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**A thesis presented in partial fulfilment of the requirements for the degree of  
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Primary School Teachers' Feelings About Teaching Mathematics Using a Problem-  
Solving Approach**



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## **Abstract**

The importance of teaching the problem solving approach in the mathematics curriculum has been centralised for many years in both curriculum development and research. Yet there is still resistance from teachers to adopting the problem-solving approach when teaching mathematics. The existing literature identifies that teachers' beliefs, attitudes, mathematical knowledge, and previous experiences in learning mathematics effect their ability to implement the problem-solving approach in mathematics, but little is known about the emotional side of the experiences of adopting problem-solving approach by primary school teachers. Emotions have a pivotal role in learning and learning outcomes. Emotions affect learning and learning affects emotions, therefore, they are central to efficient teaching and learning processes. To understand and gain insights into teachers' emotions in teaching problem-solving approach in mathematics, the aim of this research is to explore New Zealand primary school teachers' feelings in the implementation of the problem-solving approach. Qualitative research methods were employed to collect the in-depth data from four primary school teachers using semi-structured interviews via Zoom. The cognitive theory of emotions 'The OCC theory' and thematic analysis was used to identify emotions and situations that elicit such emotions. Results show both positive and negative emotions and highlight that the main sources of teachers' emotions are students' participation and collaboration, teachers' self-held beliefs, job context, and classroom environment. The study outlines that it is crucially important to understand the eliciting situations leading to such emotions in order to increase the implementation of the problem-solving approach in primary school education. Furthermore, to support teachers with the shift towards the problem-solving approach, this study also outlines that there should be some level of emotional support for teachers alongside the material support (such as providing school wide PLD and resources).

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## Introduction

Problem-solving competence is highly prioritised in curriculum documents and is considered essential (Hannula, 2015). Teaching mathematics through problem-solving has been encouraged by many studies in the past decades (Cai, 2003). Students should have the opportunity to engage in problem-solving activities from the primary school level as they tend to form their thinking patterns from a young age (Lesh & Zaeojewski, 2007; Nieuwoudt, 2015; Van de Walle et al., 2013). Moreover, the Primary School Mathematics Curriculum in Ireland stated that problem-solving experiences develop “the ability to plan, take risks, learn from trial and error, check and evaluate solutions and think logically” (O’Shea & Leavy, 2013, p. 297).

Problem-solving has been part of the New Zealand curriculum since 1992 (Holton et al., 1999). “While problem-solving is not a category within the New Zealand Curriculum (2007), the key competency of thinking includes problem-solving.” (“NZ maths,” n.d.). The New Zealand curriculum defines the key competency of thinking: “Thinking is about using creative, critical, and metacognitive processes to make sense of information, experiences, and ideas.” (The Ministry of Education, 2015, p.12). In addition, students use their thinking skills to create models and predict outcomes, conjectures, justify and verify, and seek patterns and generalisations (The Ministry of Education, 2015).

The New Zealand Curriculum emphasises the implementation of problem-solving skills from primary school education and encourages teachers to design learning tasks that promote problem-solving skills in all curriculum areas. Teachers are key in the effort to make problem-solving activities habitual (Maullyda et al., 2019). Teachers’ actions, subject knowledge, and instructional practices are considered critical factors influencing students’ problem-solving skills (Maullyda et al., 2019). Edo et al. (2013) emphasised that students are reflections of their teacher; when the teacher has good problem-solving skills, then the students will also have them.

Many researchers have outlined teachers’ experiences and the benefits of implementing the problem-solving approach in mathematics, along with corresponding challenges (Bishaw, 2010; Holton et al., 1999; O’Donnell, 2006; O’Shea & Leavy, 2013; Palraj et al., 2017). Although the problem-solving approach has been introduced for decades and there is plenty of research highlighting the benefits to students, it has not been adopted fully by teachers (Bailey, 2017). There has been a lag between the research about the problem-

solving approach in mathematics and putting it into practice. Past studies highlighted a range of constraints that teachers encounter when teaching mathematics in classrooms (Blanco et al., 2013; Holton et al., 1999; O'Shea & Leavy, 2013; Palraj et al., 2017). Teachers who learned mathematics traditionally, completing exercises focused on computational skills and facts mastery drills, can find teaching mathematics through problem-solving harder mathematically, instructionally, and personally (Blanco et al., 2013; Holton, 1990; Holton et al., 1999; Sakshaug & Wohlhuter, 2010). Therefore, these teachers tend to move away from implementing the problem-solving approach and their tentative feelings about the process pushes them to fall back on more traditional, teacher-directed teaching methods (Holton et al., 1999; Sakshaug & Wohlhuter, 2010).

Several studies have explored the mechanisms of teaching mathematics through problem-solving, teacher's affective factors, students' affective factors, designing problem-solving tasks, and problematising the curriculum. Researchers highlighted that teachers' beliefs and perceptions strongly influence their practices, motivation, and student learning (Bishaw, 2010; Blanco et al., 2011; Caballero et al., 2011; Davis et al., 2019; Palraj et al., 2017). Plenty of attention has been given to teachers' beliefs and attitudes towards implementing the problem-solving approach, however, emotions have received less attention than other affective factors (beliefs and attitudes) (Lewis, 2017). Most of the research that has centred on emotions and mathematical learning focused on anxiety, yet other feelings, such as satisfaction, pleasure, or frustration, have not been acknowledged as much (Lewis, 2017). Hannula (2015) argued that emotions are an essential part of problem-solving. In addition, emotions influence the formation and development of mathematics related beliefs, motivations, and attitudes.

Caballero et al. (2011) studied primary school preservice teachers' affective factors (beliefs, attitudes, and emotions) and confirmed that affective factors have a major influence on primary school teachers in teaching mathematics using the problem-solving approach. They also highlighted how becoming aware of emotions reduces anxiety and other negative affective factors in the teaching and learning process (Caballero et al., 2011). In addition, teachers tend to feel more motivated towards methodological change and moving away from the traditional teaching methods and towards student-centred learning (Caballero et al., 2011). Similarly, Martínez-Sierra et al. (2017, 2019, 2022) studied high school teachers' emotions in teaching mathematics and discussed the main

sources of teachers' emotions are students' behaviour, motivation, and academic achievement.

The link between learning mathematics and emotion in past studies highlighted that negative experiences leading to negative emotions are seen to disable mathematical learning (Lewis, 2017). Furthermore, Lewis pointed out that teaching mathematics through a problem-solving approach requires open-ended tasks that allow multiple entry and exit paths. However, not all teachers are trained to use the problem-solving approach when teaching mathematics and they may have different emotional reactions to teaching mathematics. For example, teachers might feel extreme happiness from a lesson or intense frustration if they failed to achieve their desired goals (Schutz, 2014). Emotions experienced by teachers cannot go unnoticed and can influence students' emotional competence and motivation (Sutton & Wheatley, 2003).

Frenzel (2014) reported that teachers with predominantly positive teaching experiences are able to effectively utilise open and creative teaching strategies and are possibly more open to risks and have more flexibility to deal with unexpected obstacles. As a result, these teachers are more able to provide better cognitive and motivational stimulation while teaching. In addition, they may also be successful in building positive relationships between the teaching subject and their students. Conversely, teachers whose classroom experiences are dominated by negative emotions, such as fear and anxiety, may find it difficult to adapt open teaching strategies and may use more rigid teaching strategies such as rote memorisation. In addition, such negative experiences during teaching can also be an obstacle in maintaining a good relationship with students. Therefore, in order to build students' social-emotional well-being and their cognitive performance in learning, teachers' emotional experiences cannot be neglected .

Changes in teachers' behaviours and actions impact their emotions and, ultimately, their motivation and willingness to adapt to the problem-solving approach (Goldin, 2002; Klein & Leikin, 2020; Leder & Grootenboer, 2005; Zan et al., 2006). Lewis's (2017) study focused on the motivations and emotions of prospective primary school teachers and how their emotions changed when teaching problem-solving tasks. The results highlighted the need for planning effective resources and strategies to build emotional intelligence and cognitive affective competences to overcome negative emotions and for the continuum of effective mathematical learning.

Early research about teachers' affects strongly stressed that affective factors influenced teachers' practices and affected the quality of students' learning in mathematics (Coppola et al., 2012). The importance of preventing or overcoming these negative emotions as a necessary condition to improve the quality of mathematical learning and for a healthy and well-functioning classroom environment has been stressed in the literature (Frenzel, 2014; Caballero et al., 2011; Coppola et al., 2012). Teachers' well-being and well-functioning not only impact teachers' professional lives but also fosters their students' emotional competence (Schutz, 2014). However, it is necessary to consider not only teachers' affect factors towards mathematics but also towards its teaching (Coppola et al., 2012). Only a small portion of research pertains to teachers' emotions toward teaching mathematics (Coppola et al., 2012; Martínez-Sierra et al., 2017) and very little research has been conducted on teachers' emotions in teaching mathematics through a problem-solving approach (Caballero et al., 2011; Leder & Grootenboer, 2005; Lester, 2007; Zan et al., 2006).

To support teachers in maintaining a positive emotional attitude towards teaching mathematics through problem-solving and practising control in case negative emotions dominate the classroom environment or their personal well-being, it is critically important to understand their emotional experiences and related stimuli while teaching the problem-solving approach in mathematics. In addition, to improve teachers' well-being and to support future teachers in delivering effective pedagogical practices to enhance the teaching of problem-solving approaches in mathematics, this study aimed to explore the possible emotional experiences that primary school teachers experience while teaching mathematics using a problem-solving approach.

## **1.2 Research Objectives**

This research explored a group of four New Zealand primary school teachers' feelings about teaching mathematics through a problem-solving approach. The aim of the study was to examine the teachers' emotions with respect to teaching mathematics through problem-solving and the situations in which these emotions emerge.

In particular, the following research questions have been addressed:

1. How do primary school teachers feel about teaching mathematics through a problem-solving approach?

2. What type of situations elicits these emotions?

## **1.4 Overview**

Chapter 2 reviews the literature from both a New Zealand and an international perspective relevant to this study. Literature outlining the models used for the implementation of the problem-solving approach in mathematics, designing and delivering problem-solving tasks, benefits and challenges in implementing the problem-solving approach in mathematics, effect in problem-solving, and teachers' emotional experiences in implementing the problem-solving approach have been reviewed. To explore teachers' emotions and eliciting situations, the appraisal theory of emotions- The OCC theory was reviewed. The OCC theory of emotions distinguishes teachers' emotions into three main categories (stimuli) - events, goals, and objects, and classifies types of emotions based on these three stimuli. In this study, the OCC theory has a significant role in identifying the eliciting situations leading to both positive and negative emotions while implementing the problem-solving approach in mathematics.

The methodology used in this study is detailed in Chapter 3. This chapter starts with an explanation of the qualitative approach and a description of the participants. The data collection method is discussed. The data is analysed using the OCC theory of emotions and thematic analysis method. Validity and reliability of the data and ethical issues are presented in this chapter.

Chapter 4 presents the main findings in regard to primary school teachers' feelings about implementing the problem-solving approach in mathematics. This chapter is structured around the different situations in which teachers experience positive and negative emotions with respect to teaching mathematics through the problem-solving approach.

Chapter 5 begins with a discussion of the findings presented in Chapter 4 with respect to relevant literature. Then, limitations of the study, along with implications for teaching and further research, are described.

## **Chapter 2**

### **Literature Review**

This chapter reviews national and international literature about teachers' pedagogical and emotional experiences with teaching mathematics through the problem-solving approach. Section 2.1 discusses the problem-solving approach in mathematics. Section 2.2 presents a range of pedagogical and mathematical practices in teaching mathematics using a problem-solving approach. Section 2.3 highlights the benefits of teaching mathematics using a problem-solving approach. Section 2.4 outlines teachers' experiences when shifting from traditional teaching methods to a problem-solving approach. Section 2.5 presents key findings from the literature about teachers' emotions as they implement a problem-solving approach, followed by the past cognitive theories of emotion in evaluating types of emotions.

#### **2.1 Mathematics and the Problem-solving Approach**

Mathematics is known as the heart of science, and problem-solving has long been regarded as an essential aspect of mathematics (Bailey, 2017; Holton et al., 1999). Problem-solving is one of the main aspects of maths curriculum that is applied worldwide (Rahayuningsih et al., 2020). Holton et al. (1999) defined the problem-solving approach as a teaching style where students are intimately involved with problem-solving tasks to understand mathematical concepts. Sakshaug and Wohlhuter (2010) described problem-solving as an instructional approach in which teachers engage their students in mathematical discourse and reasoning through investigations. Mustaffa et al. (2016), also highlighted that problem-based learning stimulates students' thinking and encourages students to apply theory to practice, leading to new knowledge and higher achievement.

#### **2.2 Implementing a problem-solving approach in mathematics**

Teaching mathematics using a problem-solving approach requires appropriate tasks, opportunities, and strategies for optimum results for mathematical inquiry within group and whole-class scenarios (Gillies, 2011). In his book, Polya (1945) outlined the four-step problem-solving process as follows:

1. Understanding the problem: The first step is understanding the problem and figuring out what is known and unknown about the problem.
2. Devising a plan: Find the connection between the known and the unknown in the problem and think about what prior knowledge can be used to figure out the unknown. Use the diagrams and representations to elaborate mathematical explanations.
3. Carrying out the plan: Carry out the plan to find the solution path and check each step using mathematical reasoning.
4. Looking back: Examine solution paths and check if the problem can be solved differently.

While Polya's problem-solving model (1945, as cited in Chapman, 2015) is commonly used in mathematics education, according to Chapman (2015), a variety of models are proposed that describe the process that problem solvers use from the beginning until they complete solving the problem. After Polya's model, Schoenfeld (1985, as cited in Chapman, 2015) developed a model for mathematical problem solving that includes five steps, namely, reading, analysis, exploration, planning and implementation, and verification. Mason et al. (1982, as cited in Chapman, 2015) described problem-solving as a three-step process that includes entry, attack, and review. The entry phase is where a problem solver focuses on the following three questions: 1) what do I know? 2) what do I want? and 3) what can I introduce (diagrams or symbols)? During the attack phase, a problem solver tries different approaches to find solution methods. In the review phase, a problem solver checks his/her findings, reflects on key ideas, and extends his/her findings to make further generalisations and conjectures. Similarly, Mayer and Wittrock (2006, as cited in Chapman, 2015) described problem-solving thinking in terms of reasoning, critical thinking, creative thinking, and decision-making.

The problem-solving approach affords students with opportunities to solve problems by doing, discussing, reflecting, investigating, observing, and reasoning. Teaching through problem-solving tasks allows students to focus on sense-making and develop mathematical practices. According to Cai and Lester (2010), the term problem-solving refers to mathematical tasks that have the potential to provide intellectual challenges to help students enhance their mathematical understanding. Such tasks promote students' conceptual understanding, foster their mathematical reasoning skills, and capture their interest and curiosity (Cai & Lester, 2010).

### ***2.2.1 Characteristics of problem-solving tasks***

To enhance students' mathematical understanding, creativity, flexibility, and sense-making, teachers are encouraged to design rich tasks that are worthwhile. Planning worthwhile tasks is critical to ensure students are challenged mathematically and cognitively (Chapman, 2015). Tasks that are cognitively-demanding and open-ended allow multiple entry and exit points to promote problem-solving skills. Bailey (2017) referred to open-ended tasks or activities with multiple solution paths, and described how they allow students to investigate via choice and autonomy. Such tasks encourage students to develop mathematical practices, such as making generalisations and conjectures (Anthony, 2016; Foong, 2000) and then by verifying their findings (Nieuwoudt, 2015; Schoenfeld, 2013). Tasks that are designed based on students' familiar experiences encourage students to use their existing knowledge to build new mathematical ideas (Callejo & Vila, 2009; Lesh & Zawojewski, 2007) and enhance students' curiosity and interest (Palraj et al., 2017) by making meaningful connections with real-world situations (Anthony, 2016; Silver, 1997). Breyfogle and Williams (2008) suggested the following steps as a guidepost for teachers to keep in mind while they are designing mathematical tasks:

- What goal is this to serve?
- Does it allow my students to make connections to the content they already know?
- Does it allow for multiple solution methods or approaches?
- Does it encourage students to reason about mathematics and allow for them to communicate mathematically? (p.277)

According to Breyfogle and Williams (2008), worthwhile tasks allow students to make connections, allow multiple approaches and solutions, require higher level thinking, and facilitate reasoning and communication.

### ***2.2.2 Delivering problem-solving tasks***

Teachers must have strategic competence to face the challenges of implementing problem-solving tasks during instruction. They also need to be prepared to intervene and provide support while ensuring that the students maintain ownership of their solution strategies (Chapman, 2015). Teachers should also be prepared for when students are stuck or students attempt a non-productive approach or make mistakes (Chapman, 2015). It is essential for teachers to build on students' thinking and prior knowledge, creating opportunities for interaction between peers and student-teachers. To facilitate

mathematical talk and respond to students' thinking during task delivery, research studies (Chapin & O'Connor, 2007; Hunter, 2008; Anthony & Walshaw, 2009) have provided a range of effective instructional practices, such as the use of talk moves as follows:

1. Revoicing: "So you are saying..."
2. Repeating: "Can you repeat what she said in your own words?"
3. Reasoning: "Do you agree or disagree and why?"
4. Adding on: "Would someone like to add on to this"?
5. Wait time: "Take your time..."
6. Turn-and talk: Turn and talk to your neighbour..."
7. Revise: "Has anyone's thinking changed?"

Hunter (2008) provided a communication framework for supporting students to engage in group discussions and make friendly arguments and justifications while working in small groups. Smith and Stein (2011, as cited in Nabb et al., 2018) described the following five practices teachers can use to orchestrate classroom discussions:

1. Anticipating students' responses prior to task delivery
2. Monitoring students' ideas and asking probing questions as needed
3. Selecting solution strategies for sharing in order to connect the big idea of the task
4. Sequencing students' responses in a specific order for discussion
5. Connecting different students' responses to key mathematical ideas

Teachers must encourage students to use a range of practices to become active problem-solvers, such as using their prior knowledge to make connections with the problem, using representations, and elaborating and justifying their ideas using mathematical reasoning (Anthony, 2016). Anthony also emphasised that students should be encouraged to make connections among various problem-solving strategies, make connections among representations, and reflect on their errors and dispositions.

Teaching the problem-solving approach allows NZ students to develop real-life problem-solving skills and independence in making decisions based on their prior knowledge about learning. Teachers have reported a range of benefits of teaching the problem-solving approach in mathematics worldwide. However, teaching the problem-solving approach requires effort and the knowledge of effective teaching practices; these requirements could present significant challenges to teachers who are trying to implement problem-solving. This is also likely to invoke a range of emotions that may support or

detract from the success. Sections 2.3 and 2.4 below outline the benefits and challenges that teachers have reported about teaching the problem-solving approach in mathematics.

### **2.3 Benefits of teaching mathematics using a problem-solving approach**

Most studies showed that learning mathematics through problem-solving benefits students' mathematical learning. For example, Palraj et al. (2017) argued that teaching mathematics using a problem-solving approach would produce skilled individuals and a knowledgeable society who would be able to solve problems in life and at the workplace. Bailey (2017) claimed that the problem-solving approach encourages students to map their existing knowledge onto real-life situations, explore alternatives, and make better decisions.

Teaching mathematics using a problem-solving approach helps students learn mathematics conceptually and will increase students' confidence and motivation (Anderson, 1993; Jonassen, 2000; Merrill, 2002; Mustafa et al., 2016; O'Shea & Leavy, 2013) and facilitates students' collaborative skills (Maullyda et al., 2019). Based on a review of past studies exploring teachers' experiences in using a problem-solving approach, secondary school teachers reported a positive change in their attitudes towards teaching mathematics (Palraj et al., 2017; Holton et al., 1997; Tighe, 2020). Compared to the traditional way of teaching mathematics, teachers expressed their view that the problem-solving approach is rewarding (Palraj et al., 2017). In a study exploring the beliefs of secondary school teachers on problem-solving in Malaysia, teachers reported that problem-solving tasks increase the ability to capture students' interests, real-world relevance, and cooperative interaction (Palraj et al., 2017).

Teachers have reported that the problem-solving approach increases students' excitement in learning, and all students participate in thinking and mathematical reasoning on their own, leading to greater success and satisfaction (Palraj et al., 2017). Teachers also found student collaboration and peer-teaching to be effective among students while discussing activities (Tighe, 2020). Teachers reported feeling like they have become better facilitators and more reflective in their teaching practices while they are using a problem-solving approach (O'Donnell, 2006; Tighe, 2020). In a study about Irish primary school teachers' experiences in mathematical problem-solving, teachers reported that shifting from traditional teaching encouraged more ownership for students and that teachers felt they were moving away from directed teaching (O'Shea & Leavy, 2013). However,

teachers also reported that change has been challenging due to many factors, such as self-held beliefs, for example that mathematics is about memorising rules and solution strategies, teachers' knowledge about the problem-solving approach, the classroom context, and the school curriculum (O'Donnell, 2006; Palraj et al., 2017; Tighe, 2020) and their personal experiences with learning mathematics (Bishaw, 2010; Rodley & Bailey, 2021). Teachers who learned mathematics through traditional ways of doing exercises in ability groupings focused on computational skills and facts mastery drills can find teaching mathematics through a problem-solving approach harder mathematically, pedagogically, and personally (Blanco et al., 2013; Holton, 1990; Holton et al., 1999; Sakshaug & Wohlhuter, 2010). The literature below highlights some of the challenges teachers reported while they were implementing the problem-solving approach and moving away from traditional teaching.

#### **2.4 Challenges of teaching mathematics through a problem-solving approach**

Most studies indicated that teachers believe problem-solving skills are useful for life. However, there were contradictions in their beliefs as some teachers still emphasise memorising facts and concepts for learning mathematics (Palraj et al., 2017). Teachers' prior experiences as mathematics learners influence them to view mathematics as a traditional transmission process by demonstrating the correct procedures, hindering their motivation to implement the problem-solving approach (Rodley & Bailey, 2021). Teachers believed in teaching skills prior to teaching problem-solving tasks. Some teachers emphasised that students must master basic facts and skills before teaching problem-solving (Bishaw, 2010; Palraj et al., 2017) and significantly encouraged factual information and drill practice of the solution strategies using traditional approaches (Bishaw, 2010; O'Shea & Leavy, 2013).

Teachers reported that designing problem-solving tasks can also be challenging due to the lack of learning resources available in the school curriculum. Teachers often have to learn to modify curriculum content to apply it to problem-solving scenarios (O'Donnell, 2006). Some teachers also struggled to design open-ended tasks as they did not have pre-service training about designing tasks that encourage problem-solving skills in mathematics (Bishaw, 2010). Understanding students' unexpected ideas and guiding students' mathematical thinking while teaching open-ended tasks was also a challenge for some teachers (Holton et al., 1999; O'Donnell, 2006). One of the common challenges

teachers faced was relinquishing instructional control and letting their students be free to explore, investigate, struggle, and learn from each other (O'Donnell, 2006; Rodley & Bailey, 2021). Teachers also found it difficult to guide students without giving too much help (O'Donnell, 2006; O'Shea & Leavy, 2013) suggesting a need for more practice to feel comfortable with the facilitation process (Tighe, 2020). O'Donnell (2006) suggested that anticipating the solution strategies and questions during planning tasks may support teachers in delivering their tasks effectively.

Teaching problem-solving requires debates, discussions, and argumentation, and teachers reported it was noisy and the noise was difficult to tolerate in large classrooms (Tighe, 2020). In a study exploring urban upper primary school teachers' perceptions of designing problem-based tasks in New Jersey (NJ), the teachers reported that navigating conflicts and disagreements between groups and students' avoidance of working together also hindered the progression of the problem-based task (Tighe, 2020). Teachers also believed that delivering pedagogy that requires teachers to attend to and respond to each child's thinking and reasoning is unrealistic (Tighe, 2020).

The nature of textbooks that compartmentalise each strand (number, algebra, geometry, measurement, and statistics) rather than naturally entwining them, also hinders high school teachers' dedication to teaching mathematics using a problem-solving approach (Bailey, 2017; Bishaw, 2010). Bishaw (2010) found that teachers' lack of knowledge or not having a solid model to follow while implementing problem-solving tasks was a challenge.

Implementing the problem-solving approach is time-consuming (Holton et al., 1999; Tighe, 2020), and teachers expressed trying to rush through their day and struggle to let students work on problems at their own pace (Tighe, 2020). Children and parents also show resistance to the problem-solving approach and believe that being good at mathematics is getting the correct answer using quick strategies rather than understanding the conceptual knowledge of the mathematical concepts (Bailey 2017; Holton et al., 1997; Rodley & Bailey, 2021). In a study exploring NZ primary school teachers' experiences implementing a problem-solving approach in mathematics, the teacher reported resistance from a small group of parents towards her mathematical teaching approach (Bailey, 2017). The teacher noticed that those parents did not see it as real school maths as they were not

assigned to any ability groups, and their maths books were not filled with worksheets. The teacher reported feeling very vulnerable and fragile (Bailey, 2017).

It has been difficult for teachers to adapt the problem-solving approach in mathematics to empower students to become higher-level thinkers and stimulate students in terms of critical thinking and reasoning about mathematical concepts (Holton et al., 1999).

## **2.5 Teachers' emotions in teaching mathematics through the problem-solving approach**

The term "affect" has multiple meanings in common usage. "Affect can be expressed as a physical feeling (happiness and sadness), abstract emotion (love and anger), a mental state of mind (a mood) that influences attitudes or feelings, or emotions that are part of one's character or behaviour," (Klein & Leikin, 2020 p. 352). Lester (2007) described affect as a disposition or a feeling attached to an idea and comprises emotions. Furthermore, Lester claimed that emotions can be negative or positive and change rapidly. Positive emotions emerge once an individual attains a goal, relief if the danger has been avoided, and contentment as an individual is feeling satisfied. Negative emotion, an unpleasant and disruptive emotional reaction, is evoked in individuals to express a negative affect towards an event, goal, or person (Martínez-Sierra et al., 2017).

According to Blanco et al. (2013), the negative affect of teachers could be associated with the influence of their own experiences as learners of mathematics, i.e., the experiences they themselves had as students and learners in school and their experiences with their teachers at that time, and also with the mathematical courses in their teacher education. Emotions are both an influence and an outcome of mathematics performance and are essential to the problem solver's self-regulation (Goldin, 2000; Hannula, 2015). All problem solvers encounter positive (e.g., feeling happy, satisfied, curious) and negative emotions (e.g., feeling sad, disappointed, fear) that influence their solution outcomes (Goldin, 2000).

The cognitive processes involved in problem-solving teaching are likely influenced by three aspects of affect, namely, emotions, beliefs, and attitude (Caballero et al., 2011). Similarly, Martínez-Sierra et al. (2019, p. 609), highlighted that "Emotional experiences are supported by beliefs and attitudes that depend on distant and close contexts, as well as the personal and professional lives of each teacher." Teachers who considered themselves

incapable of problem-solving reported inadequacy, uncertainty, and nervousness in implementing problem-solving tasks and tended to feel more tension, triggering fear and anxiety (Caballero et al., 2011).

In a study by Martínez-Sierra et al. (2017) exploring a high school teacher's daily emotions towards teaching mathematics, the teacher reported that students' collaboration and engagement in problem-solving tasks and in the achievement of the lesson made them feel satisfied and motivated. Some teachers have reported feeling distressed while designing and delivering open-ended tasks due to a lack of experience and training (Caballero et al., 2011). Teachers expressed feeling discouraged with the limited outcomes as they struggled to implement problem-solving tasks effectively (Caballero et al., 2011). Furthermore, teachers felt fearful of not being able to create a love of doing maths for their students while making the change in the approach as their students had never been taught mathematics through the problem-solving approach before (Coppola et al., 2012).

The teaching profession involves considerable emotional labour, including effort, planning, and control (Schutz, 2014). In addition, emotional labour can lead to health symptoms, dissatisfaction, and emotional exhaustion. Martínez-Sierra et al. (2017) suggested that negative experiences with mathematics often leads to negative emotions that are seen to disable the learning of mathematics. Therefore, it is necessary to deepen our understanding of teachers' emotions and well-being to support them with the process of implementing a problem-solving approach in mathematics (Schutz, 2014). Similarly, it is critically important to understand the situations that elicit positive and negative emotions to establish suitable environments for teaching and learning.

## **2.6 Appraisal Theories of Emotion**

In contemporary literature about teachers' emotions, several kinds of cognitive appraisal theories have focused on the cognitive determination of emotions, the triggering of emotions, and their effects (Adam et al., 2009). Frenzel argued that the appraisal theory of emotion is the most influential (2014, as cited in Martínez-Sierra et al., 2019). The appraisal theory proposes that individual differences in emotional experiences suggest different interpretations of the situation. It is not the situation itself that triggers an emotional experience, but rather an individual's subjective and cognitive interpretation of the situation (Martínez-Sierra et al., 2019).

Frenzel's model of teacher emotions (2014, as cited in Hagenauer et al., 2015) defined emotions from an appraisal theoretical perspective. He argued that, "teachers follow different teaching goals, observe the behaviour of students related to their goals and then appraise this behaviour (e.g. in terms of goal attainment), which contributes to their respective emotions," (as cited in Hagenauer et al., 2015, p.386). Similarly, according to the control-value theory by Pekrun (2006, as cited in Hagenauer et al., 2015), self-efficacy and teachers' beliefs about their capabilities to carry out a particular course of action is related to affective variables such as job satisfaction. Chen (2016) developed the Teacher Emotion Inventory to evaluate primary school teacher's emotions consisting of the five dimensions of love, joy, fear, anger, and sadness, to measure teachers' emotions inside and outside the classroom. Similarly, Frijda (1986, as cited in Adam et al., 2009) focused on action tendencies induced by emotions. According to Frijda, a stimulus passes through the evaluation process and determines its characteristics and causes and relevance with interests and urgency and then a control signal is generated to postpone or interrupt the current action, and finally, an action is executed. Lazarus (1991, as cited in Adam et al., 2009) represented a relational, motivational, and cognitive theory of emotions. According to him, emotions result from the cognitive appraisal of the interaction between an individual and their motivations, goals, and environment. Also, he distinguished the emotions into primary appraisal (assessing the relevance with the respect to individual's well-being) and secondary appraisal (evaluating the available resources to cope with the stimulus).

Ortony et al. (1988, as cited in Martínez-Sierra et al., 2019) suggested the OCC theory of the cognitive structure of emotions, known as the 'OCC theory', as an effective framework for exploring teachers' emotional reactions, based on their appraisal of *events* (goals, wishes, expectations), *reactions to agents* (norms, standards, principles) and *reaction to objects* (tastes, attitudes). The OCC model proposed by Ortony, Clore, and Collins (commonly referred to as the OCC model) focuses on the origins of emotions.

## **2.7 Summary**

The literature reviewed for this study emphasises that teaching a problem-solving approach allows students to connect with real-life learning and stimulates their critical thinking and mathematical reasoning. Designing and delivering problem-solving tasks is a process that may take time and needs teachers' resilience and determination to persevere

(Bailey, 2017). Table 1, summarises the key ideas about the literature chapter and highlights the importance of teaching problem-solving in mathematics, designing and delivering problem-solving tasks, the benefits and challenges in implementing the problem-solving approach, teachers’ emotional experiences, and the OCC theory of emotions. After reviewing the literature, it became evident that little focus has been given to primary school teachers’ emotions about implementing the problem-solving approach in mathematics. Even though there is some research on elementary teachers' and high school teachers’ emotions in teaching mathematics, it is limited to the topic of mathematical anxiety. Past research on teachers’ emotions outlined that the main cause of teachers’ negative emotions is that most elementary and pre-service teachers are not specialists in teaching mathematics subject and often have negative experiences teaching mathematics (Martínez-Sierra et al., 2017). Under negative emotional circumstances, it is often recognised that changes in mathematics education are a difficult and painful process for teachers teaching mathematics (Holton et al., 1999; Martínez-Sierra et al., 2017). This thesis intends to contribute by gaining insights into some of these gaps by identifying and gaining some understanding around primary school teachers' feelings about implementing the problem-solving approach in mathematics.

**Table 1**

*Summary of the Literature Review*

<b>Summary Table</b>		
Section 2.1	Mathematics and Problem-solving approach	Past studies about implementing the problem-solving approach indicate that teaching mathematics using a problem-solving approach engage students in mathematical discourse and mathematical reasoning through investigations. Problem-based learning stimulates students' thinking and encourages students to apply theory to practice, leading to new knowledge and higher achievement.

Section 2.2	Implementing the problem-solving approach	Elaborates on different models of implementing the problem-solving approach in mathematics.
Section 2.2.1	Characteristics of problem-solving tasks	Describes designing open-ended and cognitively demanding tasks that enhance students' problem-solving skills. The tasks with multiple entry points and exit points allow students to use their prior knowledge to build new mathematical ideas. Planning tasks using students' daily life experiences can support students to connect with real-life learning skills.
Section 2.2.2	Delivering problem-solving tasks	Highlights a range of practices to facilitate mathematical talk and response to students' thinking during task delivery such as use of talk moves, five practices to advance students' mathematical thinking (anticipating, monitoring, selecting students' responses, sequencing solution strategies, and connect big ideas).
Section 2.3	Benefits of teaching mathematics using a problem-solving approach	Discusses the benefits of teaching mathematics using a problem-solving approach in past studies. The problem-solving approach <ul style="list-style-type: none"> <li>- allows students to explore alternatives, make better decisions, and map their existing knowledge onto real-life situations</li> <li>- allows students to use a range of representations and solution paths</li> <li>- encourages students to think critically, justify their findings, and generalise the big ideas in mathematics</li> <li>- facilitates collaborative skills and builds confidence</li> </ul>

		<ul style="list-style-type: none"> <li>- increase students' engagement and excitement in mathematical learning</li> <li>- students are able to find solutions in life and at their workplace</li> </ul>
Section 2.4	Challenges of teaching mathematics using a problem-solving approach	<p>Highlights the challenges that the teachers experience implementing the problem-solving approach in mathematics.</p> <ul style="list-style-type: none"> <li>• Teachers' prior experience with learning mathematics through traditional methods hinders their motivation towards teaching mathematics through a problem-solving approach.</li> <li>• Teachers struggle to locate problem-solving tasks as the curriculum does not provide such tasks, and they were not given any pre-service training about designing high-cognitive and open-ended problem-solving tasks</li> <li>• Teaching without taking over students' thinking is challenging for teachers who learned mathematics by teaching solution strategies</li> <li>• Teachers believe students must have knowledge of basic facts and solution strategies prior to teaching problem-solving skills</li> <li>• Teaching mathematics through a problem-solving approach is time-consuming</li> <li>• Some students and parents might have a belief that being good at mathematics requires memorising the facts and solution strategies,</li> </ul>

		therefore, they show resistance to the problem-solving approach
Section 2.5	Teachers' emotional experiences in teaching mathematics using problem-solving approach	Highlights how teachers' emotions influence the quality of their mathematical teaching. Teachers encounter positive emotions (e.g., feeling happy, satisfied, curious) and negative emotions (e.g., feeling sad, disappointed, fear), which influence their motivation and willingness to teach mathematics using a problem-solving approach. Teachers tend to feel negative emotions if unable to implement the problem-solving approach in mathematics effectively. However, little focus has been given to primary school teachers' emotions in mathematics while they are implementing the problem-solving approach. Teachers' emotions affect the quality of students' learning in mathematics. Many researchers stress the importance of preventing or overcoming negative emotions as a necessary condition to improve the quality of mathematical learning. Therefore, this study aims to fill this gap in understanding: teachers' feelings about teaching mathematics using a problem-solving approach and the situations that elicit such feelings.
2.6	Appraisal Theories of Emotion	Discussed the appraisal theories of emotion e.g., Frenzel's model of teacher emotions (2014, as cited in Hagenauer et al., 2015); control-value theory by Pekrun (2006, as cited in Hagenauer et al., 2015; Lazarus (1991, as cited in Adam et al., 2009) represents a relational, motivational and cognitive theory of emotions, The OCC model proposed by Ortony et al. (1988, as cited in Martínez-Sierra et al., 2019).

## **Chapter 3**

### **Methodology**

This chapter outlines the methods and underlying research methodology used in this study to seek answers for my research question: “How do primary school teachers feel about teaching mathematics using a problem-solving approach?” Section 3.1 provides the justification for the selection of a qualitative approach for this project and describes the use of a case study design. Section 3.2 describes the participants and how they were selected. Section 3.3 discusses the data collection instrument and procedures. Section 3.4 discusses how I analysed the data, followed in Section 3.5 by ethical considerations.

#### **3.1 Qualitative research methodology**

According to Williams (2007), research is the process of understanding a phenomenon by collecting, analysing, and interpreting the data.

When planning a study for research, the researchers need to think through the philosophical worldview assumptions that they bring to study, the strategy of inquiry that is related to the worldview, and the specific methods or procedures of research that translate the approach into practice (Creswell, 2008, p. 5).

From a social constructivist worldview, Creswell (2008) explained that individuals seek an understanding of the world they live and work in and aim to focus on individuals' views through open questions so they can construct the meaning of a situation.

Qualitative research is a holistic approach that involves discovery, in which the social phenomenon is investigated from the participant's viewpoint. Qualitative research involves describing, exploring, explaining, and interpreting data and is less structured as it formulates new theories. In alignment with my research aim, qualitative research seeks to enhance the understanding of individuals' beliefs, values, and experiences in relation to particular situations. It also helps to understand exactly what happened to the participating individuals as well as what led them to the decisions they made and how their choices impacted their experiences (Kalu & Bwalya, 2017).

Qualitative research methods aim to understand the phenomena well, and the case study method is a way to explain, describe, or explore phenomena (Bhebhe et al., 2015). A case

study defines a particular situation or instance the researcher will investigate (Bhebhe et al., 2015). Cases are bound by time and activity, and the researcher collects detailed information using data collection methods within a set time (Merriam & Tisdell, 2015). Therefore, case studies are a strategy of inquiry that examines the relationship between people and the structures in which they live, learn, or work (Alpi & Evans, 2019). A case study could be used for multiple perspectives and acknowledges the diverse point of view of the phenomenon and their relationships. It allows for an in-depth investigation of the particular phenomenon and involves multiple sources and techniques in the data gathering process, allowing a detailed and thorough description of the data (Bhebhe et al., 2015; Savin-Baden & Major, 2013). One of the advantages of a case study approach is its capacity for understanding complexity in particular contexts (Bennett, 2004).

In this study, the phenomenon involved teaching that implements the problem-solving approach in mathematics and the case was how the primary school teachers manifests the implementation of problem-solving approach in mathematics in New Zealand primary schools. The exploratory case study approach was used (Kalu & Bwalya, 2017). In the exploratory case study, the researcher intends to find answers to such questions as 'how' and 'what', focuses on improving the environment, and seeks to gather data, including interviews, observations, focus groups, and documents for improvement (Merriam & Tisdell, 2015; Savin-Baden & Major, 2013). The goal of exploratory research is not to find definitive answers, but rather to attain some understanding of a subject and generate new ideas and hypotheses that can be further explored in future studies.

### **3.2 Participants**

Facebook, a social media platform was used to recruit the participants, specifically the NZ Primary School Teacher's Facebook page. There were many reasons for this. First, this gave the participants the full freedom to make their choice about taking part in the research. It also helped to recruit participants with diverse backgrounds and teaching experiences in teaching mathematics using a problem-solving approach across NZ. The social media platform also allowed the participants to have open communication with the researcher without any outside pressure such as school leadership. Also, due to Covid restrictions, the online recruitment made it safer for participants to participate in the research without having to meet physically with the researcher from anywhere in New Zealand. Initially,

five New Zealand primary school teachers agreed to participate in the research study, however, one of the participants withdrew from the research due to family reasons.

Potential participants had to meet two criteria: 1) participants had to be teaching in the NZ primary school sector and 2) participants had to have some experience in teaching mathematics using a problem-solving approach. As a qualitative study is focused more on quality and richness of the data rather than quantity, these four participants met the case study requirements (embedded in relationships with people and structures) and were capable of providing deep insights about the research question. The chosen participants were given pseudonyms to maintain anonymity. The pseudonym and teaching background of each participant are as follows:

- Ms. A had been teaching for more than 24 years (in South Africa and the UK, as well as in New Zealand), mostly in Year 5 and 6. She had taught in New Zealand for more than seven years. At the time of this study, Ms. A was teaching a Year 5/6 class in a high decile school in Auckland. She has had recent experience of teaching mathematics through problem-solving approach.
- Ms. T, at the time of this study, was teaching a bilingual Year 1 to 4 class in a low decile New Zealand school. Her school had been implementing the problem-solving approach for a couple of years by undertaking a professional development project named DMIC (Developing Mathematical Inquiry Communities) (Hunter et al., 2018).
- Ms. B was new to the teaching profession and teaches a Year 1 class in a low-decile school. Her school had been implementing the problem-solving approach in mathematics for one to two years through undertaking the DMIC professional development project.
- Ms. E had overseas (Singapore and India) and New Zealand teaching experience. At the time of this study, Ms. E taught a Year 1/2 class in a low decile school. She has taught mathematics using traditional teaching methods (teaching strategies and drill practice) and recently started teaching mathematics using a problem-solving approach, as her school had also joined the DMIC project.

### **3.3 Data collection methods**

Due to ongoing Covid-19 restrictions, the mode of data collection was chosen to be video calls via Zoom. This overcame the issue of requesting permission to use any outside venue for data collection. The participants took part in a 45-minute one-on-one, semi-structured interview. They had the freedom to choose the time of their interview, according to their availability and their schedule. The data were collected during the 2022 Term 2 school holidays to reduce the extra burden on the participants and to minimise the disruption to their work life and personal time.

#### ***3.3.1 Semi-Structured Interviews***

Interviewing is commonly used to collect data in education research. “The name 'semi-structured' means that the interviewer can set up a general structure by deciding in advance what ground [is] to be covered and what main questions are to be asked” (Drever, 1995, p.1). Semi-structured interviewing is a very flexible technique for exploring people's thinking and motivations and collecting high-quality data. This method seems to provide more valuable data if the sample size is relatively small.

Semi-structured interviews are well-suited to case studies where the researcher can adapt the main questions to suit people's roles and explore their perspectives in depth (Pathak & Intrat, 2012). While preparing for an interview, topics and sub-topics relevant for the research focus are identified, rather than specific questions, (Drever, 1995). It is hoped that specific questions will emerge while exploring these topics and sub-topics (Drever, 1995). Semi-structured interviews give the interviewer more freedom to explore issues as a matter of course rather than pre-empting the issues. Semi-structured interviews can yield information, such as factual information about people's preferences and opinions, and explore experiences, motivations, and reasoning in-depth (Alvarez & Urla, 2002). The main characteristics of a semi-structured interview are as follows:

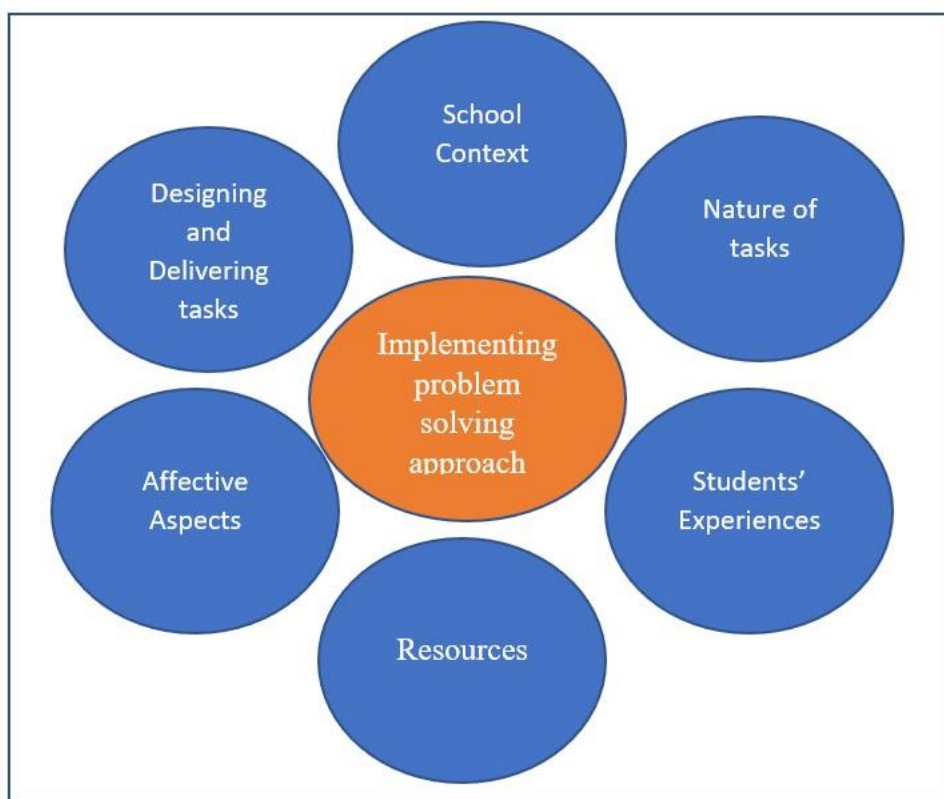
- The interviewer sets the main questions to create the overall structure based on the research question
- The interviewer uses prompts and probes to explore the answers in depth
- The interview contains a mixture of closed and open questions
- The interviewee has a fair degree of freedom regarding what to talk about and how much to say, and how to express it (Alvarez & Urla, 2002; Pathak & Intrat, 2012).

Interviews have many pros and cons compared to other data collection methods such as surveys. With interviews, the interviewer can explain any ambiguities, correct any misunderstanding of the questions, and use probing questions to get more in depth information (Drever, 1995). During interviews, the interviewer can also interpret and observe the interviewee's body language and facial impressions, especially to understand their emotional experiences. Interviews are time-consuming, compared to surveys, and it may also take more time to process the gathered information.

For this study, a general structure was set up for the interviews by deciding on the main topics and subtopics using the key ideas from Chapter 2, including designing and delivering problem-solving tasks, classroom context, school context, benefits and challenges in implementing the problem-solving approach with primary school students and the emotions they experienced in each event. More detailed and probing questions were asked to explore teachers' experiences in-depth. The interviewee had the flexibility and freedom to decide how much explanation to offer and how much detail to give. Figure 1, below, summarises the sub-topics that were used to guide the open-ended questions to explore teachers' experiences and feelings when implementing the problem-solving approach in mathematics.

**Figure 1**

*Components of implementing the problem-solving approach*



After

the main sub-topics were identified, the literature study from Chapter 2 was used to guide the possible structured and unstructured questions to elicit primary school teachers' emotions and experiences as shown in Table 2.

**Table 2**

*Interview Questions*

Structured Question/Request	Possible probing questions depending on what is said	Component targeted
1. Tell me about a recent activity you have done with your class.	How did the students like it? Where did you get the idea to do that? What resources did you use?	Nature of task Student experience Design Emotions Resources
2. How long have you been teaching mathematics using	Was it a big change for you?	Design Experience \Affect

<p>a problem-solving approach?</p>	<p>How did you feel when the school moved to problem-solving (if it did)?</p> <p>How did the students respond to it?</p>	
<p>3. Why did you/the school decide to use this approach?</p>	<p>Were you familiar with this approach earlier or was it something new? How did it make you feel if it was something new to you?</p>	<p>School context</p> <p>Personal experiences/emotions</p>
<p>4. Do you have a general strategy for using problem-solving activities?</p>	<p>How did you figure out your strategy?</p>	<p>School context</p> <p>Resources</p> <p>Design and delivery</p> <p>Experience</p>
<p>5. Have you had any activities that didn't work?</p>	<p>What went wrong?</p> <p>What was challenging?</p> <p>Do those challenges get better over time?</p>	<p>Experience</p> <p>Challenges in designing and delivering a problem-solving task</p>
<p>6. Do you work with others to design tasks?</p>	<p>How does it help you? or</p> <p>How was your experience in designing tasks with others?</p>	<p>School context</p> <p>collaboration/individual benefits and challenges</p>
<p>7. What benefits have you experienced in teaching maths</p>	<p>What are some of the shifts you have experienced in terms of</p> <ul style="list-style-type: none"> <li>• students' engagement</li> </ul>	<p>Benefits of teaching problem-solving approach</p> <p>Mathematical practices</p>

through a problem-solving approach?	<ul style="list-style-type: none"> <li>• covering the curriculum key objectives</li> <li>• personal development</li> <li>• assessments and students' achievement</li> </ul>	Students' involvement and progress
8. What support do you think has been helpful for you in teaching mathematics through problem-solving tasks?	How did you feel overall with your journey?	Professional, social and emotional support
9. Would you like to make any other comments about sharing your experiences in teaching mathematics using a problem-solving approach?		

The first question explored teachers' recent experiences implementing any maths activity using the problem-solving approach, followed by probing questions to collect or gather more in-depth data about how the teachers designed it and which resources were used. Questions 2 and 3 were about the shift in teaching mathematics using the problem-solving approach and the reasons the teachers or the school decided to implement the problem-solving approach. The probing questions were designed to explore teachers' feelings about pedagogical change. Questions 4-6 explored teachers' experiences in designing and delivering problem-solving tasks and the possible challenges. Question 7 focused on the benefits of teaching mathematics using the problem-solving approach. Question 8 explored the support the teachers found helpful while they were teaching mathematics using the problem-solving approach. Finally, the participants had an opportunity to share any other ideas about their experiences implementing the problem-solving approach in mathematics.

### 3.4 Data analysis

To familiarise myself with the data I read it several times after it was transcribed. The repeated readings of the interview transcripts allowed me to become familiar with the

participants' language and their emotional experiences. The thematic analysis method was used to identify, analyse, and report the repeated patterns and themes within the data (Braun & Clarke, 2006; Kiger & Varpio, 2020). Thematic analysis is a powerful, flexible data analysis method used to understand experiences, thoughts, or behaviours across a data set (Braun & Clarke, 2006). Thematic analysis is designed to search for common meanings and themes in the data. A theme is defined as a patterned response or meaning derived from the data that informs the research question. While engaging in thematic analysis, researchers can identify themes within the data, irrespective of the frequency of a particular idea (Kiger & Varpio, 2020). I followed a six-step process (Kiger and Varpio, 2020) to conduct the thematic analysis: familiarising myself with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and producing the report, as explained below.

- Phase 1: Familiarise yourself with the data - transcribing the data, reading and re-reading the data and writing down the initial ideas about teachers' emotions while implementing the problem-solving approach in mathematics.
- Phase 2: Generating initial codes - coding interesting features of the data across the entire data set, collecting data relevant to each code.
- Phase 3: Searching for themes - collecting codes into potential themes, gathering all the data relevant to each theme.
- Phase 4: Reviewing the themes - checking if the coding and the collated data work with respect to the chosen theme; generating a thematic 'map' of the analysis.
- Phase 5: Defining and naming themes - refining each theme and the overall story that emerged from the analysis, generating clear names and definitions for each theme.
- Phase 6: Producing the report - final analysis of selected extracts, relating back to the research questions and literature, producing a scholarly report of the analysis.

In this study, the data analysis was completed in two stages. The OCC Model of Emotion has been chosen because of its effectiveness and simplicity in understanding a range of appraisals to distinguish one emotion from another. The OCC theory uses well-

established concepts, such as beliefs, desires and standards, which made the formalisation process easier. Finally, the OCC theory is quite exhaustive, which is important for designing robust and versatile agents, and any possible target of attention can be thought of either as an event, an action, or as an object (Clore & Ortony, 2013).

### ***3.4.1 Theoretical Framework: OCC Theory***

Theories of emotion propose that people experience emotions according to their appraisals of the specific situation. In other words, individual differences in emotional experiences suggest different interpretations of the situations (Martínez-Sierra et al., 2019; Martínez-Sierra et al., 2022). According to the OCC model, humans perceive a situation, evaluate the situation and, depending on certain variables, an emotion emerges (Trujillo et al., 2018).

The OCC theory is an appraisal theory based on three kinds of stimuli that includes the consequences of events, actions of agents, and aspects of objects. Each type of stimulus is appraised with respect to appraisal variables. Regarding consequences of events, an individual judges the desirability of an event against the individual's goals (an event is pleasant if it helps the individual to reach the goal and unpleasant if it prevents him from achieving the goal). In terms of actions of agents, an individual approves an action according to their own norms and standards. For aspects of objects, an individual's attraction to an object is influenced by its aspects and properties. Ortony et al. (1988, as cited in Martínez-Sierra et al., 2019, p. 295) describe the three basic classes of emotions are used to distinguish between the reaction to events, goals, and objects: "being pleased vs displeased (reaction to consequences of events), approving vs disapproving (reaction to action of agents) and liking vs disliking (reaction to aspects of objects)"

Table 3, below, summarises the emotion types distinguished among the three main stimuli, namely, Events, Agents, and Objects. According to the OCC theory of emotions, emotions concerned with *outcomes of events* are distinguished by whether they concern one's own (e.g., feeling happy) or another's outcomes (feeling envy) and whether they involve prospective outcomes (e.g., hope) or known outcomes (e.g., grief). However, not all emotions are about the outcomes of events. Some concern the *agency of actions*. These emotions involve appraisals of actions as praiseworthy (e.g., pride) or blameworthy (e.g., shame). Within this focus, it matters whether a praiseworthy or blameworthy action is one's own (e.g., pride, shame) or another's (reproach, admiration). The *object focused*

*emotions* are emotions focused on the attributes of the objects in terms of whether the attributes of the objects are appealing (e.g., love) or unappealing (e.g., hate).

**Table 3**

*Classes of Emotions*

<b>Class of stimuli</b>	<b>Main class of emotions</b>	<b>Types of emotions</b>
Event	Pleased about event	<p>Pleased about an event desirable for someone else (happy-for)</p> <p>Pleased about an event undesirable for someone else (gloating)</p> <p>Pleased about the prospect of a desirable event (hope)</p> <p>Pleased about the confirmation of the prospect of a desirable event (satisfaction)</p> <p>Pleased about the disconfirmation of the prospect of an undesirable event (relief)</p> <p>Pleased about a desirable event (joy)</p>
	Displeased about event	<p>Displeased about an event desirable for someone else (resentment)</p> <p>Displeased about an event undesirable for someone else (sorry-for)</p> <p>Displeased about the disconfirmation of the prospect of a desirable event (disappointment)</p> <p>Displeased about the prospect of an undesirable event (fear)</p> <p>Displeased about the confirmation of the prospect of an undesirable event (fears-confirmed)</p> <p>Displeased about an undesirable event (distress)</p>
Agents	Approving of agent's action(s)	<p>Approving one's own praiseworthy actions (pride)</p> <p>Approving someone else's praiseworthy actions (appreciation)</p>

	Disapproving of agent's action(s)	Disapproving one's own blameworthy actions (self-reproach) Disapproving someone else's blameworthy actions (reproach)
Object	Liking an object	Liking an appealing object (love)
	Disliking an object	Disliking an unappealing object (hate)

The first stage involved identifying the teachers' emotional experiences and classifying them into two categories, positive emotions and negative emotions. According to the OCC theory, positive emotions emerged if the teachers reported achieving the desired goals or if they approved of their own, or others', actions with respect to their own beliefs or norms. Similarly, negative emotions emerged if the teachers expressed feeling displeased about an event or disapproving of the actions of others or their own actions.

The type of emotion was distinguished based on three stimuli - events, norms, and objects - using the OCC theory. The second stage involved finding the common themes within the two categories from the first stage and unpacking features of the situations that elicited the emotions that emerged.

**Stage 1: Identification of emotional experiences and eliciting situations.**

Following the OCC theory, I considered two aspects to identify the emotional experiences and eliciting situations present in the data: (1) words or phrases that expressed the emotion from the participants' words or phrases (highlighted) that indicated the eliciting situation/event (2) concise phrases that expressed the eliciting situations of the emotion (highlighted in bold). For example,

**Lots of generalisations and comments and feedback from the kids.** And the kids were going, "Oh, Ms. T, this one, so and so, **the solution was quite fast as compared to making sets of something.** But for them to do this on their own? And I'm looking,

and I'm just like, "Oh, my God. Oh, my God. You know,"... **They're just talking...**  
 And I'm like, "Oh, my God, look at these guys... **I love it. I love it...**" (Ms. T)

In the excerpt above, the teacher is feeling pleased about her students talking about mathematical ideas and comparing solution strategies. Furthermore, the teacher feels happy for her students as she sees them getting involved in the mathematical discourse and connecting their ideas with big mathematical concepts (generalisations). Table 4, below, shows an example of these analyses:

**Table 4**

*Stage 1 Data analysis based on OCC Theory of Emotions*

<b>Excerpts of events/emotions identified in the interviews</b>	<b>Type of emotions</b>	<b>Class of Stimuli</b>	<b>Eliciting situations</b>
<p>“And just find out that one person may differ from another, but they come to the solution at the end. And that's what you know, goes right, you know, gives me the fuzzies when they come to a different solution,” Ms. T.</p>	<p>Positive emotion</p>	<p>Events</p>	<p>Teacher noticing students' different solution strategies</p> <p>Students achieving the desired outcomes</p> <p>Teacher is feeling fuzzies by seeing students attempting different solution strategies</p>

			Students getting involved in learning
<p>But I struggle... I'm working with five-year-olds who just came fresh out of preschool... They don't know what they're looking for... Sometimes it's a struggle because if the child doesn't even know how to read... counting from one to 50, certainly I can't put them into that group. Because the child is going to go blind there. And rather than giving any input, they're going to be destructive there.” Ms. E</p>	Negative emotion	Events	<p>Teacher struggles teaching mathematics using a problem-solving approach to 5-year-old students</p> <p>Students are not able to count numbers</p> <p>Students are not able to read problems</p> <p>Students getting disengaged in learning</p>
<p>“I think, in general, when I'm doing a problem-solving task, it worked. But the goal that I'm working towards now is how am I going to launch for kids who are autistic? So, my autistic kids, they can't sit there? I don't know how to include them,</p>	Negative emotion	Events	<p>Students with diverse needs are unable to participate in this approach due to their different needs</p> <p>Unable to include all students with</p>

you know, and that's the struggle I had... Maths is supposed to be inclusive for all it's supposed to give equal opportunities for all children. So that was hard for me, especially," Ms. B.			equal learning opportunities
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### Stage 2 Analysing the characteristics of the eliciting situations

In the second stage, I looked at all the eliciting situations and reviewed them carefully to find the common themes in the language and experiences for each participant. After that I collated the data into two main categories: Teachers' experiences leading to positive emotions and teachers' experiences leading to negative emotions. Then I examined the common themes that emerged from the participants' eliciting situations in each category. Table 5, below, shows an example from the second stage of data analysis.

**Table 5**

*Stage 2: Characteristics of Eliciting Situations Leading to Positive and Negative Emotions*

<b>Theme</b>	<b>Description of events/emotions identified in the interviews</b>	<b>Emotion type</b>	<b>Eliciting situations</b>
Problem-solving enhances real-life problem-solving skills	"Beneficial in the way that it helps the student to apply the same knowledge in different aspects. So it certainly aids there... I would say certainly, yes, it's beneficial in terms of it just widens where you apply those skills, and it breaks the real-life learning, you know, into the curriculum, so it just blends	Pleased  Happy for	- Enacts real-life learning  - Students applying the skills in different situations  - Problem-solving skills can be

	<p>in... I probably add what are we doing in daily life so that just links to their life, and they get really curious about solving it..." Ms. E</p> <p>"I mean, I've never done problem-solving before, especially in this context and math, so now having a connection to the kids in the real-life world, you can see authentic learning coming from it, the experience coming from it.....So I've changed from "Ohohoh (panic expressions) to tadah (happy expressions) ...and we can share our thinking and solve problems together as a group. I love it" Ms. T</p>		<p>blended in all areas of the curriculum</p> <ul style="list-style-type: none"> <li>- Enacts authentic learning experiences</li> <li>- Students sharing ideas and learning together</li> <li>- Students get curious in learning mathematics</li> <li>- Students feel connected to learning</li> <li>- The positive shift in teacher's emotional experience</li> </ul>
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### 3.5 Ethical considerations

The research project followed Massey University's Code of Ethical Conduct for Research, Teaching, and Evaluations involving Human participants. The ethical standards also included respect for participants, respect for participants' privacy and confidentiality, social and cultural sensitivity, and the avoidance of conflict of interest to protect the participants from social, psychological, or economic harm (Davis, 1998; Morrow & Richards, 1996).

**Gaining consent:** All participants were emailed a consent form with a Participant Information Sheet outlining the study's purpose and the intended outcomes. The researcher ensured the consent forms were easy to read and the information was clearly explained.

The participants were asked whether they agreed to take part in the audio/video Zoom calls. Each participant was informed they could withdraw from the study at any time. The copy of the participant information sheet and the consent form are attached in Appendix A and Appendix B.

**Ethics of respect/care:** The researcher ensured participants' views and contributions were respected throughout the research. The researcher followed the Treaty of Waitangi principles to ensure the participants felt valued throughout the study. The participants were fully aware of any risks/harms that might arise during the interviews.

**Ethics of autonomy:** The participants were informed that they had the freedom to make choices during the Zoom interviews and could withdraw from the research without any explanation by 10 August 2022. This was to ensure that I had enough time to reschedule the data collection if any of the participants decided to withdraw as participants' data was crucial for the completion of this project.

**Ethics of privacy/confidentiality:** The researcher ensured the participants' rights and interests were protected throughout the research, and the data were stored securely to maintain confidentiality. The participants were informed that the interview data would not be shared with anyone else, and the participants had the right to decide add or remove any piece of information they shared during the interview.

**Participant burden:** It can be challenging for participants to find extra time to participate in the research after work hours due to personal commitments; therefore, the participants were given the freedom to choose the time of interview according to their availability. The data were collected during the school holidays to ensure the participants would have more flexibility to choose the time schedules.

**Principle of reliability and validity:** Evaluating the quality of the research is critically important. Qualitative research is frequently criticised for lacking rigour with poor justifications, lack of transparency in the analytical procedures, and the findings being merely a collection of personal opinions subject to researcher bias. Strategies, including data triangulation from multiple resources, peer debriefing to verify the researcher's interpretations and reduce biases, and member checking to clarify certain interpretations were used to increase the reliability of the data. The participants were given an opportunity to review the transcribed data, to ensure they had an opportunity to make any changes to increase transparency, validity, and reliability of the data and rigour of the research.

### **3.6 Summary**

A qualitative research design was selected as the most appropriate method to collect insightful data and provide the answers to the research questions in this study. The data collection was carried out using semi-structured interviews via Zoom meetings. The researcher also shared a copy of the transcribed data with participants to make any changes to ensure the reliability and validity of the data. The OCC theory of emotions and thematic analysis methods were used to analyse the data. The research project followed Massey University's Code of Ethical Conduct for Research, Teaching, and Evaluations involving Human participants, which guided the ethical principles considered during the research study. The researcher ensured that ethical considerations were maintained throughout the study to provide a safe environment for the participants.

## Chapter 4

### Data Findings

The aim of the study was to explore teachers' feelings about teaching mathematics using a problem-solving approach. This chapter discusses the findings of the data in terms of teachers' feelings about implementing the problem-solving approach in mathematics. Section 4.1 highlights teachers' positive emotions while teaching mathematics using a problem-solving approach, together with the situations that elicited these emotions. Similarly, Section 4.2 presents teachers' negative emotions in relation to teaching mathematics using a problem-solving approach, and the corresponding eliciting situations.

#### **4.1 Situations leading to positive affect while teaching mathematics using a problem-solving approach**

Teachers expressed feelings of happiness about implementing the problem-solving approach and how it leads to achieving their goals and upholding their beliefs. The following subsections elaborate on the situations that lead to positive emotions resulting from implementing the problem-solving approach in mathematics.

##### ***4.1.1 The problem-solving approach fosters students' engagement, excitement, and collaboration through real-life learning opportunities***

Ms. E reported feeling pleased about implementing the problem-solving approach as it provides real-life learning opportunities. Ms. E reported that it helped her students apply problem-solving skills in different situations.

Beneficial in the way that it helps the student to apply the same knowledge in different aspects. So, it certainly aids there... I would say certainly, yes, it's beneficial in terms of it just widens where you apply those skills, and it breaks the real-life learning, you know, into the curriculum, so it just blends in... I probably add what we are doing in daily life so that just links to their life, and they get curious about solving it. (Ms. E)

In the excerpt above, Ms. E reported that teaching problem-solving skills in mathematics helped her students to apply the learnt skills in other areas of their lives beyond school. Ms. E felt that the problem-solving approach allowed her to connect mathematical learning with students' real-life experiences, as such, this approach also enhanced her students' interest and curiosity in mathematical learning.

Similarly, Ms. T, as evident in the following excerpt, expressed feeling happy about implementing the problem-solving approach as it helped her young students to use their problem-solving skills in other areas of learning. She reported the problem-solving approach helped students to be risk-takers and free thinkers. They were more confident in terms of asking questions.

Babies are problem solvers everywhere and even in my reading, they're problem-solving there. So, yeah, and it's just applying it more. But, yeah, I will continue with this journey using this type of approach. And, you know, I see it brings up the kid in them to be Yeah, they are risk takers, and they ask those questions. Don't be shy. Just ask, I know the teacher gets annoyed, but who cares? (smiles) You know, we don't want them to shut down who they are. You know, that's all I want in my classroom. You know, I want them to speak... You ask that question whenever you want. But yeah, free thinkers, I want my kids to be just that... (Ms. T)

Ms. T also expressed how teaching mathematics using a problem-solving approach made her feel excited about teaching mathematics. In the excerpt below, Ms. T expressed feeling excited about teaching problem-solving tasks using students' real-life activities, such as sports and other cultural celebrations, to introduce authentic learning experiences. Moreover, she reported that solving problem-solving tasks in groups enhanced students' collaboration by sharing ideas and solving problems together. Ms. T expressed how she loved seeing the rewards of teaching mathematics through a problem-solving approach on her kids' faces.

I mean, I've never done problem-solving before, especially in this context and math, so now having a connection to the kids in the real-life world, you can see authentic learning coming from it, the experience coming from it... So, I've changed from "Oh oh oh (panicked expressions) to tadah (happy expressions)... and we can share our thinking and solve problems together as a group... Most of the problems that we created are authentic, and, you know, culturally responsive because it's related to what they know... in all areas, like, we know that most of our babies play different sports at their local clubs, go to church... go to a marae or just have haircuts, or whatever it is, whatever, you know, the cultural background they are from. So, we look at our problems based around those... Yeah, making learning authentic.... I love it. I love it. And you know, I apply this with the topic as well, you know, any inquiry learning

we're doing, you know, you apply the same ideas... I love it, I love the rewards from the kids' faces. (Ms. T)

Ms. A described feeling satisfied about shifting away from a teacher-centred approach and moving towards teaching mathematics using a problem-solving approach because it promotes active learning in the classroom.

I was in the classroom two weeks ago, in a day relieving situation. And I was in a Year 3 and 4 class... and the goal was to teach subtraction using place value and I got a group of 15 kids. They are sitting on the mat, and there I'm telling them the strategy. They were having a go. I was... using an old school method, modelling the strategy, have a go on your whiteboards. And then it was going okay, and I got them to assess at the end with a smiley face or straight face or a sad face. And they were like, sad faces. So, it was like, we didn't really get that. And I was like, Yeah, I just wasted everyone's time, didn't I? I just felt like it was such a waste because they're not doing active learning. They were just passively trying to take on stuff that I was giving them, and there wasn't real learning happening. And that was really disheartening. And, you know, if I had known I was going to come in, and if I could have carried on by doing my own thing, then I would have done some problem-solving, but I was just doing what I was asked to do. And it felt like a failed lesson. Because there was no real engagement. So yeah, I think problem-solving is exciting because there's a buzz in the classroom. It's like real acts of thinking... I love it. (Ms. A)

In the excerpt above, Ms. A expressed her disappointment about how more traditional forms of teaching mathematics did not afford her students opportunities to explore their own ideas and actively engage in learning mathematics. She felt displeased seeing passive engagement on the part of the students in the teaching session. On the other hand, with the implementation of a problem-solving approach, Ms. A loved teaching mathematics as it brought excitement to her students. It encouraged her students to use their mathematical thinking and reasoning skills.

#### ***4.1.2 Problem-solving enhances students' conceptual understanding, communication skills, and mathematical practices***

When asked to comment on their feelings about shifting towards the problem-solving approach in mathematics, Ms. A compared her experience teaching a student using rote learning strategies in ability level grouping and then through a problem-solving approach in a mixed-ability grouping.

Last year, the year before I had them, I had a girl who had extreme maths anxiety like I've never seen. I've never seen that anxiety on this level... she really struggles with maths, and so the year before, ability group them, and so I put her in the bottom group with some other girls who have a similar ability, we did lots of rote, which is kind of rote learning stuff and kind of very softly, softly and it didn't work... like her math anxiety was the same, she didn't make any progress. So, I was like, alright, I'm going to just throw her in the deep end with this. Yeah, this is a child who is well, well below, in maths with no confidence. And I put her in a group of random kids, possibly not the kind of level four, high level three kids, but kind of, in a group of mixed ability, and I left her. And she and this other girl did well on this activity they did, they really got their heads around it, and communicated beautifully and they got their heads around the first part. And I was like, wow... she's probably made more progress... I think it's that shared responsibility in the group. And that peer kind of support. And I kind of think that was a big turning point for her and for me, I'm really convinced by this way of teaching... I was really convinced by this way of teaching... I think the maths anxiety disappears... where kids work by themselves on maths. And the research shows that it's taken away when it becomes collaborative. (Ms. A)

In the excerpt above, Ms. A felt displeased about teaching mathematics to her student using rote learning strategies through ability grouping. She reported that her students did not make progress despite putting in a significant amount of effort, and how their mathematical anxiety remained the same. However, shifting the pedagogy to a problem-solving approach using mixed ability setting, Ms. A noticed a significant improvement. The students made progress in terms of understanding the mathematical concepts and communicating their ideas. Ms. A expressed feeling satisfied and happy for her students as she feels it helped her students to feel more confident in learning.

Similarly, Ms. E spoke about her appreciation for her students taking ownership of their learning and sharing their mathematical reasoning on their own.

I really appreciate how the kids come and share their thinking process rather than me

telling them how to solve it, and then it's so beautiful to see them teaching their peers when they teach each other... They're happily sharing, they are focused, they're teaching themselves, learning themselves, sometimes you just jump in... they just add on, and they say Ohhhh! I see what we have done wrong. And then they correct themselves, and they start teaching each other again. (Ms. E)

Similarly, Ms. A noticed the increase in students' engagement as a key benefit of teaching mathematics using a problem-solving approach. Ms. A reported that all the students were more willing to get involved in mathematical learning and they were happily engaged when she was teaching problem-solving tasks. As a result, she expressed a feeling of satisfaction about implementing the problem-solving approach in her class as it helped her minimise the boredom and challenging behaviour issues in her classroom.

I think engagement is huge. There's a massive... I mean, I give them a problem... and they go off, you know, that every child is happy to go and work on that problem. Engagement is 100%. Engagement is as high as opposed to textbook maths engagement, and the teacher talk... I think challenging behaviours will be minimised with this approach. And I've seen it with the children who are bored and then suddenly when they're getting involved in problem-solving, I think you can eliminate some challenging behaviours with this approach. (Ms. A)

Ms. A reported how problem-solving tasks led to the development of students' talk moves and emphasised the process of finding solutions instead of just getting the answers. Ms. A uses talk moves such as repeating, revoicing, justifying, and backing up their findings, adding on, and reasoning (agree/disagree) to increase students' mathematical communication skills.

So, I use talk moves, and it's a whole class. And we do a lot of work on that before we go into problem-solving. And there's a real emphasis on strategy over the answer or the process... They do peer talking, so there's a lot of peer-to-peer talking in my class... And I mean it's about really listening to each other's thinking. So, kids need to be able to revoice. And they also can add on... and I do this in my reading groups as well..... And we do lots of "I agree with you because, or I don't agree with you, because. You're going to back up and justify. And it's always about justifying, going back. And where's your proof? How do you know that? (Ms. A)

Also, Ms. A discussed how mathematical struggle is important while learning mathematics, and she loves it when her students push their mathematical thinking to communicate their findings and justify them.

I love the problem-solving that I've done... it always works. Because... unless your problem is not a problem. So, if there's a cognitive load, there's always going to be some struggle, and I feel that if they've struggled to communicate and to justify... there's a big value in that... we do need a correct answer, but I'm like so excited about the struggle... I just love that..." (Ms. A)

#### ***4.1.3 Problem-solving enhances critical thinking, creativity, flexibility and mathematical vocabulary***

In terms of teachers' feelings and experiences about delivering problem-solving tasks in mathematics, Ms. T expressed feeling happy for her students as her students were being more independent in exploring a range of solution paths and making mathematical arguments, such as comparing multiple solution strategies.

Lots of generalisations and comments and feedback from the kids. And the kids were going, "Oh, Ms. T, this one so and so the solution was quite fast as compared to making sets of something." But for them to do this on their own? And I'm looking, and I'm just like, "Oh, my God. Oh, my God. You know,"... Them just talking... And I'm like, "Oh, my God, look at these guys... I love it. I love it. It's moments like that... when students share ideas. Just listening to the kids and them getting a big idea and reaching that goal that you've got in your planning, and you're like tick, tick, tick, tick (a feeling of accomplishment)!... there are those wow moments when they do click, and they get it... That's what I love... because when I'm teaching a problem, my enthusiasm increases... the kids share their enthusiasm as well while we go through the problem... I love it. I love the rewards from the kids' faces. (Ms. T)

As evident in the excerpt above, Ms. T feels a sense of pride in teaching mathematics using the problem-solving approach as her students contribute their feedback about the solution strategies and make justifications and generalisations while solving tasks. She finds teaching the problem-solving approach rewarding as it allows students to share their thinking, understand mathematical concepts, and achieve their mathematical goals. Moreover, she expressed that her students got enthusiastic about learning mathematics, and it made her feel enthusiastic about teaching mathematics. Additionally, Ms. T reported

(below) that teaching problem-solving encouraged her students to take risks in learning and enhanced students' participation and collaboration. Similarly, Ms. E reported that teaching problem-solving tasks encouraged her Year 1 and 2 students to use a range of solution strategies using their prior knowledge.

It encourages them to be risk-takers. And allowed, allows them to, you know, solve problems at their pace, you know, their thinking time and communicating, there's collaboration, and participation. (Ms. T)

In the excerpt below, Ms. E expressed that problem-solving tasks encourage students to use their prior thinking to explore a range of solution strategies. She reported feeling happy to see her students coming up with unexpected solution ideas, especially if she did not anticipate those solution methods herself. Similarly, Ms. T noticed students' multiple solution strategies and how her students attempted different solution pathways to achieve the desired outcomes while attempting problem-solving tasks.

It was more open-ended tasks rather than closed-ended, so that gives more opportunities to the learners to think and bring their thinking onto paper. So, you can solve the same question in 10 different ways. It was sometimes just lovely to see. Because sometimes I do not even anticipate that they're going to solve like that... I'll be like, okay, that's something new. How did you find it? So, yeah, that's something great to see... And just finding out that one person's strategy may differ from another, but they come to the solution at the end. And that's what you know... it gives me the fuzzies when they come to a different solution strategy. (Ms. T)

Ms. T also expressed feeling surprised by seeing her students' unexpected solution strategies while they were working on their problem-solving tasks.

Seeing different ways how they solve the problem, you know, one's got this way, the other one's got this way, and then you got a third guy that's like, Whoa, where did that come from? I don't think I have it on my planning... (Ms. T)

Ms. A believed that multiple exit pathways allowed her students to experience success by trying harder to solve their mathematics problems and it helped them with their growth mindset.

And if you have multiple ways of getting into your solution, many more children will be successful. So, if you have one way of getting to an answer, there are only so many

children who will see that. But as soon as you get those multiple solutions, lots of children start experiencing success. And that's where the growth mindset is so powerful because they start going, oh, yeah, actually, this is true, I can do hard math. So yeah, it's nice to have multiple solutions. (Ms. A)

Similarly, Ms. B reported feeling pleased about teaching mathematics using a problem-solving approach because it improved students' mathematical language and understanding of mathematical concepts.

I think students' mathematical language improves. Yeah, it really changes because of the language you use, they're connected... But I think the wording in problem-solving, it really helps... because when I say how much is it shaded... instead of one out of four... when you say what quarter of a whole, they know that you're working with quarters and you're working with wholes. They understand now how those two words fit together. The kids get it fast. (Ms. B)

In the excerpt above, Ms. B reported that problem-solving tasks enhanced students' mathematical language as well as their reasoning skills and sense-making. She feels her students understood the conceptual understanding of the mathematical vocabulary faster, as they engaged in solving problem-solving tasks.

Similarly, Ms. E expressed satisfaction with the problem-solving approach to increasing students' mathematical vocabulary. She reported that problem-solving tasks helped students to learn new vocabulary as students explored mathematical concepts.

It certainly increases. And the beauty of this is you just induce unintentionally without letting the kids know, the teacher induces the vocab during the problems... you use a lot of vocabulary. (Ms. E)

#### ***4.1.4 PLD and studying the literature supports teachers with the implementation of the problem-solving approach***

When asked about the support that has been helpful while moving towards the problem-solving approach, Ms. A reported that watching her colleague and reading the literature on the problem-solving approach had supported her with her journey.

So, my collaborative partner last year... he was just happy to go with the flow and let me lead it. And he was open to stuff, and he was open. He was doing lots of stuff like, let's look at this problem. What do you notice? What do you wonder? So, I was

learning from him as well... It was nice to have this kind of new understanding and fresh approach. Often teachers of my age are not so keen. So, I think having an open mind... being open to a new idea... open to change... because I have the privilege of researching and reading all the research. And you know, you read the Jo Boaler research and there is so much research out there, I guess... problem-solving research has been around for many decades. This is not new. This is not new research. (Ms. A)

Similarly, Ms. B expressed feeling pleased about having the opportunity to study the problem-solving approach and gain more knowledge about it. She also appreciated the support from the DMIC team mentors in the classroom around teaching mathematics through a problem-solving approach.

I think having the opportunity to study it was a benefit of, you know, being in the study of it, but having the mentors come and then teach alongside us and giving us PD [Professional Development], which has been good (Ms. B)

Ms. T also addressed the idea that watching and observing her colleagues supported her with her shift towards implementing the problem-solving approach. She also felt satisfied receiving mentoring support from the DMIC team to give her more guidance and support.

My key is to observe others. You know, I'd rather go observe someone to get to see how I could approach it. You know, everyone's got different ways of teaching. So yes, observing my colleagues was like, number one for me... I thought watching others, observing others, that's supportive... also getting the DMIC team to come in to refresh ourselves. Just another reminder. And I think that's what helps with my journey through problem-solving. So, it makes your practice better. (Ms. T)

Similarly, Ms. E and Ms. B reported feeling satisfied with the task booklets from the DMIC team as it helped them to use premade resources and activities and it saved time. Ms. E also mentioned that attending the online webinars helped her learn more about the mathematical content and teaching it. Ms. B explained that the task booklets had prewritten problem-solving tasks along with anticipation of students' solution strategies and misconceptions, and the teachers could modify the tasks to make them more suitable to their classroom context.

We have been given a lot of support... we got all the task booklets. So that was helpful.

Because in COVID time, we didn't get time to sit as a whole team. We used to do it before, but those tasks booklets were a Bible... everyone was on the same page, there are a lot of resources that we can reflect on. And it was easy, it saved time. In other parts, we were getting a lot of PLD [Professional Learning Development]. I have myself. I've attended a lot of online webinars focused on specific things. So that was helpful as well. (Ms. E)

Likewise, Ms. B also felt satisfied with the ongoing PLD support and resources provided by the DMIC team.

We have received resources from the DMIC. The mentor has given us master booklets. And we get tasks, and we just modify them. We see the anticipations and misconceptions. It's really good because the whole team is in the same boat. (Ms. B)

#### **4.2 Situations that elicit negative emotions when teaching mathematics using a problem-solving approach**

Teachers reported a range of situations that hindered their implementation of the problem-solving approach in mathematics, such as students' literacy and arithmetic skills and classroom context, the nature of the primary school teacher job, and using the problem-solving approach with neuro-diverse students.

##### ***4.2.1 Teaching the problem-solving approach to low ability students***

Teachers reported feeling disappointed with merely focusing on the problem-solving approach in the early years of primary school education. Ms. B reported feeling distressed about delivering problem-solving tasks to her five-year-old students because her students were not able to read or understand the context of the tasks. Similarly, Ms. E expected her students to have some competence in arithmetic skills prior to teaching a problem-solving approach in mathematics.

I struggle, I'm working with five-year-olds who just came fresh out of pre-school because I know problem-solving is effective. But the question is, how do you break the barrier for kids who don't know how to read or understand... (Ms. B)

Likewise, Ms. E felt distressed teaching problem-solving tasks to those students who do not have basic number knowledge and skills.

.... there are probably a few of the children who don't have the core knowledge. Base

knowledge is very necessary for maths. So, when you talk about the basics of math it is about how subtraction and addition work... the skills... that are missing, and the core knowledge of numbers is missing. And then we must tell them how to solve a problem because they don't know what subtraction or addition is and how that works. And then the problem is critical thinking where they must find out... not even how to solve it, but what the question is asking as well... so there's a big, I would say there's a long bridge that they must pass through, but sometimes they struggle so much that they start hating the subject, start disliking the subject because that's a difficult journey for them. (Ms. E)

She reported that her students struggled to understand what the problem was asking them to do. As they were still learning the basics, such as counting numbers, it was a huge struggle for them to solve the problem-solving tasks. Ms E reported that her students started to dislike the subject as they failed to overcome the knowledge gaps.

Ms. T also felt that some of her colleagues in the early years of primary school feel distressed while teaching mathematics to Year 1 and 2 students as those students are still learning the basic skills of counting and sorting objects into groups.

There are a few teachers like I've been in the Year 1 junior team, and they feel that this approach doesn't work with babies... because they've got a five-year-old... five or six-year-olds, they're still learning what is a number and what that looks like? They don't know, sets of what, what are you talking about? You know, so it's that context, and I get it, you know, show me one, and they go, hmmm? so, some of my colleagues, but only the junior team, they just feel it doesn't work for them... (Ms. T)

Similarly, Ms. B felt dissatisfied with merely focusing on teaching problem-solving skills.

To be honest, in my class, I don't use just problem-solving. So, in my warm-up, I will teach the strategy, just skip counting in 2s. And then problem-solving. So, for me, if I don't teach the strategy first, then the problem-solving is not going to be effective for me in person. So, in my quick warm-up, I teach the number knowledge strategies. And before and afterwards (numbers). So, when they get to my launch, they will be familiar. It's not all you know, it's confusing... I just think for me personally, for little kids, you need to have both ... (Ms. B)

In the excerpt above, Ms. B expressed that she teaches counting strategies and number knowledge skills in her warm-up activities prior to teaching the problem-solving tasks. She felt that teaching the basic strategies during warm-up activities helped her students to get familiar with the mathematical concepts of the problem-solving tasks. Therefore, she believed in integrating teaching number knowledge and strategies as well as teaching problem-solving in her daily routines.

In summary, the teachers reported a negative affect due to young students' difficulties in reading and understanding problem-solving tasks. Teachers believed that students must have some prior numerical knowledge and arithmetic skills before introducing the problem-solving approach in mathematics. Teachers also reported feeling distressed and dissatisfied while delivering problem-solving tasks to young students as these students failed to read or understand the task context.

#### ***4.2.2 Timing issues around designing and delivering problem-solving tasks and the classroom/job context***

The time factor is one of the challenges the teachers reported that hindered the implementation of the problem-solving approach in mathematics. Ms. A reported feeling distressed as there was not enough time to design the problem-solving tasks.

It's difficult and it's a lot of work, it's something that teachers don't have time to do... actually, creating your own activities is not practical for teachers. We are just too busy... And, then now I'm just on the plain stage. So, I grab a learning area, I grab the activity... we go... when we have a go, it's messy for now. But I'd rather let the kids have experienced this than pull out a textbook... Like, I'd rather have okay problem-solving sessions. So, America and other countries get so much release time (CRT) for planning. New Zealand teachers don't get much. (Ms. A)

In the excerpt above, Ms. A expressed the difficulty of finding the time to design the problem-solving tasks because of her busy schedule. It is an unrealistic expectation to expect teachers to design their own activities as they do not get much release time like other countries to plan such resources. Ms. A felt distressed that primary school teachers are expected to plan for students with a range of needs and gaps in literacy and numeracy skills. However, Ms. A was still convinced that students should be taught problem-solving skills rather than taught via a textbook. Ms. A also addressed that the classroom context could affect the implementation of the problem-solving approach, especially in open-

learning environments with many students. She reported feeling distressed about delivering the problem-solving tasks in the large classroom setting, as it tended to get noisy, and for teachers, it could be difficult to attend to or listen to students' ideas.

It's just the nature of the job. I think teachers are expected to do way too much. I mean, I've got children who are working at, you know, using counting on strategy to high school math in one class... I need to figure out just how to balance the problem-solving. I want to teach the big concepts. I want to teach the big ideas. and I want to have a heavy problem-solving classroom. But I know that... it's tricky because we teach collaboratively. So, we have 60 children in Years 5 and 6 with two teachers. And it's all open... so, it can be noisy. (Ms. A)

Likewise, Ms. E expressed her disappointment about not meeting the expectation of teaching mathematics using a problem-solving approach every day due to the nature of the primary school teacher's job.

I would say that it's hard, as expected, for us to take (that approach) every day. But it is... it has been a challenge for me to take (that approach) every day. Like teaching them problem-solving tasks every day is quite challenging for me... So, you must juggle around... It's just the thing that I really struggled with was the time they expected me to teach maths every day. I would love to, but then I didn't get time. It is not possible to take maths, literacy, and writing every day... And I'm quite vocal about that like, with that paperwork, with crazy days where we have behaviour issues; when we have this coming in the school, and that coming in the school. And then it's not possible to take that approach with maths, literacy, writing every day. (Ms. E)

In the excerpt above, Ms. E explains feeling distressed as her days were equipped with a range of other extracurricular activities, e.g., attending sports events or day trips. She reported struggling to meet the expectation of teaching each subject due to a lack of time.

Similarly, Ms. A reported feeling distressed about how teachers must juggle their day to meet their day-to-day expectations. In the excerpt below, Ms. A explains primary school teachers have a responsibility to teach a range of subjects alongside the other co-curricular activities and have very little extra support available in the classroom.

It's just the nature of the job. I think teachers are expected to do way too much... you know, that is, to teach maths every day is lucky. Like, you know, suddenly, you've got

this thing... in the hall that you need to be in, and then there's a soccer thing, and teachers are juggling, reading, writing, maths, you know... (Ms. A)

Ms. A mentioned that bringing the change in the teaching pedagogy and getting upskilled is not easy as teachers are busy in the classroom. She reported that teachers also have fears and anxiety about mathematics, which makes it harder to get upskilled. Also, she thinks that the New Zealand maths curriculum is too big to cover in a timely manner.

...Teachers are busy, there's no time for PD. Really there's no time to be upskilled as much as we'd like... and there's a big gap in maths... some teachers have maths anxiety themselves, they don't understand maths. The Maths Curriculum is too big. Like this... that's too big. (Ms. A)

In this sub-section, negative effects (e.g., disappointment, distress) were seen as teachers implemented problem-solving tasks in the classroom due to expected norms, such as teaching mathematics every day and meeting other paperwork expectations, such as administering the assessments in the primary teaching job as well as attending co-curricular activities.

#### ***4.2.3 Teaching problem-solving approach while managing students with a range of needs such as neurodiverse students and challenging behaviours***

Ms. B felt disappointed about not being able to cater for the diverse needs of students while teaching mathematics using the problem-solving approach.

I think, in general when I'm doing a problem-solving task, it worked. But how am I going to launch for kids who are autistic? So, my autistic kids, they can't sit there? Yeah. Don't know how to, you know, and that's the struggle I had is, you know, maths is supposed to be inclusive for all, it's supposed to give equal, you know, opportunities for all children. So that was hard for me, you know, especially. (Ms. B)

In the excerpt above, Ms. B felt sorry for her neurodiverse students who were unable to work in groups while they were working on problem-solving tasks. Ms. B felt that those students were left behind on their own. Similarly, Ms. E also felt that a problem-solving approach requires a well-managed environment, however with young children and behavioural issues, the teacher may not be able to implement it properly.

I've got three autistic children, I've got two with dyslexia, and then I have got one behavioural when things turn out I'm not able to deliver because it just impacts the

whole group and then the other, the other rest of the kids just lose it. Certainly, there's no teacher aide. So, again, it depends, sometimes it just goes like, you know, flawless but if you do not have control, you do not have one-to-one because... my class needs a lot of teacher attention sometimes, then they just tend to, you know, find an opportunity there to just walk around and try to hide themselves. (Ms. E)

Teachers believed that the classroom context also hinders the implementation of the problem-solving approach in mathematics. Ms. B believed that teachers should create equitable learning opportunities for all students. She feels disappointed she could not include her students who have special learning needs, such as autism and dyslexia. Ms. E believed that teaching mathematics through a problem-solving approach needs a lot of time. Since teachers have a range of students with diverse needs, it can be challenging to meet the expectation of teaching mathematics using a problem-solving approach every day because of the interruptions in the classroom.

#### ***4.2.4 Teachers' different teaching philosophies and beliefs hinder the implementation of a problem-solving approach school-wide***

Ms. B expressed that moving away from traditional forms of teaching to teaching mathematics using a problem-solving approach had not been easy because of the way she learnt mathematics during her schooling. Ms. B learned mathematics by memorising facts and strategies, which differs significantly from how she was currently expected to teach mathematics. Moreover, she found it difficult to move away from focusing on getting the right answer.

It's not maths that we're used to doing in school, aye, like memorising. I think it's hard because, as teachers, we must get away from giving the answers. And I guess, for me, the struggle would be being the facilitator because you must just facilitate that's what the problem tasks are that you have got to facilitate, let the kids come up with the x or whatever... So, I guess for me that was a struggle for me as a teacher as being facilitator. (Ms. B)

Ms. B expressed that letting her students work or compose their own ideas and facilitating students' learning was a challenging role.

Ms. E expressed that teaching mathematics through a problem-solving approach contradicted her beliefs. She discussed how she had been trained to teach the skills and

strategies prior to introducing the problem-solving tasks. However, by only focusing on teaching problem-solving, she experienced that children most often do not have the knowledge of basic maths skills and therefore, it contradicted her teaching philosophy.

It's just sometimes, I struggle with the way I used to teach back in India, and I've taught in Thailand as well... But what I have realised is that sometimes, not sometimes, it's quite often that the kids do not have basic knowledge. And it has been expected that you do problem-solving, and then you unpack the stuff... whereas my teaching values now contradict here because of my personal way of teaching that is a massively different way... so, for me it is, for example, if a child doesn't know how to do addition or subtraction... You need to pull them up if they are struggling with the place values... you need to teach the strategy first. (Ms. E)

When asked about how teachers feel about the implementation of the problem-solving approach school-wide, Ms. B also expressed emotions of dissatisfaction and reported that teachers' personal beliefs also affected the implementation of the problem-solving approach in mathematics. She expressed that teachers who have been in the teaching profession for a long time may not believe in teaching mathematics through a problem-solving approach.

If it's consistent throughout the whole school, that every teacher is consistent. The reality is teachers who have been in a profession for 40 years don't agree because they believe in giving strategies and rote learning and memorising, and then you have teachers who believe in this (problem-solving approach), so the philosophy is all different, you know, and then each classroom teacher is different. So, in my class, there might be problem-solving, or we, we may get to Year 1 and 2, you might get a teacher who doesn't do it, and then it's all gone. It's not easy... (Ms. B)

In the excerpt above, Ms. B alluded to the inconsistencies in the implementation of the problem-solving approach school-wide due to different teaching philosophies, which impacted the outcomes of the approach. Similarly, Ms. A expressed dissatisfaction with the inconsistency of the problem-solving approach while teaching mathematics. She reported that some of her colleagues still believed in teaching mathematics through rote learning and worksheets, and only a few implemented the problem-solving approach in mathematics.

I mean, some teachers are still quite old school. And it's a lot of parrot fashion learning.

Yeah, a lot of worksheets teaching, a smattering of problem-solving. But to have a whole problem-solving approach, I think we've got one teacher who does that. One to two, who do that fully out of 17 or 19 teachers. (Ms. A)

Likewise, Ms. T indicated dissatisfaction with the implementation of the problem-solving approach school-wide and reported that the senior school (Years 5 & 6) implemented the approach consistently however there were gaps in the rest of the school.

When I was in the senior team... because the goals are much higher to achieve, so there was like, you know, it was done every day. It was almost every other day... And now, in the middle team and the junior team that I've come down to (I moved to junior and middle team) the past few years, it's not too much, but I do it, I enjoy it. So, hope they're doing it. I don't know how often... like, I'll ask my team, "Have you started?" And they are going like, oh, no. Aye? Do it, man. What are you waiting for? (Ms. T)

### 4.3 Summary

This chapter elaborated on teachers' feelings about implementing the problem-solving approach in mathematics caused by different situations (benefits and challenges, and self-beliefs). Table 6, below, summarises the commonly found themes and types of emotions experienced by the teachers based on the eliciting situations.

**Table 6**

*Themes and types of emotions experienced by teachers*

<b>Situations leading to positive emotions teaching mathematics using a problem-solving approach</b>		
Theme	Emotion type	Situations/events
Problem-solving enhances real-life problem-solving skills	Pleased Happy for Love Excited	<ul style="list-style-type: none"> <li>- Students applying the skills in different situations</li> <li>- Blending problem-solving skills in areas of the curriculum</li> <li>- Enactment of authentic learning</li> <li>- Students get curious in learning</li> </ul>

		<p>mathematics</p> <ul style="list-style-type: none"> <li>- Students feel connected to learning</li> </ul>
<p>Problem-solving enhances students' confidence, collaboration, and engagement in learning</p>	<p>Pleased</p> <p>Satisfaction</p> <p>Appreciation</p> <p>Happy for</p>	<ul style="list-style-type: none"> <li>- Students making sense of the ideas</li> <li>- Students building on their prior knowledge and exploring new ideas</li> <li>- Students working together and helping each other</li> <li>- Students gaining more confidence in sharing ideas and participating in learning</li> </ul>
<p>Problem-solving promotes flexible thinking, creativity, and mathematical practices</p>	<p>Pride</p> <p>Happy for</p> <p>Surprised</p> <p>Satisfaction</p>	<ul style="list-style-type: none"> <li>- Students composing a range of solution strategies</li> <li>- Students comparing solution strategies and making justifications and generalisations</li> <li>- Students being independent at trying new ideas</li> </ul>
<p>PLD and studying the literature supports the implementation of the problem-solving approach in mathematics</p>	<p>Satisfaction</p>	<ul style="list-style-type: none"> <li>- Teachers given mentoring support from the DMIC team</li> <li>- Teachers given tasks booklets</li> <li>- Observing each other and sharing ideas with colleagues</li> <li>- Studying the past literature about the problem-solving approach</li> </ul>

<b>Situations leading to negative emotions teaching mathematics using a problem-solving approach</b>		
Theme	Type of emotion	Eliciting situations
Lack of core knowledge and literacy skills in the early years of primary education	Distressed Sorry for	<ul style="list-style-type: none"> <li>- Students not being able to read or understand the tasks</li> <li>- Students don't have knowledge of basic operations such as addition and subtraction</li> <li>- Students not able to connect with the task</li> <li>- Students not able to come up with solution strategies due to lack of knowledge about the basic number knowledge and strategies</li> </ul>
Busy nature of the primary teacher job	Disappointed Distressed	<ul style="list-style-type: none"> <li>- Teachers are expected to teach a range of subjects along with the extra co-curricular activities</li> <li>- Problem-solving approach is time consuming</li> <li>- Teachers must juggle around to meet day to day expectations</li> <li>- Not having enough time to plan high-cognitive problem-solving tasks</li> </ul>
Including neurodiverse learners	Sorry for Disappointed	<ul style="list-style-type: none"> <li>- Diverse and special needs students are left behind with this approach as they are unable to take part in the group learning</li> </ul>

		<ul style="list-style-type: none"> <li>- Teacher has difficulty managing students with a range of needs while teaching</li> </ul>
Teachers' different teaching philosophies and beliefs hinder the implementation of a problem-solving approach school-wide	<p>Displeased</p> <p>Distressed</p> <p>Dissatisfaction</p>	<ul style="list-style-type: none"> <li>- Learned mathematics through memorisation at school</li> <li>- Beliefs in teaching skills and strategies prior to teaching problem-solving skills</li> <li>- Contradicts teaching philosophy</li> </ul>

This chapter began by analysing interview data about teachers' feelings about implementing the problem-solving approach in mathematics. The chapter looked at the eliciting situation leading to both positive and negative affect. Participants' voices were presented to provide authenticity and evidence. In the next chapter, the above findings are discussed, and links to the literature are made.

## Chapter 5

### Discussions and Conclusion

The previous chapter presented the study's findings about primary school teachers' feelings regarding implementing the problem-solving approach in mathematics. This chapter will discuss the findings in relation to the literature. Section 5.1 discusses the eliciting situations leading to teachers' positive emotions based on their goals and norms about teaching via a problem-solving approach in mathematics. Section 5.2 looks at the eliciting situations leading to teachers' negative emotions based on their goals and norms while implementing the problem-solving approach in mathematics. Section 5.3 presents some thoughts about future research directions. Section 5.4 outlines the limitations of the study. Section 5.5 highlights the implications, conclusion, and final thoughts.

#### **5.1 Teachers' positive emotions and eliciting situations while teaching mathematics using a problem-solving approach**

The findings of this study are consistent with the research literature that highlighted the sources of teachers' positive and negative emotions implementing the problem-solving approach in mathematics and explains they are based on beliefs, behaviour, and students' success. In this study, teachers reported emotions of happiness, love, satisfaction, pride, excitement, surprise, appreciation, and joy based on feeling pleased about an event, approval of their own or others' actions, or liking an object (real or abstract). The discussion below highlights eliciting situations leading to positive feelings while teaching mathematics using a problem-solving approach.

In this study, teachers expressed feeling pleased about teaching mathematics through a problem-solving approach that is characterised by a range of situations. Posing problem-solving tasks related to everyday activities and making meaningful connections with real-life experiences through a problem-solving approach helped the teachers to enhance students' interest and curiosity in mathematics. This aligns with past research by Anthony and Walshaw (2009) and O'Shea and Leavy (2013) who highlighted that students begin to view mathematics as a relevant and interesting subject if teachers help students to make connections to real experiences and solve problems in their everyday lives. Adding on, the novelty of the problem-solving tasks using students' personalised contexts can make mathematical learning more interesting and enjoyable ("NZ maths," n.d.).

Similarly, teachers in this study felt happy as their students could apply the learnt skills in different topics and aspects of life. Like O'Shea and Leavy (2013) described, students can solve real-life problems by applying learnt problem-solving skills in different situations to become real problem solvers. In addition, teachers from this study noticed enhanced student engagement and willingness to learn mathematics, which resonates with research linking students' engagement and learning in mathematics with problem-solving tasks (e.g., Bailey, 2017; Holton et al., 1997). These findings also align with Palraj et al.'s (2017) research, which highlighted that problem-solving methods allow students to map their prior knowledge into real-life situations. Like the experience of a primary school teacher in Bailey's (2017) study, Ms. A's experiences suggest the approach also enhanced the engagement and learning of students who had previously struggled with mathematics. Similarly, Ms. E noticed students gaining more independence in investigating their solution strategies, which is also similar to the findings from Palraj et al. (2017). The secondary school teachers in Palraj et al.'s (2017) study reported that students gained more independence as they practiced and applied their knowledge to explore multiple solutions through problem-solving approach.

Satisfaction was the second most experienced emotion elicited in this study. From the OCC theory's point of view, an individual feels satisfied if pleased about the confirmation of the prospect of a desirable event. In this study, teachers expressed the feeling of satisfaction by achieving the goals of creating opportunities for students to use their reasoning skills and mathematical practice while they were teaching mathematical concepts. Ms. T reported that teaching mathematics through a problem-solving approach enhanced students' sense-making and reasoning skills and lead to greater success and satisfaction. This was also evident in Palraj et al.'s (2017) study, where teachers reported that problem-solving not only brings benefits to the students, but it also makes teaching more fun and satisfying for the teachers.

Furthermore, teachers in this study expressed satisfaction as they were able to achieve the goal of creating a learning opportunity for students to be creative and flexible in investigating and communicating mathematical ideas through a problem-solving approach. Ms. E's satisfaction emerged via seeing her students using their prior knowledge to investigate multiple solution paths and learn mathematics through meaningful conversations similar to the secondary school teachers' responses in Palraj et al.'s (2017) study. Also, participants felt satisfied because the problem-solving approach supports

students' learning and understanding of the taught topics and collaboration (Tighe, 2020). This aligns with findings from Martínez-Sierra et al.'s (2017) study where high school teachers reported feeling satisfied when students understood the taught topics and mathematical concepts and actively participated in daily mathematical activities. Ms. T reported being satisfied as she noticed increased social interaction between learners during problem-solving activities by explaining and discussing their ideas, which was also highlighted in Nieuwoudt's (2015) research where the social interaction during problem-solving activities assisted the students in exploring and constructing 'new' mathematical knowledge.

Moreover, teachers felt satisfied with their shift towards problem-solving pedagogy when observing and learning from their colleagues, undertaking school PLD (DMIC), and receiving mentoring support. These findings reflect suggestions by Anderson (2005) that primary school teachers need to see a clear image of their role and what it looks like in the classroom while teaching mathematics using a problem-solving approach. The participant teachers in this study agreed that modelling the problem-solving approach by expert teachers could benefit other teachers through seeing what it looked like in practice. However, this has not been emphasised much in the literature.

The teachers experienced the third most common emotion of love while implementing the problem-solving approach in mathematics. Teachers expressed that teaching mathematics through a problem-solving approach provided opportunities for productive struggle for students and brought excitement to students and teachers. Ms. A loved teaching mathematics using a problem-solving approach as it helped her achieve the learning objectives outlined in the New Zealand curriculum that include "create models and predict outcomes, conjecture, justify and verify, and seek patterns and generalisations." Ms. A confirmed that solving problem-solving tasks enhanced her students' sense-making of mathematics ideas using a range of practices, such as explaining, justifying, and making generalisations.

Likewise, Ms. T loved seeing the rewards of her efforts on her students' faces and seeing their enthusiasm. This aligns with Palraj et al.'s (2017) findings that teachers believe problem-solving makes teaching mathematics rewarding as it increases students' engagement and interest in learning.

Teachers expressed feeling the emotion of appreciation (approving someone else's praiseworthy actions) for their students being independent and showing initiative in their learning. This is also evident in Martínez-Sierra et al.'s (2022) study, where secondary school teachers expressed appreciation emotion as their students showed more independence in carrying out mathematical activities and became more interested in learning mathematics. In this study, teachers' appreciation for their students is also linked to students' group work, participation in learning, and increased enthusiasm while the students are working on solving problem-solving tasks. Similarly, teachers also expressed feelings of pride (approving one's praiseworthy actions) by praising their actions and seeing their students taking risks, composing unexpected solution strategies, making generalisations, contrasting solution strategies, and being engaged in making sense of mathematical ideas. These mathematical practices are also encouraged by Anthony (2016) and Foong (2000).

## **5.2 Teachers' negative emotions and eliciting situations while teaching mathematics using a problem-solving approach**

Most of the eliciting situations leading to negative emotions in this study aligned with past studies of teachers' emotions in teaching mathematics (Martínez-Sierra et al., 2019; 2022). In this study, teachers expressed the emotions of displeased, disapproval, and dislike due to a range of eliciting situations related to their beliefs, students' participation, classroom and school context, and personal experiences learning mathematics. Such eliciting situations are similar to those found in past studies, as reviewed in Chapter 2 (e.g., (Bishaw, 2010); O'Donnell, 2006; Palraj et al., 2017; Rodley & Bailey, 2021; Tighe, 2020).

Ms. B expressed disappointment (i.e., displeased about the disconfirmation of the prospect of a desirable event) (Martínez-Sierra et al., 2022) as she found teaching mathematics nowadays is different to how she learnt mathematics through memorising facts and solution strategies (Bishaw, 2010; O'Shea & Leavy, 2013). She expressed the difficulty of moving away from teaching solutions to her students. This aligns with findings from Rodley and Bailey (2021), which indicated that teachers' prior experiences as mathematical learners can hinder their motivation to implement a problem-solving approach.

McLeod (1993) pointed out that traditional classrooms often lead individuals to develop beliefs about mathematics that generate negative responses to problem-solving, which is

true for Ms. B and Ms. E, as they both reported having beliefs about teaching number knowledge, facts, and strategy skills prior to teaching problem-solving tasks. Such beliefs are in line with findings from Bishaw (2010) that showed teachers teaching at Grades 9 and 10 emphasised more factual information which encouraged memorisation. In another study, by Palraj et al. (2017), high school teachers agreed that problem-solving allows meaningful learning and there was still an average level of agreement by the teachers about the importance of the memorisation of facts and concepts. Overall, three out of four participants (Ms. A, Ms. T, and Ms. B) expressed disappointment while they were teaching young students problem-solving tasks as the students did not know the core knowledge of numbers and basic computation skills.

Distress was the most common negative emotion (displeased about an undesirable event) perceived by the participating teachers in relation to implementing the problem-solving approach due to many undesirable situations, such as students not having enough basic knowledge of numbers and arithmetic skills, such as addition and subtraction. Teachers in this study seemed to be of the belief that students must know their basic computation skills prior to solving problem-solving tasks. However, researchers such as Campbell (1984) argued against the assumption that primary school students must acquire computational skills prior to solving problems. Campbell emphasised that problem-solving does not isolate addition and subtraction concepts from their application in the children's experience. Instead, students gain a further understanding of the problem and the meaning of arithmetic operations. More importantly, she suggested that teaching problem-solving in the early years may prevent students from developing the idea that mathematics is a collection of meaningless procedures that must be memorised.

Ms. B felt distressed about not being able to manage the facilitator role effectively while the students investigated and attempted a range of solution methods. She expressed difficulty in guiding students' mathematical thinking. This is in line with O'Donnell's (2006) study, where the fifth-grade teacher reported that giving a guiding question without giving the answer was hard. However, why should this be stressful? Is it because Ms. B associates being good at the facilitation role with her professional status/identity or is she having a personal expectation of being good at her teaching practices? Does it impact her job status?

Time was another factor in teachers' negative emotional experiences, causing feelings of distress and disappointment. Ms. B and Ms. E expressed feelings of distress towards teaching a problem-solving approach to young students due to its time-consuming nature. This was also highlighted by Tighe (2020), where three out of the six participants reported that they would love to implement a problem-solving approach in everyday teaching, but they were concerned that students would not have enough time to explore and investigate their topic and it would be difficult to have enough time to focus and implement the problem-solving approach for best results. In the current study, four participants reported that they were expected to teach a range of subjects, as well as organise other co-curricular activities and administer the paperwork and expressed feeling disappointed as it was difficult to teach mathematics every day as they must rush through their day to meet daily expectations. This is in line with the study by Jain (2021) about investigating primary school teachers' work stress. The findings suggested that teachers perceived stress due to increased workload, multiple sources of stress, the emotional demands of the role and constraints they faced in the job that affected them physically and emotionally. Similarly, the findings from another study by Bridges and Searle (2011) who investigated NZ primary school teachers' feelings about the workload in primary classrooms, suggested that the education reforms and initiatives impact not only teachers' work life but also their home life, health, and view of teaching as a career. Primary teachers reported feeling stressed and burnout due to long hours worked, reduced enthusiasm for their job while meeting all the classroom duties, paperwork, and managing heavy work overload impacting their family time, personal hobbies and interests (Bridges & Searle, 2011). The concerns with time highlights an issue within the school's curricular mandates showing that problem-solving is still not an essential part of the curriculum and only a portion of the class time is devoted to problem-solving.

Equitable inclusiveness is another factor influencing teachers' negative emotions in relation to the problem-solving approach as they were not able to include the neurodiverse students in this approach. Teachers felt sorry for their neurodiverse students as they were not able to take part in this approach. There has not been much attention given to teaching mathematics using a problem-solving approach to neurodiverse students. Therefore, it is a new eliciting situation that has been introduced in this study.

Ms. A reported feeling distressed about teaching students in large classrooms and implementing the problem-solving approach as it gets noisy and it can be hard to manage,

which is also been reported by teachers in Tighe's (2020) study. Similarly, O'Shea and Leavy (2013) pointed out that adopting a problem-solving approach involving debates and discussions can be noisy in the realities of classrooms, such as large classes, and it can be difficult to tolerate on a sustained basis, which also affects teachers' well-being.

### **5.3 Digging further into the sources of teachers' emotions? Thoughts for future study**

In this study, the primary school teachers reported both positive and negative feelings about implementing the problem-solving approach based on their beliefs, teaching goals, and classroom contexts. Emotions are intimately linked with the ideas that are created with the goal, thus the emotions of teachers are in some ways manipulated by curriculum goals. The findings of this study suggest that teachers experience positive emotions if they achieve desired outcomes, which almost always aligns with expected outcomes stated in the curriculum. For example, teachers have goals to increase students' engagement, collaboration, sense-making, problem-solving skills, flexibility, and creativity in mathematics using mathematical practices, such as using representations, different approaches to solving problems, predicting outcomes, verifying findings, and making generalisations, all of which align with objectives and expected outcomes stated in the New Zealand Mathematics curriculum (Ministry of Education, 2015). For the most part, teachers experienced positive emotions if they felt they had achieved these goals, and experienced negative emotions otherwise. However, some important questions still remain. For example, the findings highlight that the same event can elicit different types of emotions across different individuals. For example, Ms. T was happy to include five-year-old students while she is teaching mathematics through a problem-solving approach regardless of their prior knowledge about the strategies and facts and seems to feel happier. However, Ms. B and Ms. E felt disappointed teaching a problem-solving approach prior to students having mastered basic computational skills. Why do the exact same situations cause different feelings or emotions? What is the source of happiness for the teacher?

Also, why do these teachers feel satisfied by teaching computational strategies prior to teaching mathematical concepts? How are students' fluency in arithmetic skills linked with teachers' feelings? Is it because these teachers have a goal to prepare students for certain assessments based on numeracy skills rather than understanding concepts? What is the motivation behind this goal? Further study about understanding why teachers feel

disappointed while they are teaching using the problem-solving approach prior to teaching basic strategies and number facts might help understand why teachers have such goals while they are teaching mathematics.

The data findings in this study indicate that there is resistance from primary school teachers to adopt the problem-solving approach. If it is emphasised in the official New Zealand curriculum, why do some teachers choose to adopt this approach and some not? What is the motivation behind their actions? Is it motivated by the school management, or the curriculum, or their own beliefs? Therefore, it will be interesting to research the reasons some teachers choose to teach mathematics using a problem-solving approach while other teachers do not. Also, why is there resistance to implementing the problem-solving approach in the primary education sector?

Moreover, to support the primary school teachers with their negative emotions about teaching mathematics, the data findings from the current study pointed out that it might not be the problem-solving approach that the teachers are struggling with, but rather their classroom environment and job context. Primary school teachers are expected to cater for students with a wide range of needs (challenging behaviours and neurodiverse students), alongside meeting other expectations, such as administering students' assessments and attending extra co-curricular activities, such as sports and other cultural activities. Therefore, more research is needed to understand these eliciting situations to support teachers with the implementation of the problem-solving approach that is also strongly encouraged by the New Zealand curriculum.

To support primary school teachers with their pedagogical knowledge as well as well-being, it is critically important to understand why certain events create certain emotions and what the motivation is behind such events, teachers' goals, beliefs, curriculum policies, or school requirements? By understanding the context behind such emotions, we can look at possible resources to attend to and understand teachers' emotions and well-being and support them for the betterment of their own growth and development, as well as for the growth and development of their students.

#### **5.4 Limitations of the study**

There are several limitations to this study. The sample of teachers was small and limited to four teachers and is not representative of all primary school teachers in New Zealand. In addition, some of the results of this study represent teachers' beliefs and job context for

that point in time, and it is assumed that the teachers' beliefs and job context may change in the future depending on the training they have received and other external factors in the school environment. The interview questions helped more to understand about how teachers feel and implement the problem-solving approach, however the interview questions did not delve deeply enough into the issues of why emotions are elicited by situations. It is still unknown why teachers feel such emotions at certain times and how those emotions are related to the problem-solving activity? Therefore, the interview questions were quite limited in terms of gaining a deeper understanding about why such emotions are present in the certain activity or moment. The OCC theory of emotions is quite helpful for understanding the type of emotions, and eliciting situations leading to such emotions. However, it does not explain why a certain emotion is linked with a certain event. For example, why does the teacher feel distressed when unable to teach using a problem-solving approach every day? What are the components associated with being distressed? A deeper understanding of each emotion is needed while evaluating certain events. However, the data findings from this study provide an indication of the emotional aspects of teachers teaching mathematics using a problem-solving approach and they provide a baseline for future research.

### **5.5 Conclusion and final thoughts**

This research contributes to the exploration of emotions that the primary school teachers experience in teaching mathematics using a problem-solving approach. Qualitative data were collected to identify the eliciting situations of the emotional experiences of the teachers. Past studies strongly emphasise that it is through problem-solving that students develop a deeper understanding of mathematical concepts. Primary school teachers are encouraged to implement the problem-solving approach in the early years of schooling so the students can develop a conceptual understanding of mathematical concepts as well as arithmetic skills from a young age. However, the implementation of the problem-solving approach in primary school encounters many barriers. The focus of this study has been to explore primary school teachers' feelings about implementing the problem-solving approach in mathematics.

To understand teachers' emotions, factors such as their self-held beliefs, their experience with learning mathematics, their classroom environment, and school context are all important factors that support teachers' emotional well-being as well as strengthen

their pedagogical knowledge about teaching mathematics through a problem-solving approach. For example, if teachers hold onto traditional beliefs about mathematics, their negative emotions to problem-solving will make it a challenge for them to feel confident and motivated. To be able to influence teachers' practices in teaching problem-solving, we must understand their emotional experiences from their perspective and should provide such support when providing PLD opportunities.

Moreover, this study encourages to seek more information to understand why certain emotions emerge in certain situations. Why are teachers trying to achieve particular goals/events? What is the motivation behind their beliefs in relation to teaching the New Zealand mathematics curriculum? Also, understanding the classroom context, such as including neurodiverse students and meeting realistic expectations also need more attention since primary school teachers are expected to implement the problem-solving approach in mathematics.

Being aware of and supporting the emotional aspects of teaching by organising school wide PLD opportunities where teachers are given opportunities to share their feelings about any new or old pedagogical approach that has been introduced in the curriculum or at the school level is important. This will help schools design systems or professional development to support them with their journey (pedagogically and emotionally) and to improve their well-being and help them avoid a negative affect towards the problem-solving approach. Based on the results from this study and past research, the emotional experiences of primary school teachers in implementing the problem-solving approach are influenced by complex relationships among beliefs, personal experiences with learning mathematics, classroom context (wide range of students' needs such as gaps in academic abilities, challenging behaviours, and neurodiverse students), personal expectations of teachers towards their own performance and by the nature of the teaching profession.

This study might help schools and curriculum leaders in terms of effective professional development supporting teachers' emotional as well as pedagogical experiences as they make the pedagogical shifts from traditional teaching methods to a problem-solving approach that emphasises more conceptual understanding. In conclusion, it is suggested that understanding and attending to the emotional side of teachers' experiences while introducing the implementation of the problem-solving approach in mathematics, is essential for improving the quality of teachers' overall experiences.

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## Appendix A: Participant information sheet



### MASSEY UNIVERSITY INSTITUTE OF EDUCATION TE KURA O TE MĀTAURANGA

**Title of Project:** Primary School Teachers' Feelings About Teaching Mathematics Using a Problem-Solving Approach

#### **Who am I?**

Kia ora. My name is Rajvir Kaur. I have been living in New Zealand for 12 years, and originally, I'm from Punjab, India. Currently, I live in South Auckland with my husband and two sons. Teaching mathematics is my passion, and I have been teaching in the primary education sector for 10 years. Currently, I'm completing my master's degree in Mathematics Education at Massey University. Alongside my teaching journey, I have also completed the MST (Maths Support Teacher) professional development course and a postgraduate diploma in mathematics education.

#### **What is the research?**

New Zealand Curriculum emphasises the development of problem-solving skills from primary school education and encourages teachers to design learning tasks that promote problem-solving skills in all curriculum areas. As teachers play a crucial part in designing and delivering problem-solving mathematical tasks, the aim of the project is to gain insights into the challenges and support that primary school teachers experience when teaching mathematics through a problem-solving approach. Throughout the research process, I'll be supported by two experienced supervisors from Massey University.

#### **Who will benefit from the research?**

I hope this research will help identify barriers and affordances teachers experience when designing and delivering problem-solving tasks. Such affordances can be suggested to teachers in the future when implementing problem-solving tasks. The study will also help teachers support students' engagement and motivation in problem-based tasks and develop 21st-century skills such as critical thinking, collaboration, creativity, and communication. The research findings can help schools in the future to plan their professional development opportunities to support teachers to minimise the challenges and find ways to provide a range of resources when using problem-solving tasks in mathematics.

#### **What are you being invited to do?**

If you accept the invitation to participate, I will be doing one one-on-one semi-structured interview via ZOOM. The interview will take about 45 minutes to discuss your experiences in designing and delivering problem-solving tasks in mathematics. I will transcribe the interview and share a copy of the interview with you so you can review it. During the interview, you

can ask to stop the recording if you wish to. You have the right to make any changes in the statements you made in the interview or if you don't want to include any data in the research.

You have the right to withdraw from the research study anytime, up to **10<sup>th</sup> August 2022** when data analysis begins. I will get in touch with you via email before the data analysis period starts and seek permission to use the data for project findings. If I don't hear back by **10<sup>th</sup> August**, the data will be retained for the project's final completion.

### **What will happen to your data?**

All the identifying information, such as personal names, school names will be anonymised in the data (e.g., a pseudonym will be used instead of your real name). Only the researcher and the two supervisors will be aware of the participants' identifying information. Your privacy and confidentiality will be protected at all times. Every care will be taken as far as possible not to identify you in research outputs.

The supervisors and the researcher will have access to the consent forms and the interview data. Your information will be kept secured by the researcher and supervisors for a period of five years, after which it will be destroyed and deleted. After the study, a summary of the findings can be sent to you at your request.

Thank you very much for your time and for making this project possible. If you have any queries or wish to know more, please write to me at the address below:

Yours sincerely,

Student: Rajvir Kaur

Supervisor: Dr Brian Tweed

Institute of Education

Institute of Education

Massey University

Massey University

Email: [rajvirnagra14@gmail.com](mailto:rajvirnagra14@gmail.com)

Email: [B.Tweed@massey.ac.nz](mailto:B.Tweed@massey.ac.nz)

Supervisor: Dr John Tupouniua

Institute of Education

Massey University

Email: [J.G.Tupouniua@massey.ac.nz](mailto:J.G.Tupouniua@massey.ac.nz)

*This project has been reviewed and approved by the Massey University Human Ethics Committee: Northern, Application NOR 22/25. If you have any concerns about the conduct of this research, please contact A/Prof Fiona Te Momo, Chair, Massey University Human Ethics Committee: Northern, telephone 09 414 0800, x 43347, email [humanethicsnorth@massey.ac.nz](mailto:humanethicsnorth@massey.ac.nz).*

## Appendix B: Participant consent form



**MASSEY UNIVERSITY**  
**INSTITUTE OF EDUCATION**  
TE KURA O TE MĀTAURANGA

### **Primary School Teachers' Feelings About Teaching Mathematics using a Problem-solving approach**

#### **CONSENT FORM**

#### **THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF FIVE (5) YEARS**

I have read the Information Sheet and have had the details of the study explained to me. I understand that I may ask further questions at any time.

I understand that my participation is voluntary and that I can withdraw myself from this project at any time during the research up to 10<sup>th</sup> August 2022, and any data relating to me will not be used in the study.

I understand that I will be interviewed via ZOOM. The length of the interviews is about 45 minutes, and the interview will be video recorded and transcribed by the researcher.

I understand that information obtained about me will remain confidential and secured by the researcher.

I understand that my privacy and confidentiality will be protected at all times and that my name will not be identified throughout the course of the research or in any publication that arises from it.

I agree/ do not agree (circle one) to participate in this research.

I agree/do not agree (circle one) to have a summary of the findings sent to me.

**Participant Full Name:**

**Participant Signature:**

**Date:**

## Appendix C: Interview questionnaire

### Interview Questions

1. Tell me about a recent activity you have done with your class.
2. How long have you been teaching mathematics using a problem-solving approach?
3. Why did you/did the school decide to use this approach?
4. Do you have a general strategy for using problem-solving activities?
5. Have you had any activities that didn't work?
6. Do you work with others to design tasks?
7. What benefits have you experienced in teaching maths through a problem-solving approach?
8. What support do you think has been helpful for you in teaching mathematics through problem-solving tasks?
9. Would you like to make any other comments about sharing your experiences in teaching mathematics using a problem-solving approach?

**Appendix D: Transcript Release Authority**



**MASSEY UNIVERSITY**  
**INSTITUTE OF EDUCATION**  
**TE KURA O TE MĀTAURANGA**

***Primary School Teachers' Feelings About Teaching Mathematics Using a Problem-Solving Approach***

**AUTHORITY FOR THE RELEASE OF TRANSCRIPTS**

I confirm that I have had the opportunity to read and amend the transcript of the interview(s) conducted with me.

I agree that the edited transcript and extracts from this may be used in reports and publications arising from the research.

**Signature:**

**Date:**

.....

**Full Name - printed**

.....

## **Appendix E: Advertising letter**

Kia ora. My name is Rajvir Kaur. I'm completing my master's degree in Mathematics Education at Massey University and undertaking a research project about exploring NZ primary teachers' experiences designing and delivering problem-based tasks. The aim of this study is to gain insights into the challenges and support that primary school teachers report experiencing in using the problem-based approach in mathematics. The data will be collected via ZOOM interview calls for about 45 minutes. The participants will be offered food vouchers as a 'thank-you' for contributing their time and efforts to the study.

For further information and consent forms, please contact me directly via messenger or at [rajvirnagra14@gmail.com](mailto:rajvirnagra14@gmail.com)

I greatly appreciate your input.

Thank you

Kind regards

Rajvir Kaur