.

Section 5: Participating in interviews/observations:

School leaders: Would you like to participate in an interview for this research about the implementation computational thinking? (1 hour)

Yes / No

If yes, will be directed to a page asking for their name and contact details

Teachers only. Would you like to participate in an interview (1 hour) and observation (30-45 minutes) for this research about the implementation and teaching of computational thinking?

Yes / No

If yes, will be directed to a page asking for their name and contact details

Appendix 9 – Interview Questions

Welcome and thank you for participating in an interview. The following questions are prompts to find out more about your planning and teaching of computational thinking. There are no right or wrong answers, I am interested in what you have to say.

The following questions relate to RQ1:

What are teachers and school leaders' (principals, deputy principals, assistant principals) understanding of computational thinking?

1. Can you explain to me what you think computational thinking is?
2. How has computational thinking been introduced to you at school?
3. What are some activities you use to teach computational thinking?
4. How confident are you teaching computational thinking on a device? Off a device?
5. Can you please give me some examples where you have integrated computational thinking into a learning task for your students? Into other curriculum areas?

The following questions relate to RQ2:

How do self, teacher and collective efficacy beliefs of teachers shape their teaching of computational thinking?

6. How successful do you think you are with implementing and teaching computational thinking? Why / why not?
7. What are some ways you encourage other staff members (in your team/school) to learn computational thinking?
8. Can you give me examples of how you have modelled computational thinking to other teachers? How did you find this experience?

The following questions relate to RQ3:

What are the enablers and barriers in developing self, teacher, and collective efficacy beliefs for implementing and teaching computational thinking?

9. What factors affect how computational thinking is taught in your class? Why is that?
10. What factors affect how computational thinking is taught at your school? Why is that?
11. What factors help you implement and teach computational thinking?
12. What factors have you encountered that make it difficult to implement and teach computational thinking?
13. How do you think the school's strategies assist computational thinking being taught in your class?
14. How do you think school policies affect computational thinking being taught in your class?

Appendix 10 – Observation Outline

Observations are often used to triangulate data and can be used in conjunction with interviews and document analysis to substantiate findings. The researcher observes the behaviour firsthand and uses their knowledge to interpret what is observed rather than relying on second-hand interview accounts (Merriam, 1998). During the case studies, I will be an observer as a participant because the teacher and students know why I am there and conducting an observation, however I will not be interacting with the students/teacher.

During the observation, I will take notes on:

1. The physical setting (it will be a classroom - but this could be an open learning environment or a more traditional single-celled classroom. There may also be resources in use (chromebooks, iPads, robotics).
2. The participants involved (teacher and students).
3. The activities and interactions during the observation. This will include what is happening in the activity, the sequence of the activity, how the teacher and students interact with each other and other students, what rules structure the activity, the duration, and whether this task seems like a usual task or a new one.
4. Conversation between the teacher and students and the students with each other (provided they have consent). I will note down relevant quotes.
5. Anything subtle that is happening during the observation - in particular if something does not happen when it may have been supposed to.
6. Any observer comments and how my presence may affect the observation.

The field notes will contain verbal descriptions of the classroom setting, the people involved and the activities being completed. Notes will also contain direct quotes of what the teacher has said in relation to computational thinking. The researcher will have observation notes throughout the document initialed RC (researcher comment).

During the observations I will be looking for these key identifiers in comments/questions from the teachers. These key identifiers have been modified from:

Yadav, A., Rich, K., Schwarz, C., & Larimore, R. (2021). Developing elementary teachers' competencies in integrating computational thinking ideas in classrooms: Using a toolkit as a scaffold. In C. Mouza, A. Leftwich, & A. Yadav (Eds). Professional Development for In-Service Teachers: Research and Practices in Computing Education. Information Age: Charlotte, NC.

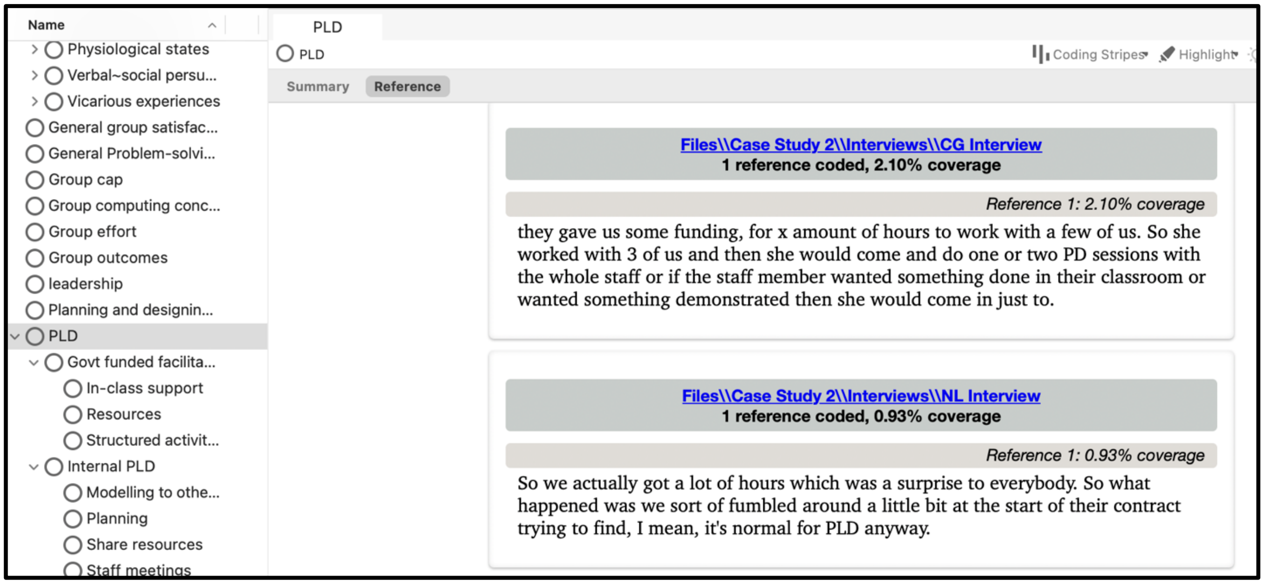
The physical setting	
The participants involved	
Activities occurring	
Conversation	
Subtleties	

Decomposition - key identifiers: • What are the individual details of this problem? • Can this be broken down into smaller sections and then solved?
Abstraction - key identifiers: • What aspects are the most important? • What can be filtered out? • What information from solving this problem can be applied to other problems?
Pattern recognition - key identifiers: • What similarities and differences do you notice? • Can you describe the pattern? Can this be used to draw a conclusion?
Debugging - key identifiers: • Can you identify where there is a bug/mistake/error? • How can you modify the sequence to address the problem? • How can you test your sequence?

Appendix 11 – Example of NVivo codes

PLD	20	36	1/20/22, 8:39 AM	VM	12/20/22, 10:14 AM	VM
Govt funded facilita...	7	16	1/20/22, 8:39 AM	VM	1/29/22, 5:59 AM	VM
In-class support	2	4	1/20/22, 8:39 AM	VM	1/25/22, 7:35 AM	VM
Resources	2	2	1/20/22, 8:39 AM	VM	1/28/22, 7:39 AM	VM
Structured activit...	4	8	1/20/22, 8:39 AM	VM	1/29/22, 5:27 AM	VM
Internal PLD	13	28	1/20/22, 8:39 AM	VM	12/20/22, 9:45 AM	VM
Modelling to othe...	6	14	1/20/22, 8:39 AM	VM	1/29/22, 5:44 AM	VM
Planning	4	4	1/20/22, 8:39 AM	VM	10/12/22, 3:02 AM	VM
Share resources	10	20	1/20/22, 8:39 AM	VM	10/12/22, 4:43 AM	VM
Staff meetings	1	1	1/20/22, 8:39 AM	VM	1/25/22, 6:27 AM	VM
Team teach	0	0	1/20/22, 8:39 AM	VM	1/20/22, 8:39 AM	VM
Off-site	0	0	1/20/22, 8:39 AM	VM	1/20/22, 8:39 AM	VM
External courses	3	4	1/20/22, 8:39 AM	VM	1/28/22, 7:05 AM	VM
Online	0	0	1/20/22, 8:39 AM	VM	1/20/22, 8:39 AM	VM
Own research	4	4	1/20/22, 8:39 AM	VM	1/29/22, 5:25 AM	VM

Appendix 12– NVivo Codes to Key Sections of Text



Appendix 13 – CS1 Teacher Participants' Understanding of Abstraction

ID	Pseudonym	Abstraction	Interview evidence	Observation evidence
P1	Kerry	30 Somewhat can do	"Finding the quickest route and noticing that there were different routes to get to the same place" (Interview – CS1P1Q3).	"Abstraction – getting rid of that unnecessary information. So that must mean the others are together" (Observation – CS1P1).
P2	Ashley	50 Moderately can do	"So that was quite a good one because the students actually have to think about the instructions that they were giving, and check that they would actually be successful for this other student who was then going to follow the instructions to hopefully create the same structure" (Interview – CS1P2Q3).	"He needed to focus on the most important thing he needed to do first. Then we look at the smaller parts and we focus on the part that we need" (Observation – CS1P2).
P3	Jennifer	53 Moderately can do	"There was more than one way to get there - what was the fastest way to get there, what was the longest way, what was water only, what was flying" (Interview – CS1P3Q5).	Students could all break down the bitmap image into sections - pixels. Jennifer explained that each box was a pixel (Observation – CS1P3).
P4	Rachel	84 Totally can do	"I actually modelled it right down from what binary was, to the final product, so they understood it and they were creating their name in the jewellery" (Interview – CS1P4Q8).	The Beebots are moving through the shape and then the students are finding out the perimeter, removing extra unnecessary information (Observation – CS1P4).
P5	Daniel	62 Mostly can do	"Working out what the best way is to do it, what information is required, what isn't required" (Interview – CS1P5Q1).	"It's not 1/0 and they've represented it with different code. This is going to represent a 1/0 (points to the particular code) – abstraction" (Observation – CS1P5).
P6	Luke	29 Somewhat can do	No interview evidence.	The students are working through creating their activity from camp (their recount) and not worrying about all the other details (Observation – CS1P6).
Group median		**52 Moderately can do**		

Appendix 14 - CS1 Teacher Participants' Understanding of Pattern Recognition

ID	Pseudonym	Pattern Recognition	Interview evidence	Observation evidence
P1	Kerry	50 Moderately can do	No interview evidence.	"Make sure you've done your pattern and then you've done your key" (Observation – CS1P1).
P2	Ashley	39 Somewhat can do	No interview evidence.	"It's about looking and identifying things we see" (Observation – CS1P2).
P3	Jennifer	68 Mostly can do	"We turned it into a coordinates lesson on NSEW and moving in directions and they had to move around the different school zones" (Interview – CS1P3Q5).	Jennifer explains what it is and asks the students to give the binary code for one of the sections of the bitmap image. [Student] gets it correct "01000010, yes" "What number represents white (0) and what number represents black? (1)" (Observation – CS1P3).
P4	Rachel	100 Totally can do	"Step by step chunks of information that follow a logical pattern. Beginning, middle end kind of thing, and connect with each other to create what you are wanting to create or solve whatever problem you have" (Interview – CS1P4Q1).	"Do you know your 5x tables and your 10x tables? Then you know how to work this out" (Observation – CS1P4)
P5	Daniel	72 Mostly can do	"So, it's just finding what's best for each situation because each situation could be a little bit different (Interview – CS1P5Q1).	"Have we seen any of these numbers before? 1, 2, 4, 8, 16? Who can explain why it looks like that?" "The star is either a 1 or a 0, and that means it's either on or off. So now you need to match which image has the same 'star star star' [pattern]. What does it relate to?"
P6	Luke	30 Somewhat can do	No evidence.	No evidence
Group median		**59** **Moderately can do**		

Appendix 15 – CS1 Teacher Participants' Understanding of Debugging

ID	Pseudonym	Debugging	Interview evidence	Observation evidence
P1	Kerry	30 Somewhat can do	No evidence.	"So now, test it, try to do it" (Observation – CS1
P2	Ashley	70 Mostly can do	"They [the students] have to debug it as well, which is obviously if they make a mistake they need to go and change it" (Interview – CS1P2Q3).	"You need to think about what people have to get out or get organised in order to create their food" (Observation – CS1P2).
P3	Jennifer	50 Moderately can do	"How they work so if something does go wrong, how do we then fix it?" (Interview – CS1P3Q3).	"You had to do a bit of debugging there". "What would you do differently if you were doing it again?" (Observation – CS1P3).
P4	Rachel	80 Mostly can do	"Or give them the end output and get them to figure out the instructions behind it" (Interview – CS1P4Q3).	"You have to test that you can make those shapes, before you can make your own". "Ok, try it again, sometimes we make mistakes, what was that one?" (Observation – CS1P4).
P5	Daniel	71 Mostly can do	"Them [the students] using Scratch on the devices and having bugs and problems and that where they can locate the bug and then try and fix what's going on" (Interview – CS1P5Q2).	"If you put in the wrong binary code, you're going to get the wrong letter. Another thing is if I don't know how to spell the word. The binary will be different. There were people not doing the code properly, and people who didn't know how to spell the words" (Observation – CS1P5).
P6	Luke	30 Somewhat can do	No evidence.	No evidence.
Group median		**60 Moderately can do**		

Appendix 16 – CS1 Teacher Participants' Understanding of General Problem-Solving

ID	Pseudonym	General Problem-Solving	Interview evidence	Observation evidence
P1	Kerry	53 Moderately can do	No evidence.	No evidence.
P2	Ashley	61 Mostly can do	No evidence.	No evidence.
P3	Jennifer	77 Mostly can do	"The ability to problem-solve, to deconstruct a problem, or an idea, and use a range of problem-solving skills to then solve that problem" (Interview – CS1P3Q1).	No evidence.
P4	Rachel	83 Totally can do	No evidence.	No evidence.
P5	Daniel	61 Mostly can do	No evidence.	No evidence.
P6	Luke	48 Moderately can do	No evidence.	No evidence.
Group median		**61 Mostly can do**		

Appendix 17 – CS1 Teacher Participants' Collective Efficacy Beliefs and Group Effort

ID	Pseudonym	Group effort	Interview Evidence
P1	Kerry	60 Moderately confident	"I've shared resources with - resources that I used last year with new colleagues that are in the junior school this year. And they used it, which was great, so that was good" (Interview – CS1P1Q8).
P2	Ashley	81 Totally confident	"Because I think that some people just need to actually see it to know how to implement it and understand what the next step is" (Interview – CS1P2Q9).
P3	Jennifer	42 Moderately confident	"I noticed that all the kids might not have ever had a go at doing a CT task and for my all-planning checks, I might notice that there is no CT in there and I wonder if it's being taught, or there are ways you could teach it to just start. Even just start with a simple task and then build into it" (Interview – CS1P3Q7).
P4	Rachel	100 Totally confident	"I think it's because we had quite a big investment from leadership in getting the teachers confident in doing so, through PLD and the ongoing opportunities with that that we've had as a school" (Interview – CS1P4Q10).
P5	Daniel	82 Totally confident	"He's done more than I have on it that's for sure. So yeah, you know - everyone is willing to learn here which is good, and we've got the resources, it's just sort of choosing chunks because we don't want to do too much too fast" (Interview – CS1P5Q7).
P6	Luke	*	No evidence
Group median		**81 Totally confident**	

Appendix 18 – CS1 Teacher Participants' Collective Efficacy Beliefs and Group Quality of Outcomes

ID	Pseudonym	Group quality of outcomes	Interview Evidence
P1	Kerry	50 Moderately confident	"Yeah, and I'm sure if asked they would be more than willing to come and show or allow me or other teachers to observe them and learn" (Interview – CS1P1Q11).
P2	Ashley	96 Totally confident	"They not only have a better understanding of computational thinking, but they feel more confident implementing it into their classrooms as well" (Interview – CS1P2Q8).
P3	Jennifer	66 Mostly confident	"When I'm doing observations or in my team in term 1 we reflected on all the things that we were doing and we highlighted them off. And then the stuff we didn't highlight, we looked at term 2, how are we going to implement that so that we are meeting that" (Interview – CS1P3Q13).
P4	Rachel	100 Totally confident	"Our school has made it a priority and I think that it shows in the way that it [CT] has been delivered" (Interview – CS1P4Q13).
P5	Daniel	80 Mostly confident	"Our team at the moment (this team is 3 lead teachers), we have Ashley and Jennifer [and they] are very au fait with it as well. So, they do it in their teams" (Interview – CS1P5Q7).
P6	Luke	*	No evidence
Group median		**80 Mostly confident**	

Appendix 19 – CS1 Teacher Participants' Collective Efficacy Beliefs and General Group Satisfaction

ID	Pseudonym	General Group Satisfaction	Interview Evidence
P1	Kerry	50 Moderately confident	"Yeah, and I'm sure if asked they would be more than willing to come and show or allow me or other teachers to observe them and learn" (Interview – CS1P1Q11).
P2	Ashley	95 Totally confident	"I think it's quite successful because my team understands what we are doing with implementation and they are also able to ask questions, and it's quite a, we learn from each other type of thing as well. I think it's good, because it means that they feel confident in their understanding as well to share ideas." (Interview – CS1P2Q6).
P3	Jennifer	40 Somewhat confident	"I think the way it's taught to schools and the way [the facilitator] presented it meant that it was possible, but I could see that it wouldn't work if you didn't have such a passionate person or such an explicit - [the facilitator] had a very thorough programme that covered it" (Interview – CS1P3Q14).
P4	Rachel	100 Totally confident	"I feel like I'm really lucky because I'm at a school where we are doing a lot of CT and it's becoming a habit with everybody and I'm starting to see, especially having left for a year and then coming back - seeing just how it is integrated so much more into everyone's planning (Interview – CS1P4Q14).
P5	Daniel	77 Mostly confident	"We've got good resources and good staff so I think it'll keep going at this school. We're well placed I think" (Interview – CS1P5Q14).
P6	Luke	*	"This school is like 'go for it, go figure it out and share it around' so culture in this school is huge for actually engaging in this [CT]. Lead from the top, they are that into it, and if you can justify it, they'll buy it - they want to see it be used, but they are totally for it" (Interview – CS1P6Q10).
Group median		**80 Mostly confident**	

Appendix 20 – CS1 Teacher Participants' Collective Efficacy and Group Technology Collaboration and Communication

ID	Pseudonym	General Technology Collaboration and Communication	Interview Evidence
P1	Kerry	100 Totally confident	No evidence.
P2	Ashley	100 Totally confident	No evidence.
P3	Jennifer	71 Mostly confident	"I make a lot of lessons and share them to staff, so I'm big on giving them a lesson they can actually do" (Interview – CS1P3Q7).
P4	Rachel	100 Totally confident	"I'm at a school where we are doing a lot of CT and it's becoming a habit with everybody" (Interview – CS1P4Q14).
P5	Daniel	89 Totally confident	"We've got the knowledge, and we've got the resources so it's just keeping a push on it" (Interview – CS1P5Q2).
P6	Luke	98 Totally confident	No evidence.
Group median		**99** **Totally confident**	

Appendix 21 – CS1 School Leader Participants' Understanding of Abstraction

ID	Pseudonym	Abstraction	Interview evidence
P7	Brent	65 Mostly can do	No evidence
P8	Eliza	65 Mostly can do	"Manageable components, to be able complete a task or to be able to show a process. So, the aspects of decomposition, and abstraction" (Interview – CS1P8Q1).
Group median		**65** **Mostly can do**	

Appendix 22 – CS1 School Leader Participants' Understanding of Pattern Recognition

ID	Pseudonym	Pattern Recognition	Interview evidence
P7	Brent	80 Totally can do	No evidence
P8	Eliza	90 Totally can do	No evidence
Group median		**85** **Totally can do**	

Appendix 23 – CS1 School Leader Participants' Understanding of Debugging

ID	Pseudonym	Debugging	Interview evidence
P7	Brent	*	No evidence
P8	Eliza	60 Moderately can do	No evidence
Group median		**60** **Moderately can do**	

Appendix 24 – CS1 School Leader Participants' Understanding of General Problem Solving

ID	Pseudonym	General Problem Solving	Interview evidence
P7	Brent	58 Moderately can do	"I sort of understand the need to engage our students in these environments that promotes this CT or this multifaceted approach to problem-solving" (Interview – CS1P7Q1).
P8	Eliza	65 Mostly can do	"Looking at how the theme for the term and the problems lend themselves toward CT" (Interview – CS1P8Q3).
Group median		**62** **Mostly can do**	

Appendix 25 – CS1 School Leader Participants' Collective Efficacy Beliefs and Group Technology Collaboration and Communication

ID	Pseudonym	Group technology collaboration and communication	Interview Evidence
P7	Brent	80 Mostly confident	"I think that where we were in terms of the school, where we were in terms of the staff, things just fell into place for us. We were initiating BYOD" (Interview – CS1P7Q8).
P8	Eliza	85 Mostly confident	"Therefore, everyone had to be digitally quite fluent and capable and competent" (Interview – CS1P8Q7).
Group median		**83** **Mostly confident**	

Appendix 26 – CS1 School Leader Participants' Collective Efficacy Beliefs and Group Capability

ID	Pseudonym	Group capability	Interview Evidence
P7	Brent	80 Mostly confident	"I have great confidence in some of my leaders sharing and disseminating that amongst staff" (Interview – CS1P7Q4).
P8	Eliza	90 Totally confident	"It's not like we have to lead it, because our staff are quite confident with it" (Interview – CS1P8Q4).
Group median		**85** **Totally confident**	

Appendix 27 – CS1 School Leader Participants' Collective Efficacy Beliefs and Group Quality of Outcomes

ID	Pseudonym	Group Quality of outcomes	Interview Evidence
P7	Brent	100 Totally confident	"I think that the big things, and they're always going to be, teachers' own professional outreach and resourcing. You're always going to have those people at the different ends of the continuum" (Interview – CS1P7Q5).
P8	Eliza	90 Totally confident	"Yes, we have the expectation of integration of our full curriculum but also digital technologies but it's more so for our learners, we know how important it is for their future rather than just doing it as a tick box I suppose (Interview – CS1P8Q6).
Group median		**95** **Totally confident**	

Appendix 28 – CS1 School Leader Participants' Collective Efficacy Beliefs and General Group Satisfaction

ID	Pseudonym	Group Satisfaction	Interview Evidence
P7	Brent	100 Totally confident	"An understanding and a willingness" (Interview – CS1P7Q3).
P8	Eliza	90 Totally confident	"That accelerates the process in terms of the confidence and competence to implement but also just the collegiality of our staff" (Interview – CS1P8Q6).
Group median		**95** **Totally confident**	

Appendix 26 – CS2 Teacher Participants' Understanding of Abstraction

ID	Pseudonym	Abstraction	Interview evidence	Observation evidence
P1	Steven	85 Totally can do	No evidence.	"What are the key things we have to focus on?" (Observation – CS2P1). "Key details need to be included. Specifics" (Observation – CS2P1).
P2	Andrea	41 Moderately can do	No evidence.	"Did they overcomplicate it? If it was the ones that worked, were they simple or overcomplicated? (Observation – CS2P2).
P3	Cherie	52 Moderately can do	No evidence.	"Remember only the number of instructions those lines will take" (Observation – CS2P3).
P4	Isla	70 Mostly can do	No evidence.	No evidence.
P5	Theo	50 Moderately can do	No evidence.	No evidence.
Group median		**52** **Moderately can do**		

Appendix 27 – CS2 Teacher Participants' Understanding of Pattern Recognition

ID	Pseudonym	Pattern Recognition	Interview evidence	Observation evidence
P1	Steven	84 Mostly can do	No evidence.	No evidence.
P2	Andrea	57 Moderately can do	"Helped aide the students' understanding so that they would recognise patterns" (Interview – CS2P2Q6).	"Separate each command with a comma" (Observation – CS2P2).
P3	Cherie	57 Moderately can do	No evidence.	"What symbol do you want for that? We've already got lots of arrows and that might be a bit confusing" (Observation – CS2P3).
P4	Isla	75 Mostly can do	No evidence.	No evidence.
P5	Theo	52 Moderately can do	"We've done a simple square, getting them [the students] to be able to program that" (Interview – CS2P5Q3).	"How many degrees in a full circle? 360 degrees. How many degrees if I go right, backwards, left?" (Observation – CS2P5).
Group median		**57** **Moderately can do**		

Appendix 28 – CS2 Teacher Participants' Understanding of Debugging

ID	Pseudonym	Debugging	Interview evidence	Observation evidence
P1	Steven	86 Totally can do	"How to debug their program and then fine tune it to make sure it actually worked as intended" (Interview – CS2P1Q3).	No evidence.
P2	Andrea	0 Cannot do	"If they make an error, they have to like debug, and go back" (Interview – CS2P2Q3). "Understand that if they made a mistake, instead of rubbing it out, they could take the code away and change it" (Interview – CS2P2Q6).	"Test your program, did it work? No, debug. What does debug mean?" Student – "find out what the problem is in your code and try to fix it" (Observation – CS2P2). "Figure it out if you have to debug" (Observation – CS2P2).
P3	Cherie	79 Mostly can do	"Debugging type thing" (Interview – CS2P3Q1). "Learning the language or how to debug something on paper" (Interview – CS2P3Q3).	"But they had to go back and fix it. What do we call that?" (Observation – CS2P3).
P4	Isla	43 Moderately can do	"When things go wrong, what went wrong, and how we can learn from it" (Interview – CS2P4Q4).	No evidence.
P5	Theo	61 Moderately can do	"I couldn't say ' Hey I had this problem and I debugged' and all that sort of thing. Not explicitly I wouldn't imagine. I'm sure I have" (Interview – CS2P5Q8).	"What do you do if you've got a bug? You've got to debug it. You've got to fix it" (Observation – CS2P5).
Group median		**61** **Moderately can do**		

Appendix 29 – CS2 Teacher Participants' Understanding of General Problem Solving

ID	Pseudonym	General problem solving	Interview evidence	Observation evidence
P1	Steven	80 Mostly can do	No evidence.	No evidence.
P2	Andrea	16 Somewhat can do	No evidence.	"What sort of step by step instructions have you been taught for reading? What happens when you come across a word you don't know? You debug it using google or a dictionary" (Observation – CS2P1)
P3	Cherie	56 Moderately can do	"It's actually solving problems" (Interview – CS2P3Q1). "So if they've got a problem they've got to figure out how to manage it, or solve it" (Interview – CS2P3Q1).	No evidence.
P4	Isla	66 Mostly can do	"So I learn about what I can do by breaking it down with instructions" (Interview – CS2P4Q5).	No evidence.
P5	Theo	61 Mostly can do	" I'll just try anything and see if I can get the hang of it I guess" (Interview – CS2P5Q4).	No evidence.
Group median		**61** **Mostly can do**		

Appendix 30 – CS2 Teacher Participants' Collective Efficacy Beliefs and Group Computing Concepts Knowledge and Skills

ID	Pseudonym	Group computing concepts knowledge and skills	Interview evidence
P1	Steven	61 Moderately confident	No evidence.
P2	Andrea	11 Not confident	"It would be the differing of knowledge or willingness" (Interview – CS2P2Q10). "Time to upskill is tricky" (Interview – CS2P2Q12).
P3	Cherie	60 Moderately confident	"Some people might overthink things" (Interview – CS2P3Q12). "It just takes a little longer to pick up activities and things" (Interview – CS2P3Q12).
P4	Isla	44 Moderately confident	"I don't know. That I don't know" (Interview – CS2P4Q10).
P5	Theo	60 Moderately confident	"It's a good thing because people are willing to give things a go and technology is a bit more second nature to them because they've always had devices" (Interview – CS2P5Q10).
Group median		**60 Moderately confident**	

Appendix 31 – CS2 Teacher Participants' Collective Efficacy Beliefs and Group Technology Collaboration and Communication

ID	Pseudonym	Group technology collaboration and communication	Interview evidence
P1	Steven	89 Totally confident	No evidence.
P2	Andrea	100 Totally confident	No evidence.
P3	Cherie	56 Moderately confident	No evidence.
P4	Isla	0 Not confident	No evidence.
P5	Theo	63 Mostly confident	No evidence.
Group median		**63** **Mostly confident**	

Appendix 32 – CS2 Teacher Participants' Collective Efficacy and Group Effort

ID	Pseudonym	Group Effort	Interview Evidence
P1	Steven	72 Mostly confident	"But then I think across the whole school, this year especially, we've felt like our workload is quite a lot. So, we've found it's quite difficult to give a lot of explicit teaching on CT" (Interview – CS2P1Q10).
P2	Andrea	52 Moderately confident	"Like I mean we are quite a willing school, but I guess that everybody is at different levels of what they want to learn and what they don't. And that runs along the side of the fact that we are a very willing school" (Interview – CS2P2Q10).
P3	Cherie	63 Moderately confident	"I do understand with timetable constraints and we've got heaps of other things to fit in with maths and things like that, I totally understand" (Interview – CS2P3Q12).
P4	Isla	81 Mostly confident	"I can't answer that because I've never seen it put in front of me or been addressed. I think it may be - what happens in classrooms is never physically seen" (Interview – CS2P4Q13).
P5	Theo	25 Somewhat confident	"If it's something new, you go back to how you were taught and it's - I see that - I see people who get really comfortable. They teach this way because that's the way they've always done it and that's worked ok for them, maybe not the best" (Interview – CS2P5Q14).
Group median		**63** **Mostly confident**	

Appendix 33 – CS2 Teacher Participants' Collective Efficacy and Group Quality of Outcomes

ID	Pseudonym	Group quality of outcomes	Interview Evidence
P1	Steven	77 Mostly confident	"I think because the whole school has made it a little bit of a focus, the fact that we are sharing a lot of ideas and resources definitely helps get it across" (Interview – CS2P1Q11).
P2	Andrea	73 Mostly confident	"And there was a great support with the roll-out with the hours, and even with moving into lockdown and being able to use all the technology" (Interview – CS2P2Q13).
P3	Cherie	75 Mostly confident	"We've got people doing it in inquiry, we've got some teachers using it in writing, and that kind of thing. So it started off as a maths thing but as teachers are growing in confidence they are using it in other areas which is quite cool" (Interview – CS2P3Q13).
P4	Isla	82 Mostly confident	No evidence.
P5	Theo	19 Somewhat confident	"Teachers probably don't know they are already doing this anyway and they think 'Oh god I've got to do something extra now' when they are actually already doing it. They're debugging with their classes, they're going through - you've got to write this part of your story before you write that part and they're probably thinking about it, but not with the title of CT" (Interview – CS2P5Q14).
Group median		**76** **Mostly confident**	

Appendix 34 – CS2 School Leader Participant Understanding of Abstraction

ID	Pseudonym	Abstraction	Interview evidence
P7	Nathan	52 Moderately can do	No evidence.
Overall		**52** **Moderately can do**	

Appendix 35 – CS2 School Leader Participant Understanding of Pattern Recognition

ID	Pseudonym	Abstraction	Interview evidence
P7	Nathan	51 Moderately can do	No evidence.
Overall		**51** **Moderately can do**	

Appendix 36 – CS2 School Leader Participant Understanding of Debugging

ID	Pseudonym	Abstraction	Interview evidence
P7	Nathan	52 Moderately can do	No evidence.
Overall		**52** **Moderately can do**	

Appendix 37 – CS2 School Leader Participant Understanding of General Problem Solving

ID	Pseudonym	Abstraction	Interview evidence
P7	Nathan	40 Moderately can do	No evidence.
Overall		**40** **Moderately can do**	

Appendix 38 – CS2 School Leader Participant Collective Efficacy and Group Technology Collaboration and Communication

ID	Pseudonym	Group technology collaboration and communication	Interview Evidence
P6	Nathan	81 Totally confident	"[A teacher] was using spheros in mathematics and that was sort of like, here's a unit plan to go with. If you're going to use the spheros we don't want you to have to just sort of make it all up" (Interview – CS2P6Q2).
Overall		**81** **Totally confident**	

Appendix 39 – CS2 School Leader Participant Collective Efficacy and Group Capability

ID	Pseudonym	Group capability	Interview Evidence
P6	Nathan	62 Mostly confident	"I haven't walked around our school and seen spheros used outside of maths or inquiry. I haven't seen them used in a different curriculum area when someone's gone, 'You know, this could really add to the experience for those students in this, in this area'. I haven't seen it used in science for example" (Interview – CS2P6Q3)
Overall		**62** **Mostly confident**	

Appendix 40 – CS2 School Leader Participant Collective Efficacy and Group Effort

ID	Pseudonym	Group effort	Interview Evidence
P6	Nathan	72 Mostly confident	"The staff are very willing; we don't get a lot of resistance for new learning. I don't necessarily know, if you're a facilitator who comes in I don't think you walk in and 'go wow what a staff who just visibly blown away and are just so keen'. There's sort of like, okay, cool. I'll do that" (Interview – CS2P6Q6). "It's just a matter of prioritizing it within a busy week and opening those opportunities" (Interview – CS2P6Q7).
Overall		**72** **Mostly confident**	

Appendix 41 – CS2 School Leader Participant Collective Efficacy and Group Quality of Outcomes

ID	Pseudonym	Group quality of outcomes	Interview Evidence
P6	Nathan	74 Mostly confident	"That had varying levels of success, you know, a lot depending on the confidence of the, of the teacher, but also the ability to I guess, flex into some new learning within a subject that they're probably learning a bit more as they go anyway" (Interview – CS2P6Q2).
Overall		**72** **Mostly confident**	

Appendix 42 – CS3 Teacher Participants' Understanding of Abstraction

ID	Pseudonym	Abstraction	Interview evidence	Observation evidence
P1	Linda	70 Mostly can do	"The important parts of the problem" (Interview – CS3P1Q1).	"Is that a part that they need to do in order to be successful with their algorithm?" (Observation – CS3P2).
P2	Daryl	47 Moderately can do	No Interview evidence	Daryl connected the parity bits activity to how data is stored and transmitted.
P3	Addison	70 Mostly can do	"Abstraction is looking at something, and being able to discern what the important information is that you need in that moment, and being able to let everything kind of fall to the background that is unnecessary at that time" (Interview – CS3P3Q1).	"Focus on the important bit and let everything else fade away" (Observation – CS3P3).
P4	Maria	80 Mostly can do	"Abstraction is ignoring certain aspects of the problem and focusing on a particular part of the problem" (Interview – CS3P4Q1).	No evidence.
P5	Jessica	50 Moderately can do	"Abstraction is focusing just on one thing, not focusing on everything, but just focusing on one main thing" (Interview – CS3P5Q1).	No evidence.
P6	Ted	41 Moderately can do	No interview evidence	"Abstraction - how did it help us figure out the problems? Maybe it helped us to really zero in on the important stuff. We only focused on the two wires we used." (Observation – CS3P6).

ID	Pseudonym	Abstraction	Interview evidence	Observation evidence
P7	Susan	75 Mostly can do	"Where it is like when we look at abstraction and taking out what we don't need" (Interview – CS3P7Q1).	"So, we could say, 'go to the top' - how else do we say directions? Can we use right and left to describe where to start?" (Observation – CS3P7).
P8	Christina	48 Moderately can do	"They can see if they're abstracting the important information the game goes a little bit quicker, than if they're focusing on stuff that isn't as important" (Interview – CS3P8Q3).	No evidence.
P9	Kelly	100 Totally can do	No evidence	"Tell me about those pink blocks? What do they do?" Student – "those are repeat blocks. You attach it there and it'll keep going in that direction." (Observation – CS3P9).
P10	Holly	76 Mostly can do	No evidence.	No evidence.
Group median		**70 Mostly can do**		

Appendix 43 – CS3 Teacher Participants' Understanding of Algorithmic Thinking

ID	Pseudonym	Algorithmic Thinking	Interview evidence	Observation evidence
P1	Linda	50 Moderately can do	"Help them to better figure out the steps that they might need to do" (Interview – CS3P1Q1).	"We've got a blank sheet of paper, what's the first thing you'd write? Would you write it like this? How would you write it?" (Observation – CS3P1).
P2	Daryl	55 Moderately can do	No interview evidence	"It was following an algorithm; it was following a set of rules" (Observation – CS3P2).
P3	Addison	0 Cannot do at all	No interview evidence	
P4	Maria	44 Moderately can do	"Creating algorithms to solve problems" (Interview – CS3P4Q1).	No evidence.
P5	Jessica	20 Somewhat can do	No evidence	Jenna sits on the floor and helps a student work through the problem. She asks the student to finger point his way through the activity.
P6	Ted	16 Cannot do at all	No evidence.	"What's the first step that we use?" (Observation – CS3P6).

ID	Pseudonym	Algorithmic Thinking	Interview evidence	Observation evidence
P7	Susan	0 Cannot do at all	No evidence.	“If I go two stops, watch me. One, two.” (Observation – CS3P7).
P8	Christina	39	“Being able to problem solve by going through the steps of, you know, thinking through a situation like it's an algorithm” (Interview – CS3P9Q1). “Not everybody's steps are the same, I wanted them to understand that we have to go through the steps” (Interview – CS3P9Q3).	No evidence.
P9	Kelly	51	“help them to better figure out the steps that they might need to do” (Interview – CS3P1Q1).	“Let’s take a look at our directions. Kelly points to various things on the screen. So how are we going to make it go from there to there?” (Observation – CS3P9).
P10	Holly	54	No evidence.	The activity in itself was using algorithmic thinking, however, this was no explicitly discussed during the observation.
Group median		**42** **Moderately can do**		

Appendix 44 – CS3 Teacher Participants' Understanding of Debugging

ID	Pseudonym	Debugging	Interview evidence	Observation evidence
P1	Linda	70 Moderately can do	No evidence	"Which parts of your algorithm are clear? Which are difficult to understand? Think about what they could change, so it can be 'debugged'" (Observation – CS3P1).
P2	Daryl	10 Cannot do at all	No evidence	"When I did that trick, I was finding the error. Computers can do it on a much grander scale. Computers can find and check for errors" (Observation – CS3P2).
P3	Addison	60 Moderately can do	"Debugging is looking for ways that the problem, you know that you might have run into things that have prevented you from maybe solving the problem or creating what you're trying to create and figuring out a way to get around those two would be the debugging" (Interview – CS3P3Q1).	"Think about the problems you ran into, and how you could debug to get around that problem" (Observation – CS3P3).
P4	Maria	30 Somewhat can do	"Debugging is finding errors in an algorithm or a process and fixing those errors" (Interview – CS3P4Q1).	"Give one example how your groups debugged today? And how did that help you learn?" (Observation – CS3P4).
P5	Jessica	20 Cannot do at all	"I always explain it to my kids that there's a problem, and that we have to go back in, so a problem with the code we have to go back in and try to figure out what the problem is, not throw the whole code away, but looking for where there was like a specific step that might have gone wrong" (Interview – CS3P5Q1).	"You have to find out where did I make a mistake, go back and solve that problem" (Observation – CS3P5). Jessica circles the section which is incorrect and then explains that only the circled section needs to be fixed.

ID	Pseudonym	Debugging	Interview evidence	Observation evidence
P6	Ted	15 Cannot do at all	No evidence	“I heard a lot of groups use the word debug. What did you have to debug? Tell me what it was? And then how you went back and fixed your mistake” (Observation – CS3P6).
P7	Susan	70 Mostly can do	No evidence	“We have to test our code. Who remembers what debugging means? To fix our mistakes. Is debugging bad? No.” (Observation – CS3P7).
P8	Christina	46 Moderately can do	“And if they got to the last shape and it didn't match their partner's shape - using their debugging skills to figure out where they went wrong” (Interview – CS3P8Q3).	No observation evidence.
P9	Kelly	71 Mostly can do	“What's not working, and just kind of troubleshooting through those problem-solving steps” (Interview – CS3P9Q1).	“Now see if it works for you. Remember it won’t do it until you hit reset and run.” (Observation – CS3P9).
P10	Holly	57 Moderately can do	“Debugging is finding and fixing the mistakes” (Interview – CS3P10Q1). “I like debugging, because we use that in math. And I've kind of forced myself to use that vocabulary. When we're trying to find a mistake? Or does my answer make sense, or can I go back and like I messed one step? What can I debug?” (Interview – CS3P10Q3).	“We need to debug it, there is something blocking him, what should we do? I suggest we get rid of the code and start over.” (Observation – CS3P10).
Group median		**52 Moderately can do**		

Appendix 45 – CS3 Teacher Participants' Understanding of General Problem Solving

ID	Pseudonym	General problem solving	Interview evidence	Observation evidence
P1	Linda	83 Totally can do	"I think being able to think through that a little bit more intentionally, instead of just trying problem after problem after problem" (Interview – CS3P1Q3).	"What do you mean by that? When you say you multiply them, what do you mean by that?" (Observation – CS3P1).
P2	Daryl	71 Mostly can do	"And that design thinking was more about going, had a personal touch to it where they were looking at a specific person's problem, and thinking about creative and different ways to solve that problem" (Interview – CS3P2Q2).	No evidence.
P3	Addison	70 Mostly can do	"Gives them a set of tools that will assist them in figuring out ways to plan and attack problems that they're presented with" (Interview – CS3P3Q1).	No evidence.
P4	Maria	72 Mostly can do	"So they're reinforcing what they're learning in the collaboration centre. And reading also, we think about solving problems" (Interview – CS3P4Q7).	No evidence.
P5	Jessica	75 Mostly can do	No evidence.	No evidence.
P6	Ted	30 Somewhat can do	"When they get stuck on the problem, they've got some other options" (Interview – CS3P6Q1).	No evidence.
P7	Susan	40 Somewhat can do	No evidence.	No evidence.
P8	Christina	38 Somewhat can do	No evidence.	No evidence.

P9	Kelly	70 Mostly can do	No evidence.	No evidence.
P10	Holly	78 Mostly can do	No evidence.	No evidence.
Group median		**71 Mostly can do**		

Appendix 46 – CS3 Teacher Participants' Collective Efficacy and Group Computing Knowledge and Skills

ID	Pseudonym	Group computing concepts knowledge and skills	Interview evidence
P1	Linda	80 Mostly confident	No evidence.
P2	Daryl	35 Somewhat confident	No evidence.
P3	Addison	80 Mostly confident	"Linda teaches our gifted and talented program, and is constantly looking for those extensions, and she's always had a bit more freedom than we have when it comes to content, because her goal in her classroom is more of this problem solving, outside the box, computational thinking" (Interview – CS3P3Q11).
P4	Maria	84 Totally confident	No evidence.
P5	Jessica	80 Mostly confident	No evidence.
P6	Ted	14 Not confident at all	No evidence.
P7	Susan	70 Mostly confident	"I go into her room a lot. She was my teaching partner before, and she's a lot younger than me. So, she's a lot better at technology than I am" (Interview – CS3P7Q8).
P8	Christina	49 Moderately confident	No evidence.

ID	Pseudonym	Group computing concepts knowledge and skills	Interview evidence
P9	Kelly	50 Moderately confident	No interview evidence.
P10	Holly	85 Totally confident	No interview evidence.
Group median		**75** **Mostly confident**	

Appendix 47 – CS3 Teacher Participants' Collective Efficacy and Group Capability

ID	Pseudonym	Group capability	Interview evidence
P1	Linda	100 Totally confident	"So there's also a smaller program that I'm a part of where there's a third, fourth, and fifth here at Explorer and Debbie Hayes is the third grade, and then we have a fifth grade teacher, who did not do the computational thinking. So we're trying to pull her along a little bit, too, and think if there's some things that we might be able to do across grade level along with computational thinking, so that her kids can get some of that, too" (Interview – CS3P1Q7).
P2	Daryl	83 Totally confident	"If I didn't have someone that was encouraging me and excited about this at the same time it would be really difficult" (Interview – CS3P2Q12).
P3	Addison	100 Totally confident	"Everything that we've done in our group has been really helpful. I think that the text that we've read have been important, and something that's nice to be able to refer back to. But I really like the hands-on experiences that we did in our professional development because it put us in the seats of the kids. And, you know. Really, let us experience the engagement" (Interview – CS3P3Q10).
P4	Maria	91 Totally confident	"I think we are very lucky that we have three of my co-teachers that are in the class with us, and then another one that is supportive of us doing the CT lessons. I think it would be much more difficult to implement it if we didn't have each other because the load would fall, like we share the load, we share our activities" (Interview – CS3P4Q11).
P5	Jessica	100 Totally confident	"I think that if other teachers have that professional development on CT that they could easily think about how it could be incorporated into their classroom as well" (Interview – CS3P5Q11).
P6	Ted	65 Mostly confident	No evidence.

ID	Pseudonym	Group capability	Interview evidence
P7	Susan	100 Totally confident	"I've gone into other teachers' rooms that have done the CT, and observed them before. I felt more confident when I didn't have students in my classroom, and I wanted to see how they were doing it. I went into their classroom, so I went into Christina's classroom, and then Daryl's" (Interview – CS3P7Q8).
P8	Christina	62 Mostly confident	No interview evidence.
P9	Kelly	70 Mostly confident	"It's such an unknown concept. So and how it can be used, and why it's beneficial for kids to start now rather than wait, you know, until middle school and high school" (Interview – CS3P9Q11).
P10	Holly	79 Mostly confident	"They ask about it. But you know, they don't, they don't throw it out and say, you know that's not for me or my kids are too little. They're curious. So I guess awareness and just talking about it is a positive thing" (Interview – CS3P10Q11).
Group median		**87** **Totally confident**	

Appendix 48 – CS3 Teacher Participants' Collective Efficacy and Group Quality of Outcomes

ID	Pseudonym	Group quality of outcomes	Interview evidence
P1	Linda	75 Mostly confident	"So I think that'd be really cool for this is to be able to see what other people are doing and how they're incorporating it, cause I can see for some people if they're like the only one in their building. They probably feel like a little bit of an island right now, and they're not maybe like It's a lot harder to find resources on your own. If you don't have anyone to talk to" (Interview – CS3P1Q10).
P2	Daryl	81 Totally confident	No evidence.
P3	Addison	100 Totally confident	No evidence.
P4	Maria	91 Totally confident	No evidence.
P5	Jessica	100 Totally confident	No evidence.
P6	Ted	45 Moderately confident	No evidence.
P7	Susan	70 Mostly confident	"She was my teaching partner before, and she's a lot younger than me. So she's a lot better at technology than I am" (Interview – CS3P7Q8).
P8	Christina	86 Totally confident	No evidence.

ID	Pseudonym	Group quality of outcomes	Interview evidence
P9	Kelly	100 Totally confident	No evidence.
P10	Holly	0 Not confident at all	No evidence.
Group median		**84** **Totally confident**	

Appendix 49 – CS3 Teacher Participants' Collective Efficacy and General Group Satisfaction

ID	Pseudonym	General group satisfaction	Interview evidence
P1	Linda	100 Totally confident	"I would say a really big role. I think that they keep it more on the forefront of my mind as well, because we talk about it every week. 'What are you doing? What do we want to do?' Moving forward. What have we already done? So I think without them it might be easier for it to just be kind of 'Oh, like I've got a I'm behind on this', so I just won't do CT for today, or something like that. So I think that they do help me move forward and help keep me accountable" (Interview – CS3P1Q11).
P2	Daryl	88 Totally confident	"Being held accountable like 'Okay, by Friday they need to know these few things'. So they can perform on Friday and that is a level of accountability that's really valuable and important (Interview – CS3P2Q12).
P3	Addison	100 Totally confident	"Everything that we've done in our group has been really helpful" (Interview – CS3P3Q10).
P4	Maria	90 Totally confident	"So I know our principal supports us. But I wonder if there are other principals, if they don't know much about it - would they see the value, or can see it without really studying it or knowing much about it. That would be another thing. I might be nervous to talk to [the principal] about it" (Interview – CS3P4Q9). "I know that our superintendent is big on the computational thing, and just because he invited you guys and kind of reached out and accepted this class as an option. So I definitely feel supported in that. If you were to, you know, come in and see us in the Collaboration Centre, I would be excited to share that with him, just because I know he has a positive mindset about it" (interview – CS3P4Q9).

ID	Pseudonym	General group satisfaction	Interview evidence
P5	Jessica	100 Totally confident	"So I think, like the summer, us learning about it, having those days to kind of experiment and talk and make lessons, and just kind of get us thinking that was my big thing. I just needed to understand what it was, and then I could think like, 'Okay, can I incorporate it this way? Can this still work', you know, and just kind of getting that reassurance that I am on the right track" (Interview – CS3P5Q11).
P6	Ted	41 Moderately confident	"So I I would say that there's an overall interest, especially when you're saying, there doesn't really have to be intense training for it. And it's something that you can use with almost anything in your class. So say they seem interested" (Interview – CS3P6Q7).
P7	Susan	100 Totally confident	"But it really helped it come alive and have the chance to kind of work with the people there" (Interview – CS3P7Q10).
P8	Christina	93 Totally confident	"I really enjoy it. I wish I knew more, and I wish it was kind of like a district or building thing because I think it's very interesting and very important, and I think it will help content [understanding] as well" (Interview – CS3P8Q13).
P9	Kelly	100 Totally confident	"I think that everything is easier with peers" (Interview – CS3P9Q11).
P10	Holly	0 Not confident at all	No evidence.
Group median		**97 Totally confident**	

Appendix 50 – CS3 Coach Participants' Understanding of Decomposition

ID	Pseudonym	Decomposition	Interview evidence
P11	Ruth	50 Moderately can do	"Decomposition would mean to break something down into smaller pieces. So, but like a word problem, for example, like, Okay, where do I start first? And what am I trying to figure out?" (Interview – CS3P11Q1).
P12	Beth	64 Moderately can do	"Decomposition would be really to break that information down into manageable steps" (Interview – CS3P12Q1). "What's the problem? What are we trying to fix? How can we break that down?'" (Interview – CS3P12Q8).
Group median		**57** **Moderately can do**	

Appendix 51 – CS3 Coach Participants' Understanding of Algorithmic Thinking

ID	Pseudonym	Algorithmic Thinking	Interview evidence
P11	Ruth	20 Somewhat can do	No evidence.
P12	Beth	52 Moderately can do	No evidence.
Group median		**36** **Somewhat can do**	

Appendix 52 – CS3 Coach Participants' Understanding of Debugging

ID	Pseudonym	Debugging	Interview evidence
P11	Ruth	0	"Well, where is the problem in this, which is the part that we could fix. So that's exactly that, debugging right? You're trying to find it" (Interview – CS3P11Q1).
P12	Beth	61 Moderately can do	"Debugging kind of comes into the troubleshooting process and coming back and trying new things" (Interview – CS3P12Q1).
Group median		**31** **Somewhat can do**	

Appendix 53 – CS3 Coach Participant Understanding of General Problem Solving

ID	Pseudonym	General problem solving	Interview evidence
P11	Ruth	73 Mostly can do	No evidence.
P12	Beth	67 Mostly can do	No evidence.
Group median		**70** **Mostly can do**	

Appendix 54 – CS3 Coach Participants' Collective Efficacy and Group Computing Concepts Knowledge and Skills

ID	Pseudonym	Group computing concepts knowledge and skills	Interview evidence
P11	Ruth	31 Somewhat confident	"What has been working in your class? How have you tried working with CT with your students. What does that look like?" (Interview – CS3P11Q10).
P12	Beth	91 Totally confident	"Helping them establish a vision of how they can incorporate it in their classrooms" (Interview – CS3P12Q7).
Group median		**61** **Moderately confident**	

Appendix 55 – CS3 Coach Participants' Collective Efficacy and Group Capability

ID	Pseudonym	Group capability	Interview evidence
P11	Ruth	100 Totally confident	"We've got a number of key players from different schools who were those early adopters, and ready to try it out and dedicate a couple of days over the summer, and some asynchronous learning opportunities to learn more about it, and I think that as more people find out about it, they're going to be totally on board with using CT" (Interview – CS3P11Q7).
P12	Beth	91 Totally confident	"Some just want me to provide them with the technology, and then they can develop things on their own" (Interview – CS3P12Q5).
Group median		**96** **Totally confident**	

Appendix 56 – CS3 Coach Participants' Collective Efficacy and Group Effort

ID	Pseudonym	Group effort	Interview evidence
P11	Ruth	100 Totally confident	"The teachers that I've worked with have all kind of done it on their own. And I've found out after the fact, like, 'Okay, wait, you're doing something. Can I come in and watch?'" (Interview – CS3P11Q3).
P12	Beth	84 Mostly confident	"I think it's [CT] something that we've already been doing" (Interview – CS3P12Q8).
Group median		**92** **Totally confident**	

Appendix 57 – CS3 Coach Participants' Collective Efficacy and Group Quality of Outcomes

ID	Pseudonym	Group quality of outcomes	Interview evidence
P11	Ruth	100 Totally confident	"The teacher didn't really have necessarily a focus or a goal that she wanted the students to accomplish. It was really to just think about how they were applying the components of computational thinking throughout that exploration process" (Interview – CS3P11Q3).
P12	Beth	83 Mostly confident	"I've recently worked with teachers on integrating the mice robots, and it gets to introducing that to start bringing forth that vocabulary in our lower EL grades" (Interview – CS3P12Q3).
Group median		**91** **Totally confident**	