Perceptions of Theory in Practice:

Influences that shape early career teachers' mathematics lessons

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Abstract

Teaching primary school mathematics is an ongoing challenge, with many researchers, practitioners and policymakers arguing the merits of theory-based education or practical-based experience. This theory-practice divide is much debated. This study investigates what learning crosses the boundaries from Initial Teacher Education (ITE) to classroom practice in mathematics. It examines the perceptions of three early career teachers in Year 1 or Year 2 classes, specifically focused on their use of theory within a mathematics lesson, using the lens of situated learning and the concept of boundary objects.

The investigative approach was an exploratory case study. Video observation of a mathematics lesson and two semi-structured interviews were used to reflect with the teacher participants on what influenced their teaching and explore their beliefs about education theory in teaching and learning. Critical incidents and frameworks supported reflection and recall by participants.

Findings suggest that ITE has minimal impact on classroom practice and that what crosses the boundaries from ITE to school is idiosyncratic and partially understood. The findings highlight that learning is done in situ and does not fully carry over from the ITE environment to classroom practice. Professional development in school seems to be more influential on teachers' practice choices. Importantly, what did cross the boundary was that the teachers respond to learners on a socially inclusive, collaborative level. However, the development of the mathematical concepts in their lessons was not as evident.

This study argues that ITE providers need to be more deliberate in designing programmes that allow pre-service teachers to experience and understand how theory enhances practice. Connections between ITE and schools will enable teachers to carry over the ideas and theoretical principles from ITE to the classroom. ITE providers, school communities, and policymakers need to work alongside one another to ensure mathematics learning and teaching crosses over from ITE to the classroom. All voices will be needed if the divide between theory and practice in mathematics teaching is to close.

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Table of Contents

List of Figures

List of Tables

Chapter 1: INTRODUCTION

1.1 Purpose of the Study

The purpose of this study is to explore the perceptions that early career teachers have about teaching and learning theories in their mathematics teaching and what influences the decisions these teachers make while teaching a mathematics lesson. It explores the conscious and unconscious use of theory in practice and where these influences might have originated.

1.2 Background

Since the days of Plato (428 BC- 347 BC), teachers have asked themselves how an individual learns something new. Today, multiple theories of learning provide a foundation to examine what motivates people to learn and explain, describe, and evaluate learning.

I started teaching as a New Zealand trained teacher in Auckland primary schools thirty years ago. After ten years of teaching, I was presented with an opportunity to go back to university and upgrade my teaching diploma to a Bachelor of Education (Teaching) degree.

Although I was anxious about returning to academic life after so long away, I was also looking forward to learning the 'latest' educational practices and the time to reflect, challenge and evaluate my teaching ideology.

I was not expecting to find that the programmes, decisions, and plans that I developed in my classroom were not my inventions. In fact, some theories about teaching and learning that defined my practice were formed before I was born. I assumed I made a difference in the classroom because of the techniques I had developed to create successful learning for my students. I had not connected my actions to any theories of teaching and learning. Theory, to me, was something abstract for non-practitioner academics and had little relevance in a realistic classroom environment. It turned out I might have been mistaken.

Even now, twenty years on from upgrading my qualification, I continue to ask myself, "Can I be using theory in the classroom that I thought was irrelevant or believed was my own invention without realising it?" "Am I just using what works for me without knowing where it came from?"

I feel New Zealand is beginning a re-imagining of the way we prepare pre-service teachers for primary school teaching. These new ideas represent a substantial shift in how teacher education programmes are designed and facilitated. There has been talk of more practical and in-school training for Initial Teacher Education (ITE). There are now several employment-based ITE programmes in New Zealand, in the Early Childhood Education (ECE) and secondary sectors, with primary programmes in development. Different ways to study are often discussed in the media as we search for the best possible pathways for teacher education (Teaching Council of Aotearoa New Zealand [TCANZ], 2021). There is an assumption underpinning these moves that student teachers will learn more from practitioners in classrooms than from work in universities or other providers, making them better prepared for the classroom. Practical experience is seen as more valuable than learning about teaching and learning in abstract ways. This phenomenon is often characterised as a 'divide' or 'gap' between 'practice' and 'theory'.

I have worked at the University of Auckland with a myriad of job descriptions as a mathematics education lecturer/ adviser/tutor for ITE students for 15 years. I have seen many changes and implementations over this time. Rather than focus on the debate around the components of the pre-service teacher's education, I am interested in whether early career teachers use, or value, the theory they have experienced during their preparation. I am also keen to examine the impact their teacher education might have when teaching a primary school mathematics lesson with their own classes after becoming provisionally registered teachers. Many researchers have described the failure of teacher education to influence teachers' practices (e.g., Ball, 2000; Clark & Lampert, 1986; Korthagen, 2011; Oonk et al., 2020; Vescio et al., 2008). These researchers examine the relationship between theory and practice inside pre-service teacher education in most instances. This study aims to explore teachers' perceptions in the first four years of their careers. The study will examine what influences from theory are present in a mathematics lesson and whether the teacher delivering the mathematics lesson is aware of those influences. Are these early career teachers aware of what has informed their decisions while teaching a mathematics lesson? And what impact does this have on their decisions when teaching mathematics to their learners?

1.3 Research Question

This study examines how early career teachers make decisions while teaching a mathematics lesson and how those decisions are formed through conscious or unconscious links to theory.

Focus Question

How do early career teachers apply theories of teaching and learning mathematics in a classroom mathematics lesson?

Sub questions:

- What theories do early career teachers draw on to inform their mathematics teaching practice?
- To what extent is the use of theory explicit and visible in early career teachers' lessons?
- Are early career teachers aware of theory when they make decisions in their teaching?

1.4 Significance of the Research

By examining the outcomes of this small research project, we may gain greater insight into what both communities of practice, ITE and schools, value and how both communities can function together to ensure a balance of theory and practical classroom applications.

1.5 Overview of the Thesis

Chapter One examines the background of the study, identifies the research question, and briefly discusses the purpose and significance of the research.

Chapter Two reviews existing literature. Research on different areas of theory is identified, and critical approaches to theories of learning are discussed within the context of Initial Teacher Education programmes and how this learning manifests itself in the practical classroom setting.

Chapter Three presents the methodology used in the study. The implementation of a qualitative research approach is justified, and the general research design is discussed. Data analysis and procedures are explained, alongside limitations and ethical considerations.

Chapter Four shares the three participants' contributions and findings from the research. The views and influences of three participants of junior level teaching are presented, as well as researcher observations.

In Chapter Five, these findings are discussed in relation to the research question, and a summary concludes the chapter, with implications for future practice, policy and research presented.

Chapter 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, I will present literature that explores current thinking on the theory/practice divide. I will explore some current literature on initial teacher education, specifically, the influence of theory in mathematical practice. I will explore the current policies and changes within New Zealand's initial teacher education. There will be a review of teachers' beliefs and values of mathematical theory in everyday primary teaching practice, and the ideas of boundary-crossing will be introduced. This chapter will conclude with an overview of the theoretical framework of situated learning theory.

Teaching mathematics is an ongoing challenge that New Zealand faces, with declining comparative scores and inequitable outcomes (Ministry of Education, 2021). Therefore, people are looking for ways to better prepare teachers of mathematics. Trends in International Mathematics and Science Study (TIMSS) is one group that monitor mathematics outcomes. They conduct testing in 41 countries to evaluate differences in national educational systems to raise achievement in teaching and learning of mathematics and science. On the TIMSS test, New Zealand learners score at about the international average, and these scores have fallen each time the test is done. This, and other indicators that suggest similar decreasing patterns, have led to a lot of research and thinking about how learners learn mathematics best and how mathematics should be taught. There is no agreement about these things, which complicates the task of preparing teachers to teach mathematics and ways that improve outcomes for all learners (Ministry of Education, 2021).

The theory-practice divide is a seemingly unending, complex issue that focuses attention not only on the way teachers are introduced to teaching in teacher preparation but also on how they apply or value that initial teacher education once they are practitioners. Many worldwide discussions have debated the merits of theory-based instruction for pre-service teachers or the preference for a more practical based experience in the classroom (Cochran-Smith et al., 2008; Darling-Hammond & Richardson, 2009; Jaworski & Gellert, 2003).

However, the common theme in these debates surrounding pedagogical theory and educational practice is the necessity for teachers and others to choose a side: theory or practice. It is suggested that classroom teachers, in valuing experience, and practical classroom teaching methods, are not utilising theory in their practice. It also implies that teachers, or educational

facilities, who value and promote learning theory have emphasised research and failed to communicate it into practical classroom usage. To understand the theory-practice divide better, this study aims to look at what teachers' value or take from their Initial Teacher Education (ITE) and use in their classrooms.

2.2 The Theory – Practice Divide

The 'theory-practice divide' is an idea that situates practice as a separate focus from theory while seemingly acknowledging the value of a variety of theoretical constructs to support teachers. Many describe the theory-practice divide as gaping and suggest the issue is that theory is not necessarily present in teaching, as research fails to inform actions and decisions made by policymakers and institutions as well as by individuals (Carr, 2006; Czerniawski, 2011; McGarr et al., 2017). There is a difference between the knowledge that researchers investigate, and the knowledge valued by teachers in the classroom (Grossman, 2008; Hagger & McIntyre, 2006; Loughran et al., 2008). The theory-practice divide has been portrayed as "the Achilles heel of teacher education" (Darling-Hammond & Richardson, 2009, p.8). An example of the theory-practice divide could be as simple as a lecturer giving a student a research article that clearly highlights the importance or significance of a teaching approach, and the pre-service teacher reads it, unpacks it, and even agrees or disagrees with its intentions during the course and then never refers to it again once they are in the reality of classroom practice.

Unfortunately, there is limited research into how pre-service teachers create or process theoretical knowledge or how it influences their perceptions of theory or their practice (Grossman, 1992, Jaworski, 2001). Numerous authors refer to the divide as an argument between 'episteme'- the conceptual knowledge or set of beliefs a teacher might use to apply to a situation and, 'phronesis' - the practical knowledge a teacher might identify in a practical problem and take action to solve (Hennissen et al., 2017; Korthagen, 2010; Korthagan & Kessels, 1999; Wubbels, 1992). The divide in teacher education between practice and theory is essentially a gap between these different kinds of knowledge and is most often conveyed as a negative issue, with unfavourable consequences.

In the 1980s and 1990s, a highly influential project in mathematics education, Cognitive Guided Instruction (CGI), showed how theories of learning could inform the teaching of mathematics (Carpenter et al., 1989). In the CGI study, teachers were provided with information about children's thinking and approach to problem-solving. They were not told how to teach; instead,

teachers were shown how to notice and focus on children's learning and thinking. The CGI study then focused on how teachers changed their instruction when they had this information about learning. What the researchers didn't anticipate was the change in teachers' expectations of students' mathematical learning. The teachers realised they needed to expose children to more than the curriculum level expectation and to listen to the children's explanations of their mathematical thinking. The teachers became more aware of the need to create opportunities for the children to share their ideas and have questions prepared to encourage more mathematical discussion. The examination of their practice also led to the teachers identifying their own need to possess the content knowledge to understand the children's thinking and where to go from there in terms of mathematical learning (Carpenter et al., 1989; Franke & Kazemi, 2001). This seminal study demonstrated that theory is essential in teaching mathematics. It showed that when theoretical knowledge is shared with the teacher, it can impact practice. It also raised the issue of teacher content knowledge as another obstacle in bridging the divide between theory and practice.

When teachers are working with learners in mathematics, they are immersed in practice. However, for learning and teaching to be successful, research suggests that teachers must first have the knowledge and ability to focus in-depth and richly on students' thinking (Hiebert et al., 2002). The development of mathematics learning is closely related to improvement in teaching (Kashefi et al., 2017). In a diverse learning environment with different approaches to learning and levels of achievement, teachers often struggle to accommodate the learning differences in a class. The teacher is required to have the ability to make decisions at that moment to apply the most suitable strategies to support the learner and maintain the rich mathematical ideas (Kashefi et al., 2017; Mason & Davis, 2013). Mason believes what we know tends to be compartmentalized, whereas what really matters are the connections between topics and learners (Mason, 2013). If we solely focus on facts and techniques in teaching, we do not necessarily develop the learners' awareness of how to use that knowledge in new situations. Using theory and research, teachers can be made more aware of the decisions they make, the effect their decisions have on learning and delve into mathematical concepts. This, in turn, may impact the development of teachers' practices. Kashefi et al. (2017) found in a questionnaire study that many teachers are willing to change their teaching strategies when they face problems in students' learning. He also found teachers need to improve their mathematics teaching skills. When asked, half the respondents stated that they were using constructivist theory in their teaching. Still, when they were asked how they apply this theory to their lessons, the responses

were not related to constructivism. These findings show that teachers are willing to change their practice to improve their teaching, but how theory can assist them is not fully established in their minds.

When looking at theory and practice as separate entities, it appears that educators may choose to position themselves with more emphasis on either theory or practice to make their decisions. However, when we focus on theory and practice in teaching mathematics in the classroom, we discover an undercurrent of discontent from both camps, the theoretical educational view and the processes used by teachers in the classroom. Flessner (2012) believes there are many methods of integrating teacher theory and teacher practice. Darling-Hammond and Sykes (1999) describe how more comprehensible learning has been experienced by pre-service teachers who are allowed to focus on teaching and learning in teams with expert teachers in schools. They believe it is also beneficial for the experts, allowing them to extend their knowledge by serving as advisers and teacher leaders.

So, what do teachers need to know to teach in the classroom? Jaworski and Gellert (2003) look at mathematics classes as a space where teachers' and students' experiences are mutually adjusted to each other. The teachers and students together develop a set of ingrained actions and responses that are deemed effective and therefore are replicated in future lessons. These routine decisions tend to relieve the pressure of the teaching moment, but they are not usually subject to reflection or scrutiny. As a result, teaching interactions are highly constrained by patterns and routines (Wood et al., 1993). Everyday teaching practice develops as a normal, desirable state (Brown & McIntyre 1993). In this way, theory may instinctively exist in the mathematics classroom, embedded in the routines teachers use in their day-to-day practice.

A variety of theories are advocated at teacher education facilities and in professional development opportunities. Stigler and Hiebert (2009) acknowledge that, depending on the context, understanding a variety of methods of teaching compares more favourably to thinking there can be only one way to teach. They describe the importance of collaboration between teachers, schools, and researchers. Good teaching, according to their research, comes from providing learning opportunities that children can use. In mathematics, this is reflected in engaging learners in rich tasks that promote mathematical understanding and relationships rather than applying a specific method (Stigler & Hiebert, 2009). Teaching in this way contains elements of both ‘practice’ and ‘theory’: knowing what to do and knowing why it might be useful.

Most teacher preparation programmes try to explain theories of learning and what their implications might be for practice (Grossman et al., 2009; Korthagen et al., 2006). This delivery leads to a perception that teacher preparation is about learning 'theory', with 'practice only occurring during practicum placements (Wubbels 1992). One of the most recurrent claims about teacher preparation is that a 'theory-practice divide' exists between learning in preparation institutions and classrooms (Darling-Hammond, 2020).

2.3 Moving from Initial Teacher Education

Korthagen et al. (2001), McIntyre (1995), and Gravett (2012) question the validity of a theory-practice divide in initial teacher education (ITE). They believe it is important to think deeply about teacher education and how the programmes being developed may be creating an opportunity for the divide to exist before teaching begins. Their idea is that when pre-service teachers examine theory from books, articles and inside lectures and workshops and then apply it when on practicum experience in schools, a divide is being built. The 'lecture and learn' method may be deemed a cause and instigate the perception of the divide, as theory and practice are separated in this approach. Examining teacher education programmes in various countries highlighted this conventional view of teacher education despite the lack of evidence about its success (Gravett, 2012; Korthagen, 2011).

Zeichner et al. (2015) describes the theory-practice divide as a disconnect between ITE and schools. They believe a shift towards a more inclusive way of working with schools will improve teacher education. Zeichner's research says we can create a 'third space' if we reject the dichotomy and hierarchy of the traditional ITE perceptions (2010). A third space combines teacher knowledge and academic knowledge in a partnership that supports pre-service teachers. Martin et al. (2011) highlights the difficulties encountered by ITE teacher educators working in schools and conclude that working in this hybrid space is essentially about "negotiating a web of relationships" (p. 305). Providing a third space allows pre-service teachers to identify theory in schools and practice in ITE programmes, but it can be complicated to establish and enact. The model allows pre-service teachers an opportunity to view complex teaching practices. It can also provide a model for experienced teachers to continue to learn through their practice (Zeichner et al., 2015). Working in this way would be an upheaval of traditional programmes and expectations not only for ITE providers but for everyone involved in the partnership.

The belief that teacher education programmes cannot support teachers' classroom practice has been identified as one of the barriers to overcoming the theory-practice divide. Various researchers note that expecting pre-service teachers who learn theory during lectures to apply it in their practice creates a barrier because the contexts are so different. These same researchers also acknowledge that changing existing cultures in teacher education institutions remains difficult (Cochran-Smith et al., 2008; Jaworski, 2006; Korthagen, 2010; Lave 1996; Oonk et al., 2020; Stigler & Hiebert 1999). Stigler and Hiebert (2009) and Ostergaard (2013) state that creating consistency between theory and practice is one of the main challenges in mathematics teacher education. They discuss how more than four out of ten student teachers experience a lack of coherence between the teaching of general education at the university and teaching practice in schools.

An essential question for teacher education is how theories, including theories of instruction (Gravemeijer, 2004), can be used by pre-service teachers to deepen their understanding of their practice? From research as far back as 1975, there has been recognition that the predominant role in shaping teacher development has been the pre-service teachers' own experience of school (Lortie, 1975). Korthagen et al. (2001) found that some countries have changed to more training in schools' approaches due to the failure of traditional ITE programmes to meet the realities of the classroom. Korthagen and others also identified an issue described as 'transmission shock' when the pre-service teacher moved from ITE to teaching (Dann et al. 1981, in Korthagen et al., 2001). German research showed that teachers in their first year of teaching used their school's current practices for learning and teaching and did not utilise their ITE theoretical understanding (Korthagen, 2001). Using in-depth, well-developed ideas from ITE can be hindered by the conflicting beliefs that practical in-school experiences can have on pre-service teachers (Oonk, 2019). Moving schools and teacher education provision closer together through greater partnership or engagement with each other is often recommended as a remedy for the loss of ideas and practices promoted by teacher education (Korthagen, 2001; Zeichner, 2015). These changes require major shifts in teacher education institutions ways of working and resourcing and therefore don't happen very often. Most ITE providers are therefore stuck with more traditional approaches.

Different approaches have been suggested to connect theory to practice during pre-service education. Some suggestions have been the use of case studies as a tool to bridge the divide between theory and practice (Hennissen et al., 2017), the development of an online forum highlighting reflection and discussions (Korthagen, 2001), and watching videos of fundamental

classroom interactions to better connect theory and practice (Koc, Peker, Osmanoglu, 2009 in Furman Shaharabani & Yarden, 2019). Traditionally, ITE has integrated 'theory to practice' using a deductive approach. For example, introducing learning theory during lectures and then identifying the concepts in practicum later. Alternative ways to address the gap have also been trialled by ITE using a more inductive approach. This 'practice to theory' approach focuses pre-service teachers on practical experiences as a starting point for developing the theory and integrating theory into their teaching. Many inductive teaching models have been created to bridge the gap, such as inquiry learning, problem-based learning, case-based learning, and discovery learning (Hennissen et al., 2017).

Some teacher education facilities react to the criticism of teacher education as 'excessively theoretical' by increasing practicums in schools. The logic is that pre-service teachers who have more exposure to classroom practice will bridge the divide between theory and practice more readily because they will be doing more practice alongside their theory, and this will support their readiness for teaching in schools. As expressed by Darling-Hammond (2001), the issue is pre-service teacher needs to be placed with expert teachers who can tutor or mentor with effective, quality practice. Pre-service teachers need good examples of quality teacher practice that they can learn from but finding these expert teachers who have the capacity also to mentor can be difficult (Teaching Council Aotearoa New Zealand, 2019.).

A robust practicum model is regarded as essential in teacher education. However, many pre-service teachers believe they have not received a practicum experience that would prepare them to become effective classroom teachers (Gregory et al. 2011 in Muir et al., 2013). Due to increasing classroom numbers, behavioural management issues, diverse socio-cultural backgrounds and cognitive ranges, and lack of expert mentor teachers in schools, many pre-service teachers could be limited in their access to quality in-school learning experiences. There is no assurance that quality expert practices will be available in all schools for pre-service teachers to experience and learn from (Muir et al., 2013). Also, Feiman Nemser (2001, p.1020) remind us "cooperating teachers often feel the need to protect student teachers from 'impractical' ideas promoted by education professors who are out of touch with classroom realities", leading to confusion for the pre-service teachers.

The pre-service teachers' prior encounters and beliefs are also thought to shape what is taken from the knowledge and experiences offered in their training facility or practicum experiences (Naylor et al., 2015). Bloomfield argues that 'there is no single road to becoming a teacher, nor

a single story of learning to teach' (Bloomfield, 2010, p. 221). Forzani (2014) says that teacher preparation programmes need to move to support early career teachers in the classroom. They call for a more practice-based approach, although what this means for learning to teach is debatable (Anthony et al., 2015, Lowenberg Ball & Forzani, 2009).

Naysmith (2011) explains that little is known about how pre-service teachers construct their teaching knowledge or how they link theoretical knowledge to their practical experience. There are many definitions and opinions of what theory is and how it positions itself in education. Erant (1994, in Naysmith, 2011) describes theory as concepts, ideas, frameworks and principles that can explain and judge experiences in educational settings. Pre-service teachers state that they don't get the theory they need (Tillema & Knol, 1997). In contrast, Lampert and Ball (1998) found that pre-service teachers cannot integrate the theory they get with their expected practice.

Teacher knowledge of subject matter, in addition to knowledge of how to teach, is also part of the debate on what should be covered in teacher education. Some note limited attention to the requirements for future teachers' mathematics knowledge for teaching (Ndlovu et al., 2017). The centrality of teachers' grasp of subject matter has been emphasised (Shulman, 1987). There is no consensus about what teachers need to know or who should provide which types of information in ITE programmes (Hattie, 2015).

Teacher educators must understand the enormous responsibility they have as they build pre-service teachers' readiness to enter the complex profession of teaching, equipped with knowledge of how to teach, what to teach, and where to go to continue developing these skills as they enter the classroom - while recognising that much of what they do may quickly disappear once pre-service teachers take responsibility for their own classes.

2.4 Initial Teacher Education in New Zealand

According to the 2017 Newly Graduated Teacher's Preparation and Confidence to Teach Report from the New Zealand Education Review Office (ERO), the systemic issues of newly graduated teachers' lack of confidence and capabilities are heightened by disparities between ITE programmes, in regard to theory and practice. ERO stated there was a lack of clarity about the expectations and responsibilities of ITE providers and associate teachers when supporting pre-service teachers (Education Review Office, 2017).

The ERO report states in the 2017 report that newly graduated teachers (NGT) expressed concern over the deficiency of opportunities to learn how to teach, understanding the curriculum and the inconsistency of support from their Associate Teachers while on practicum experience.

The ERO report recommends that ITE providers integrate theory and practice and purposefully create more significant opportunities for pre-service teachers to examine experienced teachers and engage with more diverse social needs and backgrounds.

NGT reported feeling more confident in their pedagogical content knowledge than being able to use assessment when designing their practice to suit the needs of the students (Education Review Office, 2017). The NGTs also reported needing a more substantial alignment between theory and practice for planning and preparation. However, when theory and practice aligned, the NGTs felt they could utilise their previous practicum experience to gain a deeper understanding of teaching (Education Review Office, 2017).

Most New Zealand ITE providers use a variety of approaches and theoretical frameworks. There are 14 providers offering a primary teaching bachelor's degree in New Zealand currently. Although the Teaching Council of Aotearoa New Zealand (TCANZ) regulate teacher education providers to ensure they meet specific requirements for programmes, there is no standardised approach, curriculum or uniform ITE delivery. The TCANZ must approve, monitor and review all current ITE teaching programmes (TCANZ, 2019).

In 2019, TCANZ implemented new requirements for ITE programmes in response to concerns about student learning, teacher quality and the research reviewed above. One component of the new requirements for New Zealand ITE providers is the partnership element (TCANZ, 2019). A major focus of the requirements is the promotion of an authentic partnership between ITE and schools - creating a meaningful, practical experience, as well as building a relationship with common goals. However, a conflict arises in its inception. Pauline Barnes, General Manager at TCANZ, recognises that it is vital all involved in the partnerships have common expectations. However, Ms Barnes also acknowledges 'in reality' each educational setting has a different context, so the TCANZ requirements could not be too prescriptive (Gunn, 2020). The difficulties may also lie in the unbalanced nature of designing the partnerships, as the preliminary approach to starting a partnership must come from ITE (Rein & Schon, 2013; TCANZ, 2019.).

The new ITE requirements also mandate an entry assessment in mathematics and literacy for pre-service teachers in the belief that it will raise teacher standards in literacy and numeracy, indicating an increased focus on teacher content knowledge. The document acknowledges that due to the cost associated with implementing a nationwide standardised test, the entry-level assessment will be left up to the individual providers but must be approved by the Teaching Council (TCANZ, 2019).

With the new requirements, there has been a change in expectations. One change is a focus on strengthening the qualifications, so everyone has a clear focus on the Standards for the Teaching Profession. Under the new requirements, the goal is to provide an assurance to practitioners that graduates are classroom ready. Along with identifying closer partnerships between schools and providers, the TCANZ also mandated additional practicum time, which they refer to as professional experience placements (TCANZ, 2019). Teachers in schools are expected to mentor pre-service teachers for more extended periods and play a more significant role in their development, as well as fulfil their responsibilities to their class. For pre-service teachers to be able to be classroom-ready in all respects, 'with support' is a big ask of teacher education and schools (Darling-Hammond, 2001).

2.5 What Do Mathematics Teachers Need to Know?

There is little agreement on how teachers should teach mathematics to children. Two basic categories for teaching mathematics are outlined in the literature (Nisbet & Warren, 2000; Perry et al., 1999). The first is a transmission approach where the teacher shares information and rules with the students, who are expected to comprehend and recreate them. Second is a constructivist, or 'child centred', approach in which teachers are facilitators and learners assemble their mathematical knowledge through interaction with the learning environment. Some teaching and learning theories in mathematics begin from children's thinking, following Piagetian perspectives, and some come from analysing the mathematics knowledge that needs to be learned. In NZ, the more dominant theory is working from children's thinking, but there are calls in the media for an alternative approach (Cook & Kenny, 2021; Gerritsen, 2021).

Considerable research has been conducted into what teachers need to know to teach mathematics (for example, Ball et al., 2008, Grossman, 1990, Shaughnessy et al., 2016, Shulman, 1987). Ball et al., (2005) recognised that changing the curriculum or standards produced a slight improvement without focusing on teaching practice and what teachers know.

Others voice multiple challenges when preparing people to teach mathematics in ITE (for example, Grootenboer & Jorgensen 2009, Young - Loveridge 2010). They discuss how no curriculum can be delivered or standards implemented without skilled teachers who understand mathematics. Research has uncovered something we may have suspected: the better the teacher knows the subject matter, the more capable they are of assessing students, developing materials, and making judgements that affect their approaches to teaching and learning (Carpenter et al., 1989). Teachers are in a profession that requires the skills to anticipate, interpret, and correct misconceptions, find multiple solutions and extend knowledge. These skills cannot be done without teachers having knowledge of mathematics.

Hiebert et al. (1999) describe an experience with their research where they examined the practices of six high achieving countries according to The Third International Mathematics and Science Study (TIMSS) 1999 Video Study (National Center for Educational Statistics, 1999). According to their study, the difference between high-achieving countries like Japan and Australia and others was not the problems presented to the learners but how teachers supported the students to understand the concept. According to Hiebert et al. (1999), the key to learning appears to be teaching. They found that teachers could change the direction of the lesson by stepping in and directing the students towards the answer. This changed the problems from emphasising mathematical relationships to practising a mathematical procedure, effectively changing the students' learning pathways. Some of these changes were more productive for the learners than others.

Stigler et al. (2009) believe it is essential for teachers to know mathematics and understand how children think and learn about mathematics for them to be able to make their lessons productive. Furthermore, the teachers needed skills to assist children's learning and judge which methods should be used in a particular circumstance. Therefore, teachers need reflective abilities in order to learn from their teaching and make improvements (Mason & Spence, 1999). This, in turn, requires ITE to create opportunities to link theory to practical examples from classrooms (Gravett, 2012) so that pre-service teachers can learn how and when to make moves that will be productive for student learning.

Shulman (1987) expands on the idea of teacher knowledge by separating the idea into three separate areas: subject matter knowledge (SMT), pedagogical knowledge (PK) and pedagogical content knowledge (PCK). Figure 1 below shows a more recent elaboration of Shulman (1987)'s ideas, specifically in the context of mathematics education. The model, by Ball et al.

(2008), has become a widely used way to conceptualise and understand what mathematics teachers need to know. The model acknowledges that teachers need both subject matter knowledge of a particular sort and pedagogical content knowledge linked to curriculum and students.

Figure 1

Domains of Mathematical Knowledge for Teaching

Note. Domains of Mathematical Knowledge for Teaching (Figure 5). Reprinted from "Content knowledge for teaching: What makes it special?", by Loewenberg Ball, D., Thames, M. H., & Phelps, G. (2008). p 403. Copyright 2008 by Sage Publications.

The usefulness of this model has been tested in several ways by Ball et al. Notably, the students of teachers who had a high knowledge of the subject matter gained more understanding of the subject than students who didn't have a high level of content knowledge (Ball et al., 2005). The model of teacher knowledge suggests areas that ITE could work on to improve mathematics teaching and learning.

However, whether knowledge and ideas from ITE would be carried into NGTs' practice seems questionable, considering the research outlined in this chapter. The apparent divide between theory and practice is seen as a negative element of teacher preparation, but it does have some potential in learning to teach. The 'divide' could open space for teacher reflection on practice as they try to align theory with practice, and there could be potential in the divide for learning for both preservice teachers and their mentors. Knowing more about what NGTs take from their teacher preparation into their practice will help us understand the theory-practice divide better. In the next section, a theoretical framework for examining the theory-practice divide is explained and discussed.

2.6 Theoretical Framework

This research takes a situated learning approach as the theoretical framework for the study. Situated Learning Theory is a learning theory developed by Jean Lave and Etienne Wenger. Lave and Wegner (1991) claim that learning occurs in communities of practice - groups with a common purpose and shared knowledge. Situated learning theory builds on the ideas of constructivism (Vygotsky, 1978), with the added layer that learning is situated – it occurs in specific places and spaces that become part of the learning and fundamentally shape what is learned and by whom (Brown & Duguid, 1994; Lave & Wegner, 1991).

Communities of Practice are learning environments. Three key elements of Communities of Practice are domain, community, and practice. People engage in and share the same domain of interest within the community, and they socially construct or form a practice using shared resources. These elements can be summarised as engaging in different types of social collaboration to create artefacts (or objects) of shared learning. (Lave & Wenger, 1991). In other words, people learn as they participate by interacting with the community, i.e., with its history, expertise, cultural values, social rules, and patterns of association; the tools on hand, including objects, technology, language, and visuals; and the moment's activity, its purposes, norms, and practical challenges (Besar, 2018). Knowledge develops because of these factors interacting at the same time. Thus, knowing is endlessly invented and interwoven with doing and the place and time where the 'doing' occurred.

Educational research often investigates how learning develops within a particular place. If learning is situated, as Lave and Wenger (1991) suggest, then a challenge for learning that develops in a particular place happens when it needs to be used elsewhere. What happens when learning is transferred to a new place? Further learning can occur when people interact or move across different communities of practices, such as learning first aid in a course at work and then performing CPR in a road accident, or it might be that people cannot work out how to use their knowledge of CPR from their first aid course when faced with a real-life emergency. Therefore, all learning is situated and thus has boundaries it needs to cross to be useful elsewhere (Star & Griesemer, 1989). The transfer of knowledge or learning can also happen between different cultures or professions (Akkerman & Bakker, 2011).

Learning is said to be bound by the place that it was developed (Star & Griesemer, 1989). Boundaries can be described as surrounding learning in the context of a specific environment. When knowledge is transferred from one place of learning to another, it can be helped by things

from within the system where the learning occurred. These are referred to as boundary objects (Akkerman & Bakker, 2011). The boundary object could be a procedure, a word or term, an actual object such as a book or stethoscope. It is a 'tool' that assists with understanding and negotiating both spaces, carrying some of the situated learning over the boundary between two settings. The construction of boundary objects can help improve and provide unity across intersecting social worlds (Star & Griesemer, 1989). Understanding the characteristics that make boundary objects effective can improve organisational learning and better inform decision-making, ultimately improving organisational performance (Butters & Duryan, 2019).

For this research, the boundary-crossing is from an ITE environment to a school environment. The pre-service teacher in the ITE setting shifts to being an early-career teacher in a school setting. Situated learning theory provides an explanatory framework for the theory-practice divide. Pre-service teachers are learning something in one community of learning that needs to be applied in another community of learning. Boundary objects may be bridges between the two settings that allow pre-service teachers to bring some of their ITE knowledge into their first classrooms. One way to understand the theory-practice divide is to discover what features of ITE can also be identified in the classroom and therefore function as boundary objects. These could be tools like the curriculum, planning, and specific manipulatives to teach key mathematical ideas, a theoretical article or an activity.

The literature above clearly shows us that teaching is complicated. Research tells us that ITE has a place in teacher learning and development that theory is important, but how that theory is used is key. Further research tells us that the school environment and policies bind teachers, and ITE learning may be forgotten once they teach. Therefore, my question is, what ideas do early career teachers have about theory in the classroom? What do they draw on to inform their mathematics teaching practice, and are they aware they may be using theory? The question fundamental to my research is: how do the early career teachers carry the knowledge of theoretical approaches to teaching mathematics from ITE to the classroom?

2.7 Chapter Summary

The research literature demonstrates that the perceived theory-practice divide is problematic on several levels. The overall lack of agreement on the nature of the theory-practice divide and how it might be bridged or dissolved makes this a confusing area for teacher educators and

policymakers. However, the one area that all communities agree on is that there must be a change.

In this chapter, I have reviewed the literature and briefly explored the theory/practice divide. I have given an overview of teachers' beliefs and values of mathematical theory in everyday primary teaching practice. I have also reviewed the literature on initial teacher education, specifically, the influence of theory in mathematics teaching. The literature review has outlined how the ideas of boundary-crossing and situated learning could help us understand the theory-practice divide. The next chapter will outline and justify the selected methodology, research questions, and ethical considerations for this research.

Chapter 3: METHODOLOGY

This chapter describes the research design used in this study. First, it introduces the research question before it explains qualitative research and case studies. The participants are then introduced, and the data collection process is explained. Next, how data was analysed, ethical considerations, trustworthiness and authenticity, and limitations are addressed.

3.1 Research Question

The purpose of this research was to explore the perceptions that early career teachers have about theory in the classroom and what influences the decisions they make while teaching a mathematics lesson.

The research question is:

How do early career teachers apply teaching and learning theories of mathematics within a practical classroom mathematics lesson?

Sub questions:

- What theories do early career teachers draw on to inform their mathematics teaching practice?
- To what extent is the use of theory explicit and visible in early career teachers' lessons?
- Are early career teachers aware of theory when they make decisions in their teaching?

3.2 Qualitative Research Paradigm

This research was conducted within the qualitative research paradigm. Qualitative research is a systematic approach, the focus of which is understanding the "why and how" of people's behaviour in certain situations. Denzin and Lincoln (2005) describe qualitative research as a situated action that positions the viewer in that world. Qualitative research comprises a set of interpretive, material procedures that allow us to see the world (Merriam & Tisdell, 2015). Qualitative research allows a researcher to interpret phenomena to make sense of the lives, choices and experiences that support our world (Tracy, 2020).

As a teacher and researcher, I am interested in the world around us, particularly how different views and approaches shape the mathematics teaching world. As I wanted to know how

individual teachers had carried ideas from their teacher education into their practice, qualitative research methods were appropriate.

Tisher and Wideen (1990) refer to qualitative methodology as descriptive data collection consisting of various observations, interviewing, transcript analysis, and developing theories inductively. Therefore, this research project used video observation of the teacher in their natural environment and qualitative questionnaires to obtain the teachers' thoughts on specific topics. It also utilised interviews on two occasions to gather information from the teacher participants, asking questions that allowed me to notice cues and build more significant knowledge about my research question. Creswell (2007) introduces five approaches of inquiry in qualitative studies: narrative research, phenomenology, grounded theory, ethnography, and case study research. This study is a case study.

Huberman and Miles (2002) advise that even though qualitative data are a form of well-substantiated, detailed descriptions and explanations of a process occurring in local contexts, they can sometimes reflect inherent weaknesses. These weaknesses are difficulty in fitting into pre-determined categories, can be time consuming and laborious, and lack of reliability (Merriam & Tisdell, 2015). I kept these things in mind as I employed the qualitative case study approach outlined below.

A qualitative case study allowed me to look in-depth at the practice of three individuals holistically and try to understand what informs their practice within the boundaries of their classroom. Framing each classroom as a case created a pathway to investigate the theory/practice links made by each participant.

3.3 Case Study

Using a qualitative case study approach provides in-depth access to the fundamental shape of everyday events (Creswell, 2007). The research questions for this study can be answered by individual voices and ideas. Using an exploratory case study allowed me to access teacher participants' stories about applying learning and teaching theories of mathematics in their classrooms.

An exploratory case study's objective is to answer 'how' or' why' questions on events in real life. These studies are often bounded to ensure a focus on the collection of the data, but the researcher has no fixed idea of the direction of the data, apart from the bounds put in place. An

exploratory case study is employed because it is valuable and appropriate to gain experience with issues, especially when the boundaries between the phenomenon and the context are not obvious (Yin, 2003).

The exploratory case study approach opened up an intimate view of how early career teachers apply theory to their classroom mathematics lessons. According to Creswell, "case study research is a qualitative approach in which the investigator explores a bounded system (a case) over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, audio-visual material, and documents and reports), and reports a case description and case-based themes" (2013, p. 97).

The advantage of using an exploratory case study is the ability to ask general questions that open the conversation for the participant and allow the researcher to data gather a range of data about the cases (Yin, 2003). Others argue case studies can lack rigour and may allow for biased views to impact findings due to the large amount of data that can be generated (Johnson et al., 2020). I chose this case study approach to ensure the multiple sources of data were considered in context. By exploring a concept, from multiple approaches, there is a greater likelihood of accurately understanding that concept and arriving at a more justifiable interpretation (Nemoto & Beglar, 2014). This research project, therefore, utilised an exploratory case study undertaken in three stages. The data sources for the cases are detailed in Table 1. below.

3.3.1 Participants

Three early-career teachers were studied to gain insight from a variety of teachers who had all experienced the same teacher preparation. The three teacher participants were classroom teachers employed at three different urban schools around Auckland.

Caro was in her third year of teaching since graduating with a Bachelor of Education teaching degree from a university. She was teaching Year 2 students when the research was being conducted. Caro worked in a single cell classroom, at an Auckland Decile 3 school, with a roll between 600 -700 children.

Erica was in her second year of teaching since graduating with a Bachelor of Education teaching degree from the same university. She was teaching Year 2 students when the research was being conducted. She worked in a single cell classroom, at an Auckland Decile 10 school, with a roll of over 600 -700 children.

Kath was in her first year of teaching since graduating with a Bachelor of Education teaching degree, also from the same university. She was teaching Year One students when the research was being conducted. Kath worked in a single cell classroom, at a Decile 8 school, with a roll between 300 - 400 children.

3.3.2 Procedures

This is an exploratory case study of three early career teachers. The data about the cases were collected in three successive stages.

Before the study proper began, an informal conversation established a connection with the teacher participant and information about the class setting was collected. Participant information was shared, and a copy of the relevant ethics consent form was signed. The research data was then gathered over two visits. The first visit incorporated Stage One and Two of the processes, and the second visit included all of Stage Three. The visits and interviews took no more than 1 hour each.

Stage One was a video recorded observation of the teacher participant teaching a lesson within their normal class routine. The purpose was to record video evidence of the teacher engaged in a mathematics lesson. The evidence was later reviewed, and two critical incidents were chosen by the researcher and transcribed. These two transcriptions and the accompanying video extracts of the critical incidents formed the basis of the discussion with the teacher at the third stage of the study.

Stage Two was an audio-recorded interview with the teacher to ask some open questions regarding their experiences with theory since their teacher education programme. The interview also asked what they value about theory now they have responsibility for teaching mathematics in their own classroom. The interview was transcribed by the researcher.

Stage Three was a second interview that aimed to encourage an open self-reflection on the decisions made during the lesson and explore the various beliefs each teacher held about theory and its influences on their current mathematics teaching practice. Returning several weeks after the video was taken, the researcher and teacher participant reviewed the transcription of the two critical incidents and looked at the video extracts of the two incidents. The review allowed the teacher to clarify their thinking and provide their perspective on the teaching extracts. During the interview, the teacher participants were asked to complete a prompt handout regarding what

influenced their decision making when they taught mathematics. This was followed by a review of their lesson against an existing theoretical framework for practice, Anthony and Walshaw's Effective Pedagogy in Mathematics (2009). The researcher then guided the teacher to compare their observed lesson and critical incidents to the ten-point principles framework to identify any alignment within their practice.

3.4 Data Collection

Table One below summarises the data collected for this study from the procedures described above.

Table 1

Table of Data Sources

Source type, in order of collection	When collected	Nature of the data	Duration of collection
Video of classroom mathematics teaching (Stage One)	After the introductory conversation, before the audio interview	The video focused on just the teacher, audio and video of the lesson captured	30-45 minutes
Post-video recording interview (Stage Two)	Immediately after the lesson video was made	Oral responses, audio recorded following a semi-structured interview protocol (Appendix C)	15-20 minutes
Practice-theory analysis Interview (Stage Three)	On a second visit to the participant	Oral responses, audio recorded following a semi-structured interview with a specific focus on two teaching decisions made in the lesson and two discussion prompts.	45 minutes to -1 hour

3.4.1 Collection Process

Data was collected in three stages. The first data source was a video of the teacher participant teaching a mathematics lesson. The data consisted of a maximum 45-minute video recording of the teacher participant teaching mathematics, including their use of any materials and body language. The recorder was angled so only the teacher's image was captured with minimum impact on the classroom lesson or students' learning. The recording captured children's responses to the teacher participant but not their images. Schoenfeld (1998) discusses how a video exclusively focused on the teacher can be enough data as it records a significant percentage of what takes place in the classroom. In this case, it was also reinforced by the focus of the research question, which was to examine the teacher participants 'in the moment' decisions.

Stage Two consisted of an audio-recorded semi-structured interview with the teacher participant (Appendix C). The questions were designed to encourage the participant to share their ideas on any teaching theories they may currently use in their school and classroom. They were asked to recall any theorists from their teacher education days and what they value regarding theory now they have responsibility for teaching mathematics in their own classroom. The semi-structured nature of the interview allowed an opportunity to ask further questions pertaining to their answers to delve deeper into their understanding and experiences. DeJonckheere and Vaughn (2019) describe semi-structured interview methods as a powerful tool to acquire the beliefs and understandings of individuals. The short interviews took between 15 minutes and 20 minutes to complete. The Stage Two semi-structured interviews were later transcribed by the researcher.

The video data was then used to identify two critical incidents within the lesson for reflection during the second visit. These incidents were selected by the researcher as they represented a moment within the lesson that naturally occurred but may not have been planned for. The critical incidents each had an interaction between the students and the teacher, materials were present and focus questions were asked by the teacher. Critical incidents are effective for revealing thinking about practice as they encourage uncovering aspects of expertise that might not be found in routine events (Hoffman & Klein, 1993). Once the video's critical incidents were transcribed, the teacher participant had an opportunity at the next visit with the researcher to review or clarify any of the information on the transcripts of both the video and the interview.

Stage Three was a second visit and a further semi-structured interview. The time was suggested by the teacher participant so it would not impact their teaching duties. The interviews were conducted in the teacher participant's school environment. The semi-structured interview was also audio recorded. The researcher interviewed the teacher participant beginning with questions from an interview protocol (Appendix C). The questions were designed to allow the teacher participant to reflect on their teaching practice and share their ideas or opinions of theory inside their teaching approach and its relevance in a classroom mathematics lesson. The teacher participants were asked a couple of general questions regarding their ideas about theory in their classroom. Then, the teacher participant was given a transcript of the critical incidents the researcher had selected to review. The teacher participant and the researcher watched the video extracts together, and the teacher participant was asked if they thought the transcript was a correct representation of a moment in their lesson. Once this was agreed upon, the interview continued. The teacher participant was asked to expand on what they saw happening in one critical incident using prompts, e.g. "Now, tell me about what you are thinking here in terms of the decisions you made". The process was repeated for the second critical incident with the same questions.

Following the critical incident conversation, the teacher participant was given an 'influences prompt' - a handout to complete involving some pre-selected factors that may or may not influence their teaching decisions (Appendix A). These were pre-selected by the researcher to cover some ideas that may or may not be relevant to the teacher participant but were raised by the literature in this area. The participants' responses were recorded on the Influences Handout sheet.

After the 'influences prompt' handout, the researcher provided the teacher participant with a ten-point framework of Anthony and Walshaw's Effective Pedagogy in Mathematics. Educational Practices Series (2009) to use as a catalyst to further examine their teaching of the lesson, to discover any unconscious use of theory. This theoretical framework was a ten-point principles handout (Appendix B). The researcher and teacher compared each effective pedagogy listed in the principles table with the recorded lesson and critical incidents. Any responses to the ten-point principles table were audio-recorded and transcribed later.

Stage Three of the semi-structured interviews ended with the teacher participants answering their final questions about whether they consciously use theory in their maths practice or whether they make teaching decisions but may be unaware of the theory itself. The interviews

took between 45 minutes and 1 hour to complete. All responses to the interviews were transcribed by the researcher in the following weeks.

3.5 Data Sources

3.5.1 Audio and Video Recording

A smartphone with video and audio capabilities was used to record the lesson. This small device allowed the researcher to sit off to the side, reducing unnecessary intrusion into the lesson while still being able to capture the movement and expressions of the teacher. The class video observation needed to be a typical representation of how a lesson would normally be presented; therefore, the recorded mathematics lesson was timetabled to stay within the teachers' normal mathematics schedule. Several dates were made available to the researcher, so the recorded lesson was part of their everyday classroom routine and not developed especially for the researcher to observe.

One of the benefits of using a video and audio recording is it allows for the collection of rich data. It captures the individual in one continuous motion, and it provides details of conversations and interpersonal connections with the students in the participants' lesson. By recording on a device, the researcher can go back and review the events without fear of having missed any information. The video recordings were only seen by the researcher and the teacher participant.

3.5.2 Critical Incidents

After Stage One and Two were completed, the researcher reviewed the video recording and selected two critical incidents for each of the three teacher participants. A critical incident is when a specific event is identified and considered in detail. The incident is selected because it is thought to represent or reveal an event or practice that is relevant to the research question. (Robinson & Lai, 2005). The critical incidents in this research were taken from the recorded lesson. They were chosen as a conversation prompt for the second visit at Stage 3.

The purpose of the critical incidents was to enable the teacher participants to identify, describe, and explore judgments in the video that revealed aspects of the teachers' decision-making during the lessons. The criteria for selecting the extract were: it was an unplanned response (in the sense of arising spontaneously during the lesson), it involved interaction with students, a

material aid, and the use of focus questions to highlight a mathematical concept or misconception.

3.5.3 Semi-Structured Interviews

The purpose of employing semi-structured interview techniques for this research was to explore the ideas of each participant in a comparable but open way. It was a way to collect exploratory, open-ended data relating not only to the research question but to look deeply into the teachers' personal opinions and decisions without judgement. The plan was to conduct face to face interviews with the teacher participants in their school environment, somewhere convenient. The protocol began with a simple, situation-setting question before shifting to more complicated or in-depth questions (DeJonckheere & Vaughn, 2019). For example, the opening questions were developed to encourage the participant to talk about facts and general experiences, such as "Outside of your teacher training, have you had an opportunity to experience any theoretical concepts in mathematics as part of your professional development?" (Appendix C).

At Stage Three, the pre-determined questions directly related to the participant and then to the research study questions, for example, e.g., "Comparing the framework to a critical incident from your mathematics lesson, are you able to identify any further theory in your teaching?" The questions were planned before the interviews took place. However, as the researcher was actively listening to the participants, opportunities arose to ask unplanned follow-up questions, or the questions were asked slightly out of order depending on the participants' responses. The interviews were to be conducted face to face at the participants' schools; however, two of the interviews had to be conducted via zoom due to Covid -19 restrictions.

3.5.4 Prompts

As a qualitative researchers conducting interviews, Jacob and Furgerson (2012) recommended creating probes or prompts for each question to help keep you on point. Prompts help to remind you of your questions while at the same time allowing for unexpected data to emerge. Prompts allow the researcher to keep the interview on track and to make certain there is enough information to collate. The first prompt used was the influences prompt – a handout to stimulate the conversation and gain insight into areas the teacher participant may not have mentioned on their own. The second prompt used as a conversation starter was Anthony and Walshaw's

Effective Pedagogy in Mathematics (2009). The ten-point principles framework handout was given to the teacher participant, and their responses were recorded.

3.6 Data Analysis

Table Two below summarises the ways in which the different data sources were analysed. Each analysis method is then described more fully in the section following the table.

Table 2

Table of Data Analysis Method

Source type, in order of collection	Nature of the data	Analysis process
Video of classroom mathematics teaching (Stage One)	The video focused on just the teacher, audio and video of the lesson captured	Video reviewed by the researcher Two critical incidents were selected by the researcher – to include teacher/ student interaction, material or aids, and key questions from the teacher. Critical incidents were transcribed by the researcher to share with participants during the second interview
Post-video interview recording (Stage Two)	Oral responses, audio recorded to a semi-structured interview protocol (Appendix C)	The interview was transcribed by the researcher and checked by the participants. The transcript was then read and re-read to immerse the researcher in the data. Emerging themes for each participant were determined through repeated reading and iterations of coding. Vignettes for each participant were begun, summarising the emerging themes in their responses.

Source type, in order of collection	Nature of the data	Analysis process
Revisit Interview (Stage Three)	Oral responses, audio recorded to a semi-structured interview protocol (Appendix C) Influences Prompt Theoretical Framework Prompt	Interview responses were transcribed by the researcher and checked by the participants. The transcripts were read and re-read for immersion. Emerging themes and patterns for each participant were noted through repeated iterations of reading and coding. Themes and patterns were added to the vignettes derived from the first interview to provide a summary of each participant as a case. Influences Maps constructed using responses to the influences prompt and interview themes, using line thickness and node size to indicate the relative importance (Figures 2, 3 and 4). Combined Chart – derived from comparing the three Influences Handouts. (Figure 5).

3.6.1 Processing the interviews

In this research, all interviews were transcribed from audio recordings by the researcher. Transcribing is the first step in transforming the data. The transcriptions were checked by the participants to make sure they were accurate. Both interviews were used to compile narrative vignettes that characterised each participants' responses.

The researcher read and re-read the transcribed responses of each participant individually. Notes were made during this immersion in the data. These notes were used to create an overview of each individual participant. The initial overviews were then compiled into case vignettes about each teacher participant. To compile the vignettes, the researcher used keywords and ideas in the transcripts that were closely linked to the research question and the Influences Handout to select what to extract from the interview responses. This deductive analysis was accompanied by openness to emerging themes that might not have been accounted for in the

Influences Handout and interview protocol. Thus, a deductive analysis was followed by an inductive analysis to check for completeness. Each emerging theme gave insight into the teacher participants decisions, values, and practise (Creswell, 2012).

3.6.2 Influences Maps

The Influences Maps were developed from both the semi-structured interviews and responses to the influences prompt. In the Influences Handout, each item was assigned a tier from 1-5 by the teacher participant, based on how important the participant thought that influence was for their mathematics classroom practice. These perceptions from the prompt activity were brought together with the evidence from the interviews. The researcher counted how many times particular influences were mentioned as a measure of their relative importance to the participant. Some of these influences were on the Influences Handout, and some were not. The importance rating given by the participant, and the frequency of mentions of an influence by the participant, were combined to make a 'map' showing how important the different influences seemed to be for that participant's practice (Figures 2, 3, 4).

An influence map was produced for each participant individually. First, the influences that were rated four or five out of five in importance were placed on the diagram. Then the most frequently talked about influences that were not on the prompt were added. Influences that were rated most highly or talked about most frequently were placed closest to the centre. The stalks on the map also serve a purpose. A thin stalk indicates that the influence was introduced by the researcher in the prompt tool but not expanded on by the participant during the interview. The thick stalk indicates that the teacher participant introduced the topic during the interviews.

Some influences were rated highly on the prompt tool but not raised in discussion. These are close to the centre but have thin stalks. Some influences were rated less highly but were frequently discussed and raised by the participant. These are also close to the centre and have thick stalks.

3.6.3 Combined Chart

The individual participant's results were amalgamated into the Combined Chart (Figure 5) to show the similarities and differences in perceptions and values of all three participants. Figure 5 is intended to help the reader see the patterns that emerge in each case more clearly. Each participant has a characteristic pattern of influences, and by presenting them in a way that can

be readily compared, the nature of each exploratory case can be more readily seen (Baxter & Jack, 2010).

3.7 Trustworthiness

Trustworthiness refers to the authenticity, quality, and reliability of findings of qualitative research. It relates to the confidence the reader has in the results. The validity and reliability of data, methods and analysis are crucial factors when accepting or rejecting the findings of any research (Denzin & Lincoln, 2005).

This research involved three teacher participants. Rowley (2002) states that the more case studies included to establish a theory, the more robust the research can be judged. However, Rowley (2002) concedes that the number of cases depends on the nature of the research. This study has a small number of participants, meaning that the findings cannot be generalised. The findings also suggest that there are considerable differences among people with respect to the research question, so the case studies can be seen as pointing out the complexities in this area and showing ways people might differ, but not providing an overview of all the possibilities.

Lincoln and Guba (1999) state, "The basic issue in relation to trustworthiness is simple: How can an enquirer persuades his or her audience (including self) that the findings of an enquiry are worth paying attention to, worth taking account of?" (p. 398). This research used rich descriptive interviews to answer the research question, member checking to ensure the true nature of the data was expressed, data saturation to collect what the teacher participant had to say with multiple prompts, with the aim of lessening any bias from the researcher during the collection and analysis processes (Lincoln and Guba, 1999). The methods section provides details about how analytical decisions were made so that the reader can judge how the findings were determined. The process of analysis was data-based and iterative but did involve researcher judgement. The researcher's positioning has also been made clear to help readers see how the researcher's judgement may have impacted research decisions.

3.8 Limitations

There are four key limitations associated with this study: sample size, bias, limited voice and data analysis and interpretation.

The first limitation of this study is the small number of teacher participants. The objective of the study, however, was to gain an insight into what crosses the boundaries from ITE in the

classroom of three teachers. The use of rich data from multiple sources, as mentioned in Chapter Three, attempted to lessen this limitation. However, the size of the study may be too small to consider the findings meaningful, especially when the participants were very different, suggesting that further participants might also differ from this group. Due to COVID-19, some of the interviews had to be conducted over zoom, and the time between the video lesson and the revisit interviews was affected by lockdowns. Efforts were made to ensure this research was conducted with minimal disruption to the original study design.

The second limitation is that the study involves sample bias. The sample of participants all came from primary schools in Auckland and all taught in junior-level classes. There were no recorded responses from senior school or intermediate early career teachers, and this may need to be considered. The teacher participants were aged from their ’20s to ’40s. The older teacher was more self-critical and reflective. This indicates the responses of younger or older early career teachers may be different from the responses recorded here.

The third limitation is the limited voice. The study involves only teachers. While it was not within the scope of the study, different perspectives could have been captured if pre-service teachers, school experts, initial education providers and policymakers had been involved in this research. The perspectives from all involved would be less restrictive. The teachers were volunteers and cannot be said to represent early career teachers in any way. They were teaching in different types of schools in different geographic locations, but no attempt was made to obtain a group of participants from which generalisations could be drawn. The fact that they were willing to participate in a study on their mathematics teaching means that they are a particular subgroup of early career teachers.

The fourth limitation is the care required when drawing conclusions and reporting the results. The methodological choices were constrained by using a semi-structured interview, as the teachers were asked to discuss questions and discuss critical incidents of their teaching choices. Asking the teachers to discuss their choices culminated in a variety of data that was comprehensive and personal to that teacher. The interpretation of the information may be influenced by my positioning. Positionality provides the basis to state one's interpretation of the social world clearly. Knowledge is rational when it takes into consideration the knower's individual position in any context, a position always defined by gender, race, and other socially significant elements (McNiff & Whitehead, 2002). I work at the Faculty of Education and Social Work as a mathematics support tutor. My job is to assist with learning about the “what’s

and how's" in teaching and learning primary mathematics education. However, as a researcher, I need to ensure I reflect on how this research may be impacted by my attributes and experiences. My interpretations of the teachers' actions and responses are shaped by my experience of teaching and tutoring mathematics and mathematics education. I responded to this by making my positioning clear in the introduction, ensuring my protocols and procedures can be scrutinised or replicated by others and adhering to the recommendations for conducting an ethical case study. My findings, however, need to be read with my positioning in mind.

3.9 Ethical Considerations

All participants were adult volunteers. No participants had knowledge of the other participants in the study. A Participant Information Sheet (Appendix D) was emailed to each interested volunteer to ensure complete transparency of the process they would be undertaking and what would be required from them.

A Participant Information Sheet (PIS) was also given to the school principal to ensure that they were informed that the research was taking place on school property and all that the research entailed (Appendix E).

The researcher's contact details were also on the PIS, so should the Principal or Teacher Participant wish to ask any questions or clarify any of the requirements, they had the opportunity to do so. The PIS contained information informing the volunteer that they would be a video observation of a mathematics lesson as well as an audio-recorded interview and that they would be given time to edit the information recorded before it was analysed. The Teacher Participant was offered a copy of both recordings on their Consent Forms (Appendix F). The principal of the school was also asked to complete a Consent Form (Appendix G) with the option of receiving a summary of the findings.

Due to the small number of participants and requesting permission from the school, Principals were aware of the teacher being involved in the research. However, all efforts were made to keep the identity of the teacher and the school confidential in the final research. The participants were allocated a pseudonym, and all recorded information refers to that name. The individual's identity was kept confidential by the research team. No information identifying the teacher or the school was published except their years of teaching, class level and that they are in Auckland. All information collected was stored securely in locked or password-protected systems, with access only for the researcher and Principal Investigator. All participants were

updated via email and were fully consulted about the researcher's visit and revisit times. The participants were made aware they could pull out of the research at any time in documents and verbally through the collection process.

There is no conflict of interest with the participants. However, the researcher and participant may have met in previous years during their time of study at the Faculty of Education; therefore, the voluntary nature of the recruitment is emphasised on the PIS and CF forms. The participants were clearly informed of their right to withdraw from the research at any time without having to give a reason via the PIS as well as verbally with every contact they had with the researcher. Ethics approval was sought before any research began (Appendix H).

The researcher contacted principals initially to request participation from the school and asked them to pass on the participation email and information to any teachers eligible in their school. The criteria for participation were initially advertised through a recruitment email (Appendix I) to Principals from the researcher. Recruitment emails (Appendix J) were then sent to those teachers who were in their first three years of practical classroom teaching after obtaining a Bachelor of Education from the 3-year degree programme. Part of the research requirement was that only one teacher from each school could participate, and so the selection was based on the first teacher from the school, who, having met the criteria, and understood the research participation information, was then the first to have completed their consent form.

Chapter 4: FINDINGS

4.1 Introduction

This chapter presents case studies of each of the three teacher participants. There are three sections for each participant.

First, a brief background description of where the participant is in their career and their opinions and ideas about theory in practice are presented. This information came from the interviews conducted after the recording of their lesson.

For each participant, this is followed by two critical incidents selected to highlight key teaching moments. The incidents are shared, and the reflections and reactions of the participants are described. A designated research-based framework (Anthony & Walshaw, 2009) is used to explore further the participants' ideas of theory in their practice.

Finally, an Influences Map depicting the importance and value each of the three participants gave to factors that influence their mathematics teaching decisions is presented (Figures 2, 3, 4). The chapter concludes with a Combined Influences Chart (Figure 5) linking the collective data from the influences prompt.

4.2 Case Study Participant – "CARO"

Caro is a young teacher in her third year of teaching. She completed a 3-year undergraduate programme at University with a Bachelor of Education (Teaching) degree. Caro works in a single cell, a Year 2 classroom in a Decile 3 Auckland primary school. She no longer has a tutor teacher and is part of the maths leadership team. The school has had professional development support in mathematics from an outside provider.

Caro recalled the names of some theorists (Vygotsky and Piaget) from her time at university but did not feel confident to expand any further on their theories. When Caro reflects on her university studies, she feels theory has meaning and value; however, she cannot recall the theory now. Caro remembers theory being introduced through readings and in her lectures and said it was useful at the time and relevant at the time; she just cannot recall it now. Caro said theory was helpful during her teacher preparation course when it was used to plan a lesson with a group of children or on practicum. She believes the nzmaths website and her practicums as a student have influenced her teaching more than any readings that she did.

When asked her opinion on the theory in her mathematics classroom, Caro felt a need for theory in the class, but she could not remember any specific mathematics teaching-related theories. Caro said this made her rethink her previous answer about its importance.

As part of her school's maths curriculum team, Caro helped her staff examine the numeracy development project books (Ministry of Education, 2012). During these workshops, it became evident that many of the teachers were unaware of what standard or level of work their students should be achieving. She used this support material to unpack standards and make learning more transparent. Caro felt it was *"a bit wishy-washy for a while"* for everyone on her staff until they came together.

Caro herself uses the numeracy development project (Ministry of Education, 2012) for planning and support for deliberate acts of teaching and assessment. She also uses the nzmaths website for assessment, including JAM (Junior Assessment of Mathematics), because of the rubric style. She also uses the Units of Work by Strand from the nzmaths website for planning Number and Algebra, Geometry and Measurement and Statistics lessons.

In her observation lesson, Caro's current focus was on Talk Moves (Chapin et al., 2009), which she had been introduced to through a professional development programme her school undertook with an external professional development provider. Talk Moves was part of her classroom programme, where she was trying to develop conversations to improve students' understanding of mathematics concepts. She has based her teaching approach on expecting the children to regularly listen, speak and respond to each other and uses a series of hand gestures (Chapin et al., 2009). Talk Moves also allowed Caro to focus on her delivery. As well as reminding her to wait before interjecting, the programme also encouraged her to revoice and repeat for clarification. It also promoted think-pair-share for the students and allowed the children to agree or disagree with comments made. These ideas are embedded in her planning, with time allocated for sharing and talking. When she first engaged with the Talk Moves professional learning, Caro's idea of teaching had to change from her expectation of how she might run her class to these "must do/ may do" activities, which she had never experienced before. *"That pretty much changed what I came in expecting to do- like a tumble. That went out the window, and I was into these "must do / may dos" I had never heard of that tool."*

Caro connected with the professional learning provider's maths warm-ups that allowed all children to participate by agreeing or adding to others' thinking. She felt the hand signals that were part of the talk moves (thumbs up and down, for example) allowed students to agree

without the pressure of putting their hands up or feeling they had nothing to contribute. Caro recognised that her ability to wait and let children think as well as repeating back students' ideas has improved with her involvement in professional learning. She reported occasionally having no idea what the students meant with their thinking but now has Talk Moves (Chapin et al., 2009) to support her teaching approach, which has allowed the students the opportunity to self-correct.

In her lessons, Caro uses materials and modelling books and a learning intention. She focuses on the end of the lesson to check for learning, to show her what the students take away from the task, inform her practice, and what she may need to revisit in the future.

When asked directly about influences on her teaching, using the prepared Influences Handout (Appendix A), Caro said that the Ministry of Education influences the decisions she makes in her maths class because of the resources they provide; she is influenced by professional learning through courses, her past experiences of teaching the topic and support from her tutor teacher and school staff. She was sure that her parents and her own high school learning did not influence her at all.

Content ideas for lessons came from the nzmaths website for her everyday teaching, while the way she presented the ideas and the language she used came from the school's professional learning on 'Number Talks'. She feels that she makes decisions based on theory and what she feels is best for the students. She knows that the theory is out there and often has a feeling ``I kind of know that from somewhere'' but can't pinpoint where. *"I guess now, reflecting on it, those things have been so drilled into me that maybe they don't feel like it's intentional, but all those things are, especially planning, modelling books. I guess it just feels with everyday practice that maybe it doesn't. I definitely don't look at it and think- that relates to theory. I know somewhere that someone has said this is a good way of doing it. I know my school didn't pluck it out of thin air and just decide this was the sort of area or way we are going to teach maths. So yeah, it's definitely opened my eyes that maybe I'm doing more than I think, and maybe I need to look back at some theory, and it might actually help me a little bit more when you get stuck, especially. It's reassuring to know those things are there."*

4.2.1 Critical Incidents

Caro's two critical incidents were selected from one lesson with a small group of Year 2 students. The learning intention was to learn to skip count using money. The learning intention

was recorded in a modelling book and introduced as a discussion before the lesson started. There were four children in the group on the floor. The teacher had a big box of plastic coins, a modelling book, and a marker.

Critical Incident A

Critical Incident A is an extract taken from 2:06 minutes into the lesson.

Teacher: Does anyone know what this one is? (Holds out a hand with 20 cent plastic coin)
Children: 20 cents
Teacher: 20 cents, and it's also got the number on to help us, and it's also got the queen on it.
Teacher: We've got (holds out a hand with 10 cent plastic coin) this one.
Children: Ten cents
Teacher: Ten cents oh, we know that one.
Child: It's a little one.
Teacher: It is the littlest one, and it's also a different colour, it's bronze. (Places the coins on the modelling book). Searches in the box of coins, "What about this one?" (She turns it around in her hand to face the children). Waits – no answer. "Do you want your own one to look at?"
Children: Yes.
Teacher: What do you reckon it is?
Child 3: One dollar
Teacher: One dollar. And did you know it actually has one dollar written on it? Can anyone see that?
Child 2: I see the number here.
Teacher: At the back, but it's also on the front. Can you see it right there in the tiny little letters? And then what is this one?
Child 1: Two dollars?
Teacher: What's bigger, one dollar or two dollars?
Children: Two dollars.
Teacher: Two dollars is the bigger one. So, we are going to look at our money. Are there any five cents? (Waits). Have you ever seen a five cent? There used to be, but there's not

anymore. So, there is no five cents. So, the smallest amount of money is? (Places coin in her hand)
Children: Ten cents
Teacher: Ten cents. You can't really buy anything with ten cents, can you? (Children chat about spending) "probably not, maybe half a lolly?" So, the reason we are looking at our ten cents is because when we count money, it would be super easy to count in…?
Children: Tens.

Caro was asked during the interview to review the Critical Incident One from the video clip and describe what was happening from her perspective. She described the incident, *"I was aware this (money) was new to them, and I know from previous experience that money, they're quite oblivious to, they don't understand it, so I wanted to start very low level. From past experience, it's what I've had to deal with before. I was quite impressed that they know things like 10 cents. Because quite often, they can identify one dollar and two dollars. So, it quite impressed me. I wasn't surprised when they knew the dollars. But it was good to see they recognised the things that they use regularly and to see then number on the actual coin, it isn't always there, but they like to identify that as well".*

When asked, Caro justified her actions and decisions during the critical incident by saying, *"I definitely wanted to look at the dollar coins because they get quite confused with one dollar and two dollars. It takes a while for them to realise that there is a difference between them. And not just knowing that two dollars is bigger because it looks bigger. So that was intentional and asking, 'what's bigger?'. I've had that before; they choose the biggest coin, and that's the biggest one, so fifty cents get chosen every time, so they actually chose the size instead of the actual amount".*

Critical Incident B

This Critical Incident B extract is taken from 7:30 minutes into the lesson.

Teacher: I'm going to give you one now. You are going to try it by yourself, and you are going to try to count them. Do you reckon you can do that?

Children: yes

Teacher: Yeah, but I'm going to give you different coins and see if we can count them? I'm going to give you that one and that one. You are going to try to work out how much you have altogether (Shares out different coins to all four individual children in the group). Have a look at your coins and tell me how many you have altogether. Right, I'll give you a little bit of time.

Child 2: (calls out) I know—the teacher signs with a thumb up against her chest. The child sits back.

Teacher: Right, shall we have a look at your one first Child 2? (The teacher draws a picture of the coins in the modelling book). So, you have a 20 cent and two tens. How much do you think you have altogether?

Child 2: 40

Teacher: How did you work that out?

Child 2: Two plus two is four, and then you add the zero on.

(The teacher records the number equation 2 + 2 = 4 40c and records the child's name next to it.) Child 3, what coins do you have?

Child 3: 20 and one ten.

Teacher: How much money do you have?

Child 3: 30

Teacher: Can you show me how you counted? How do you do it?

Child 3: I counted

Teacher: What did you count?

Child 3: I said 20, and then I counted on my fingers.

(Teacher records 20 + a picture of fingers in the modelling book = 30). Awesome, because you know you have how many fingers?

Child 3: 10.

When asked about the decisions she made during this extract, Caro replied, *"I wanted to see them add multiple (coins)together. And skip counting was one of the learning intentions as well, so it was to get them to counting in tens and twenties and stuff, if possible. I was quite impressed. It didn't really have a place value aspect, but after I heard that kids say it back now, I should have looked deeper into the place value side of it as well. Again, the Number Talks is thumbs up and getting them to wait to share your ideas. Same with the modelling book that's all based off the number talks stuff we did as well. And it's all accepting any ideas, even if they're completely different, to take any idea and write it down. Any idea is valued when you write it down to them; no matter what they would have said it would have been recorded. And also, that rechecking that's what they did. So, they say 20 can you do that on your fingers, can you show that to me. Because quite often they tell you what you want to hear".*

4.2.2 Theoretical Framework Prompt

When asked to discuss her lesson against Anthony and Walshaw's Effective Pedagogy in Mathematics ten-point framework (Appendix B), Caro was able to identify aspects of her lesson in all the ten areas identified as research-informed practices by Anthony and Walshaw (2009).

Table Three below summarises Caro's responses to the Anthony and Walshaw (2009) ten-point framework prompt (Appendix B). Caro's voice is recorded in italics.

Table 3

Table of Caro's Response to Framework Prompt

Principle	Teacher Participant's Response
1. An ethic of care	Caro believes Talk Moves (Chaplin et al., 2009) has created a classroom culture where all ideas are accepted. She caters to special needs and a mixture of mixed ability groups, flexible groups, and deliberate teaching groups in her planning. She felt it was important to stress, not always mixed ability.
2. Arranging for learning	Caro said this lesson was a mixed ability group for strand, so she felt it was essential to allow time to explore before giving them an independent question. "*Doing a collaborative part and then doing an independent question for them to try it themselves".*
3. Building on students' thinking	Caro felt the context of money was building on the students' thinking. *It didn't have to be money, but we decided as a team as we were looking at place value and skip counting, so using materials put it into context for them.*
4. Worthwhile mathematical tasks	Caro felt the context again helped her meet this principle in her lesson. She said it would be necessary for their future and something they could also see their families using.

Principle	Teacher Participant's Response
5. Making connections	Caro felt she was making connections regarding buying things with money and having to add two amounts together, but she also said it was about connecting with other people. "*Actually thinking ', hey, I had the same idea, I might not have worded it that way, but I had that same idea."*
6. Assessment for learning	Caro says the modelling book for this lesson would be the assessment. She ensures that she records the name of the child next to the thinking. Then uses this information as part of her ongoing assessment. The information will later be transferred into her planning, but she uses the modelling book in the teaching moment.
7. Mathematical Communication	Caro explained that this comes through strongly as Talk Moves [Number Talks]. The children use hand signals to agree or disagree. She felt it wasn't used much in this lesson, but it was there.
8. Mathematical language	Caro talked about how she ensured the children kept the context by asking questions such as what you mean, can you show me how you did that, and describe what we did? And making sure they referred back to the context. *In that lesson, when they tell me 20+20= 40 but what "It had to be 40 cents because of the context so always referring back to what you have added. It's not just a number it's more than that especially in money".*
9. Tools and representations	Caro used plastic money for this lesson. She commented that she wished they had real money as the plastic money wasn't an accurate size representation. But she felt that it was worth using as the children could still connect to it and link it to the real world. Caro also mentioned the use of recording the dollar sign in the modelling book. "*That extra thing they're learning without really knowing they're learning it".*

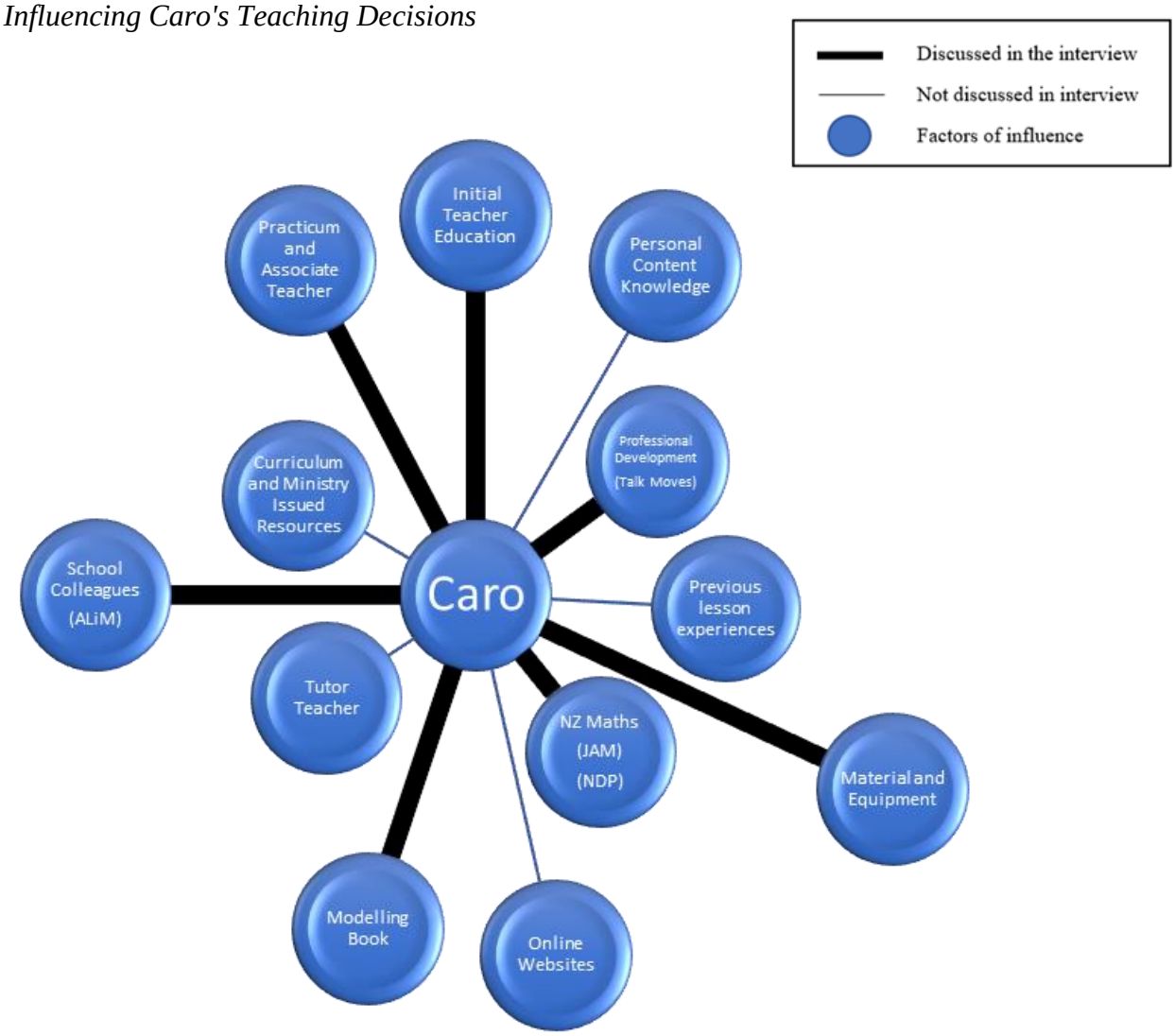
Principle	Teacher Participant's Response
10. Teacher knowledge	Caro discussed knowing where to go to get lessons and planning support on the nzmaths website as part of this principle. As well as the knowledge she uses from Talk Moves to facilitate a discussion amongst the students about incorporating techniques like repeating back or revoicing the children's thinking to make it more transparent for both the teacher and the other students.

In Caro's responses to the Anthony and Walshaw (2009) framework, two themes are emerging. First, she places a strong value on authenticity and 'real life' connections through using money in the lesson activity. Caro sees this as being a way to build on student thinking (item 3), making the activity worthwhile (item 4 on the framework) and using tools and representations (item 9). Second, she is focused on the students' responses as they relate to the task and to each other, rather than necessarily on the mathematics. Her example for making connections considers how the students' answers relate to each other, rather than the mathematical connections in the lesson, and how the students responded to the money as a context overrides the difficulties caused by the money as a model for meeting the learning outcomes.

4.2.3 Caro's Influences Map

Figure 2

Factors Influencing Caro's Teaching Decisions



Caro rated five factors as being strong influences on her practice. These are represented by being closest to the centre circle. When examining Caro's Influences Map, we can see that of the five most important factors in her practice, only two of them were discussed during her interviews; nzmaths and her in-school professional development. The other three factors were introduced through the Influences Handout, and she did not discuss them during her interview. These were the New Zealand Curriculum and Ministry of Education issued resources, and her Tutor Teacher, as well as learning from past teaching experiences. Caro did mention "the standards" (National Standards), which had been decommissioned by the Government in 2018.

Although the National Standards no longer need to be reported yearly, they are still available on Te Kete Ipurangi (TKI), a Ministry of Education website.

On the second layer of factors that influence her practice, Caro identified seven factors which she rated as four out of five on the Influences Handout. It is evident from the thick stalks that five were discussed or expanded on during the interview. Personal content knowledge and online websites were not brought up in conversation, only rated on the Influences Handout. An exception to the online websites was the nzmaths website, which she discussed several times with specific reference to accessing the Strands for planning, the numeracy development project resource materials, and the junior assessment of mathematics.

During her interview, Caro discusses how *"I learned more through practicum and stuff than what I remember from university study in maths."* However, she rated both her initial teacher education (ITE) and her practicum as four out of five.

4.3 Case Study Participant – “ERICA”

After completing a 3-year undergraduate programme at University with a Bachelor of Education (teaching) degree, Erica is a young teacher in her second year of teaching. Erica works in a single cell classroom with a Modern Learning Environment (MLE) philosophy teaching Year 2 in a Decile 10 Auckland primary school. She is in a three-teacher collaborative planning and teaching team; one of the other teachers is her tutor teacher. The school has had professional development support in mathematics from an outside provider.

Erica values a collaborative approach and recalls connecting with that approach during her time at university. Erica believes the pre-service education she received has an impact on her teaching. However, when asked what she remembered from her teacher preparation courses, she didn't recall anything specific. Erica felt if she had a chance to go over her studies again, she might be able to relate but jumping into a school with its own professional development and expectations, she had to follow the school policies. *"If I was able to go back over the different theories, I would be able to make connections".*

Erica believes collaboration is evident in her groups for teaching. She uses trios of mixed ability for most subjects except reading, she teaches maths problem-solving three times a week, and all triads see the Teacher once a week, and the other days, they are doing workshop activities.

When asked if she remembered any theorists from her time at University, Erica remembered Piaget and Vygotsky but couldn't recall what curriculum area. Again, she noted that if she had time to examine the connections, she's sure she would recognise them. She states she's not actively planning with theory but sees it in her teaching, although she did not expand any further. *"Sometimes I am not fully aware of [theory] it! But within my planning, I am aware of it, and I know I need to include them [learning theories], but through my teaching (in all curriculum areas), I'm unaware that I'm constantly doing it. I'm not very aware of any theories that I'm using, but if I was to look back at it, I would look back at it. I would probably realise - oh yeah, it is that theory, or I can relate it to that".*

Erica believes theory impacts her teaching practice mainly during the planning and assessment. Her syndicate plans collaboratively, and she meets with two other teachers each morning when children have a brain break to share ideas and collaborate to make any changes to their lesson: *"I'm not planning with theory, but I see it coming through".*

Erica mentioned that she was so overloaded with the information that she had to follow her school's plans at the beginning of the teaching year. She reflected on how once she started in the school, she noticed that many teachers had different takes on how maths should be taught. This made her use approaches she relates to, could deliver, and could imagine the children completing. "I feel that within beginning teaching, in my brain has been so overloaded with what the school is learning that I've just taken that on board."

Erica organised to observe a class in another school during her release time. It was similar in approach to her current school.

As part of her school's professional development, she experienced collaborative problem solving and believes it works. She feels children have a real hit or miss experience with early mathematics but that working within a group, they find a lot more confidence.

Erica says she uses theory when collaborating as it is throughout all the curriculum areas when teaching in an MLE. She also works in a collaborative environment as part of a teaching team. *"I think it's a bit about theory and a bit about teacher judgment as well. Then I keep them[ideas] and I take them on as my own. I may even think it is my own, and I make those connections, and I think actually this is somebody else's idea".*

4.3.1 Critical Incident

Erica's two critical incidents were selected from the one lesson with a group of 9 Year 2 students. The learning was a problem-solving activity. The teacher launches the problem by reading the problem. There are three children in each group on the floor with a modelling book. Each group (trio) has the problem already glued into their modelling book as a think board. The teacher had pre-prepared an A4 laminated board and some counters if she felt the students needed them.

Critical Incident A

Critical Incident A extract is taken from 8:44 minutes into the lesson.

Teacher: Problem solvers look at Miss Erica. I have got some resources here for you. You can use them if you want, you don't have to. Who can remind Miss Erica and everybody else how many children are running in the running race?
Children:20
Teacher: How many groups do they start off in?
Children: 2
Teacher: So, I've got some resources here to help you. What do you think this might be for? (Holds up a laminate paper with two equal boxes on it.)
Child: They are boxes.
Teacher: They are boxes, but how many boxes can you see?
Children: 2
Teacher: What do you think that might help you for?
Child: So that we can draw ten in each group.
Teacher: Maybe they might help you with your groups. So, there's one there for each trio. And I've got some. (Holds up multiple zip lock bags with counters in).
Children: counters
Teacher: Counters, if you want to (states a child's name). So, you need to decide in your trio if you want to use resources or you can draw straight onto your think board. Off you go.

Erica was asked during the interview to review the critical incident from the video clip and describe what was happening from her perspective.

"I'm sitting the children up to start their problem-solving. I went through the question and tried to get them to think more about the question. So I asked them how many "how many groups did they start off in ?" because I noticed with the children I can read the question with them / for them, we can identify the clues in the problem, but they still need the problem broken down a bit so that's why I prompted them with "how many groups did they start off in ?" and then they answered with two and then I held up the resources to remind them what the resources could be used for because the group I had the day prior I didn't give them the resources and

they were quite lost with that problem. So, some of the resources I have pre-made might help them to see it visually. It might help them a bit better. And then I sent them off".

Critical Incident B

Critical Incident B extract is taken from 27:35 minutes into the lesson. Children have a modelling book open with tally marks or drawings of counters and are now using the A4 laminate boxes with counters.

Teacher: Right, so you've got 12 and?
Child 2: Nine.
Teacher: Who is the recorder? Right, I want you Child 1 to write that as a number sentence for me now please.
Child 1 writes 12 + 9 = 20 as Child 2 says: "Write 12 plus 9 = 20." You have one in your hand (refers to counter).
Teacher: So, we are just going to double check this OK. How many have to got in your first group? (Points to counters on the laminate)
Child 1: 8
Child 2: (points to each counter and counts to 9). "9"
Teacher: OK and how many have you got in here.
Child 2: (points to each counter and counts to 11). "11"
Teacher: (Teacher checks by counting the counters aloud, "11". And what number have you written here (points to 12)
Children: 11, oh, when we had 12, we had 21.
Teacher: So, change that (Points to 12 on number sentence in book). So, when it came to 21 what did you have to change?
Child 2: The 12.

When asked about the decisions she made during Critical Incident B, Erica gave this response, *"So, I wanted to sit with this group because I could see what they had done for their problem solving because they are working in a trio, I have structured the trios where the children can learn from each other, but there are some stronger children in that group, so I wanted to have a conversation with them to discuss their problem solving, what did they do for problem-solving, so they could share the learning with each other and learn from each other. For*

example, one of the children in the video said, "we had 21," and I said to him, "what do you need to do about that?" because in the problem, there were only 20 children. So, I thought if I asked him that question again, it would make him realise "oh" and come to realisation. I started with the whole class to launch the problem and set up the problem, and then I say off you go to leave them to their own devices to solve them, and then I pop in and out of each group to monitor their learning and see what they're doing".

4.3.2 Theoretical Framework Prompt

When asked to discuss her lesson against Anthony and Walshaw's Effective Pedagogy in Mathematics ten-point framework (Appendix B), Erica was able to identify aspects of her lesson in all ten areas identified as research-informed practices by Anthony and Walshaw (2009).

Table Four below summarises Erica's responses to the Anthony and Walshaw (2009) ten-point framework prompt (Appendix B). Erica's voice is recorded in italics.

Table 4

Table of Erica's Response to Framework Prompt

Principle	Teacher Participant's Response
1. An ethic of care	Erica talked about setting up the room, so the students have a comfortable environment. *I'm encouraging them in their trios to work with each other, to make sure they're including each other while I am doing the problem-solving session, I am still aware of the surrounding children around me".*
2. Arranging for learning	Erica identified the concept of working collaboratively in trios, providing choice boards, and working independently or with a buddy as what was happening in her room during the lesson.

Principle	Teacher Participant's Response
3. Building on students' thinking	Erica believed she builds on students thinking by ensuring her term plans are adaptable. By meeting her syndicate team every day, for 10 minutes, to collaborate and adapt their planning if needed. "*So, week one, we would discuss what we have planned, but it also goes back to our 10-minute collaborative conversation that we have each day to discuss what we have noticed with the children's learning, what do we need to change for their needs, so our planning is all adapted to our children's needs and where they are at".*
4. Worthwhile mathematical tasks	Erica mentioned her problems were centred on the children's interests. *"When we are planning or choosing our choice board activities, it's all about the children's next steps. Whether they need to go, and the activities are always going to be something that is engaging to their interest".*
5. Making connections	Erica's problem-solving lesson was based on the children's interests and everyday experiences with our planning to keep them engaged. She felt the children had plenty of opportunities to connect the different ways of solving problems in their trios by working together and sharing their other ideas.
6. Assessment for learning	Erica stated she used monitoring, observation and listening as well as questioning as she teaches. Her assessment would come at a later stage. "*Also, throughout the term, we would do a problem-solving think board question that they would all do individually so I can visually see, and I'm making notes as well to see what they are able to do independently".*

Principle	Teacher Participant's Response
7. Mathematical Communication	When recording ideas about mathematical communication, Erica told me, *"That's done throughout the maths lesson with discussions as well. I've got some very vocal boys in my class, and they have a different understanding about it and definitely express their thoughts and concerns about it, so we do have those conversations as well. They [the conversations] are not always planned into the lesson. Sometimes they just pop up, and we go with it because I can see that it's something that is on their mind. It's what they are interested in, wanting to learn about, or if I can see their focus or understanding isn't correct, so I have that discussion to explain it.* Erica also talks about a 'reporting back' stage in the lesson where the trios have a discussion and plan how they will share back their learning.
8. Mathematical language	When discussing the use of mathematical language, Erica talked about incorporating specific language into planning to ensure she uses it. She also spoke about her professional development and how the students use hands gestures to communicate. "*The language that we use within our problem solving and little signals that we use with our hands to show if they agree or if they have another idea, so I use that language in my lesson, and they use the little symbols to report back to me".*
9. Tools and representations	Erica created laminated boxes and counters as she knew they would be supportive. The last time the lesson was taught to another group, the children had struggled without them.
10. Teacher knowledge	When it came to Teacher Knowledge, initially, she was unsure of what that principle might encompass. However, she discussed how she makes sure before teaching that she is familiar with the maths by talking to her mentor or curriculum learning leader.

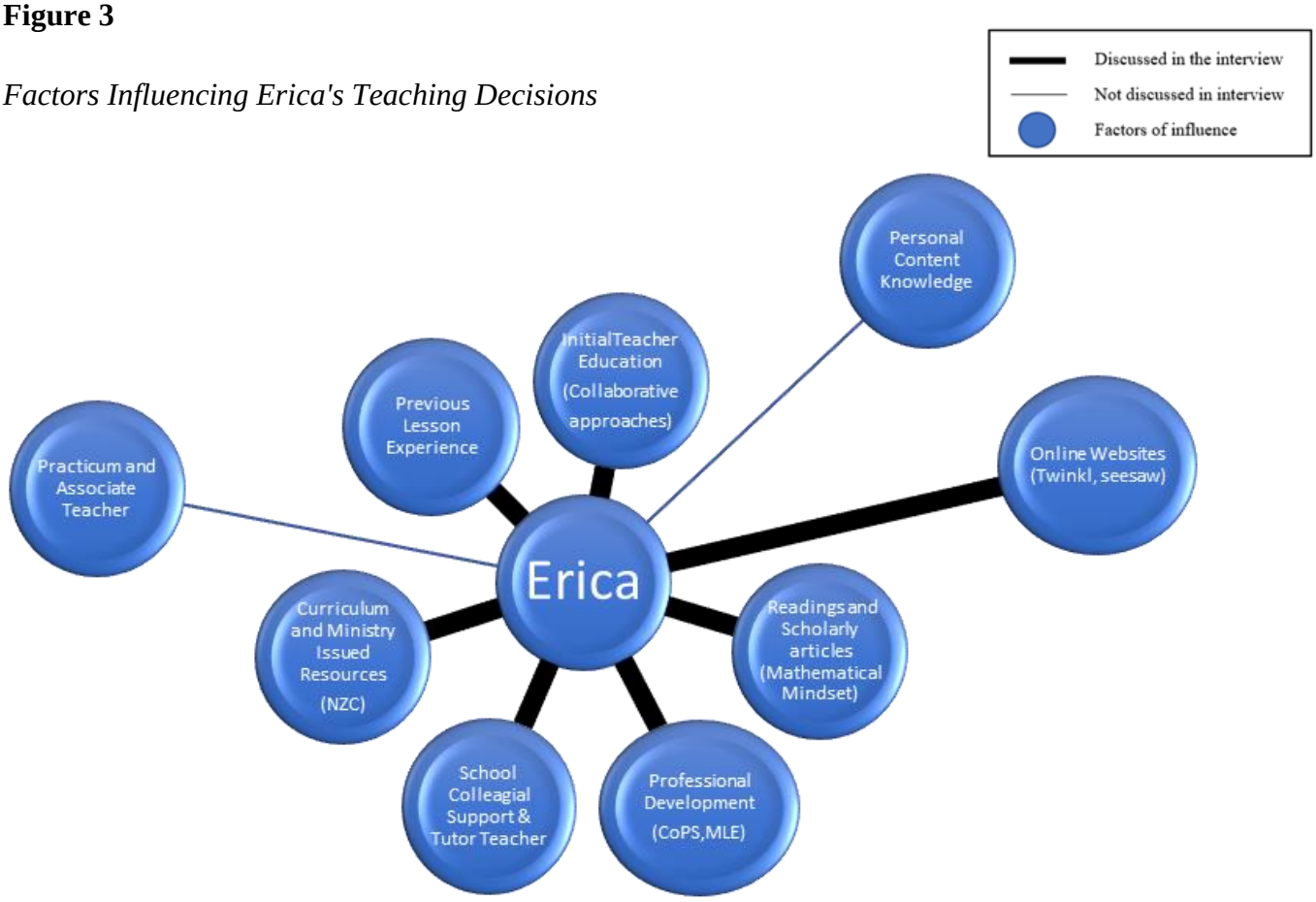
In Erica's responses to the Anthony and Walshaw framework (2009), two themes are emerging. First, she places a substantial value on a child-centred learning experience and collaboration rather than mathematics. Erica sees this in ethics of care (item 1 on the framework), creating

worthwhile tasks (item 4) and making connections (item 5) as they all seem to link to worthwhile in the children's lives, but not necessarily mathematically worthwhile. Second, she is focused on the processes from her professional development programme and how she progresses the lesson, rather than the mathematics. Her example for mathematical language (item 8) considers how the problem is launched, how they work in trios, communicate with hand signals, and share ideas, rather than the teacher modelling mathematical language in the lesson.

4.3.3 Erica's Influences Map

Figure 3

Factors Influencing Erica's Teaching Decisions



Erica's Influences Map has her six most important influences identified closest to her name. During the semi-structured interviews, she discussed all six of them in the context of her teaching as well as rated them 5 out of 5 in the Influences Handout. Five of them were discussed in relation to collaborative planning as part of her school's professional development. The sixth

was a discussion about a previous lesson she taught and how she had re-developed her lesson plan to include materials.

With Erica's second layer of factors that influence her practice, she rated online websites, personal content knowledge and practicums as a four on the Influences Handout. Of those three factors, she discussed in her interview about looking for online activities and using Teacher assist websites like Twinkl and Seesaw.

4.4 Case Study Participant – "KATH"

Kath is a mature teacher in her first year of teaching after graduating from University with a Bachelor of Education (teaching) degree from a three-year undergraduate programme. Kath works in a single cell Year One classroom in a Decile 8 Auckland primary school. She does not currently have a tutor teacher in her team, and there is no current maths leadership team. The school wants to focus on raising student achievement in mathematics and is planning to use an outside provider for professional development in mathematics in the coming year.

When asked if she could recall any theory or readings that impact her teaching, she mentioned Richard Skemp's practical ideas to retain information to help the children to recall knowledge. Kath also discussed work by Young- Loveridge (Young-Loveridge, 1999). Both comments relate to readings from her mathematics education courses. Kath recognises the importance of visual representations, quantity representations, Numbers and English language representations taught in context so students can use their knowledge to apply to a question as parts of theories of mathematics teaching and learning: "*Probably unconsciously somewhere in my mind that like, not just being maths but we were taught at university we have to bring the learning, make it worthwhile, authentic, you need to make sure the children can engage, you need to use the language, you need to make it accessible, provide opportunities for them to speak. They are all little ideas in my head, but I'm not good at executing*."

Kath continues to revisit her university readings to support her learning. Kath frequently reflects on her practice and uses websites and articles for support, particularly when wanting to know how to approach the next learning steps. *"I think about it quite often but probably more when I'm planning and when I'm thinking how I assist them, so I was a little bit slack this year. Maybe I could have done better. It's always that you could have done better, isn't it?"*

Kath has begun a Mathematical Problem-Solving programme with an outside educational provider as part of a school-wide professional development as the school is changing its current approach to teaching mathematics. The school has encouraged her to examine Jo Boaler and Carol Dweck's readings and the Growth Mindset philosophy. She understands the theory, recognising some of it from her ITE experience, but acknowledges putting it into practice is challenging.

Kath has found a personal connection with Jo Boaler's articles as she experienced feeling left behind and stupid in maths as a child and is determined that her class of students will not feel that way. She talks of finding "*the little me in the classroom and saying, hey, it's OK to say I don't know, or I don't understand."*

Kath wants to empower the children but believes she needs to increase her mathematical content knowledge and skills to have the flexibility to reach out and engage with different children and the different ways of learning. *"Whether it's Young-Loveridge or Jo Boaler trying to find what I'm looking for. Like, at the moment, I'm looking for how practically to put problem-solving into the year one classroom when the children's knowledge is not quite level two yet. So then, I'll go looking for those articles or whatever I can find from the past or present to see what they offer and what the research suggests and what I can do from there."*

Kath found a disconnect between her teacher preparation classes and what was expected at school. Her school was transitioning from having no maths curriculum leader to forming a cluster and making mathematics a priority in their strategic plan. Kath felt while this was happening, she was in limbo when it came to support for teaching how she thought she should be*: "I'm aware of the school learning style – worksheets".*

Although she is unsure about the value of theory, Kath believes in reverting to theory, especially when she is stuck or to find out what is working and what is not for the students. Kath suggests she uses theory more when she is planning or for support when she is thinking about how to assist the students than in the moment. *"I often go back when I'm not sure how to make a decision whether that's what I'm going to do next, how am I going to teach it, or what sort of material should I use. I go back to what you provided me at university, and sometimes I go back to readings.*

4.4.1 Critical Incident

Kath's two critical incidents were selected from the one lesson with a group of 10 Year 1 students. The learning intention was to make groups with 10 and 5. The teacher had the children all sit in a circle with her on the floor. She had an abacus as a teaching tool, and the children were encouraged to use their hands as materials.

Critical Incident A

Critical Incident A extract is taken from 2:30 minutes into the lesson. *Teacher: Shall we, do you think we can count in tens?* Children: I can, me too. *(Children sitting in a circle all count up in 10's together to 100; however, one child continues to count. The Teacher allows him to go until 300, stops and congratulates him).* *Teacher: Stop, stop that's very good. Shall we do it together? (Teacher grabs the abacus).* Children: (chattering about the abacus and one child wants to show 3 +3 = 6 on the abacus). *Teacher: That's good. So, let's just count in ten's, shall we? Slides the line of beads across and says "ten".* Children join in chanting ten, twenty, thirty to 100 as the Teacher slides the beads across the abacus.

Kath was asked during the interview to review the critical incident from the video clip and describe what was happening from her perspective. She describes the Incident, *"I think I was trying to get everyone on the same page. I was counting in tens, but I think this is my bad habit. I notice I ask questions instead of stating what we are going to do. I'm inviting them, which allows them to say no. I seem to do it unconsciously".*

When Kath was given the opportunity to expand on the decisions she had made during the incidents, she stated, *"Although I love people telling me what they know, which I should be able to incorporate into teaching, I was probably rushed and just wanted to get it started counting in tens. I think that is what was in my head. I just wanted everyone to start counting in tens. Then we counted in 100s, and then I used the abacus. We had a maths lady come in, but as I didn't inherit a hundred board for my classroom, I had an abacus. She said for quantity-wise,*

it's easier for her to make a connection with the abacus counting than the hundred board, so I was really keen to try the idea, while still managing the classroom, to do the same thing".

"All I see in the video and script is that I'm rushing inside of me was just trying to get on with counting together. It was like I had certain expectations, and things are not in the way I was expecting. Does that make sense? I made the decision, good and bad, I think because I didn't choose the good behaviour ones, I had a variety of behaviours and abilities. So, I try to use a mixed ability group, but I may not be executing it well enough yet. We started doing skip counting lessons in the past, before this lesson, but I found it too difficult, so I started with ten".

"My WALT [we are learning to] wasn't clear, so that was one of the things I thought about. I need to make it clear what the teaching purpose and intentions are and clearly communicate it to the kids, so they know, and I know as well".

Critical Incident B

Critical Incident B extract is taken from 5:15 minutes into the lesson.

Teacher: Now we are going to use our hands to show me the numbers. I'll show you first. You put your hands behind your back. (Teacher models both hands behind her back).
Children: (Copy the Teacher and put both hands behind their backs).
Teacher: Show me 5. (Pulls her hand from behind to the front showing five fingers).
Children:All the children show five fingers.
Teacher: Good. (Monitors all the children's answers). Now it's going to be Child 1's turn. You need to think of a number. What number can we make with two hands? What numbers can we make?
Child 4: seven
Teacher: Yes, that's one
Child 1: Holds up three fingers on one hand and one on the other.
Teacher: You need to tell the numbers first. You need to tell us the number. Tell me, whisper the number to me. (Leans to child and listens). You say it.
Child 1: 6. (The child holds up five fingers on one hand and a thumb).
Children: (All hold up six fingers).
Teacher: Well done, everyone's got it—child 2's turn. Children go around having a turn. She gets around to Child 4.

Teacher: Child 4, you need to put your hands behind your back and tell us what number we need to make. We need to listen very carefully. What will she say? Your fingers ready, fingers ready, put your hands behind your back—very good everyone. Tell me? Child 4: 80 Teacher: Hey? 80? Child 4: 80 Teacher: Can we make 80 with two hands? Children: No. Child 10: You can make it with other people's hands. Child 4: Eight The children and Teacher all make eight on their hands.

After looking at the video, Kath's shared her perspective of what was happening, *"Looking back what I feel like I had an answer in my head. You know, when we did the questioning thing, sometimes the Teacher asks questions knowing that answer in their head already. I think I'm doing that. If you wanted to make it authentic and rich, when I look back, my reflection is – "why didn't I do it? I have ten kids 80 is possible", why didn't I do it? Maybe I didn't hear it. If I'm doing counting in tens, it makes more sense to do 50 and 80, 70 and 100, so I'm missing out. My learning is not synchronised or aligned with the activity I'm doing. I should have had "how many people to show me the 80?" I started the lesson with making tens because it's one of those things we do, but I totally missed the point of doing it though. It's one of those warm-up games they like; engagement is high, and they all like joining in, but If I'm trying to teach tens, I should do it in a different way, perhaps?"*

4.4.2 Theoretical Framework Prompt

When asked to discuss her lesson against Anthony and Walshaw's Effective Pedagogy in Mathematics ten-point framework (Appendix B), Kath was able to identify aspects of her lesson in nine of the ten areas identified as research-informed practices by Anthony and Walshaw (2009).

Table Five below summarises Kath's responses to the Anthony and Walshaw (2009) ten-point framework prompt (Appendix B). Kath's voice is recorded in italics.

Table 5

Table of Kath's Response to Framework Prompt

Principle	Teacher Participant's Response
1. An ethic of care	In this lesson, Kath focused on the mathematical goal of counting in tens, which she identified as a knowledge gap from JAM testing. She stated she had grouped the students according to this gap and not from a stage or level.
2. Arranging for learning	Kath felt this principle was not evident in her lesson. Kath believed she was unclear on what she wanted to achieve or how to achieve it. *"I incorporated independent as well as collaborative activities in the one lesson."*
3. Building on students' thinking	Here, Kath felt unsure she had done this. *"I let them count until they could exhaust their knowledge. I don't think that I extended it. I didn't extend it the way that Child 4 wanted to do"* (refers to Critical Incident B).
4. Worthwhile mathematical tasks	Kath said the only thing she could think of was choosing the abacus. She had wanted to show the quantity when the children said the number and make the connection. *"Some of my learners like Child 1 he, needs to see the quantity in order to make a connection, and I need to keep solidifying that knowledge".*

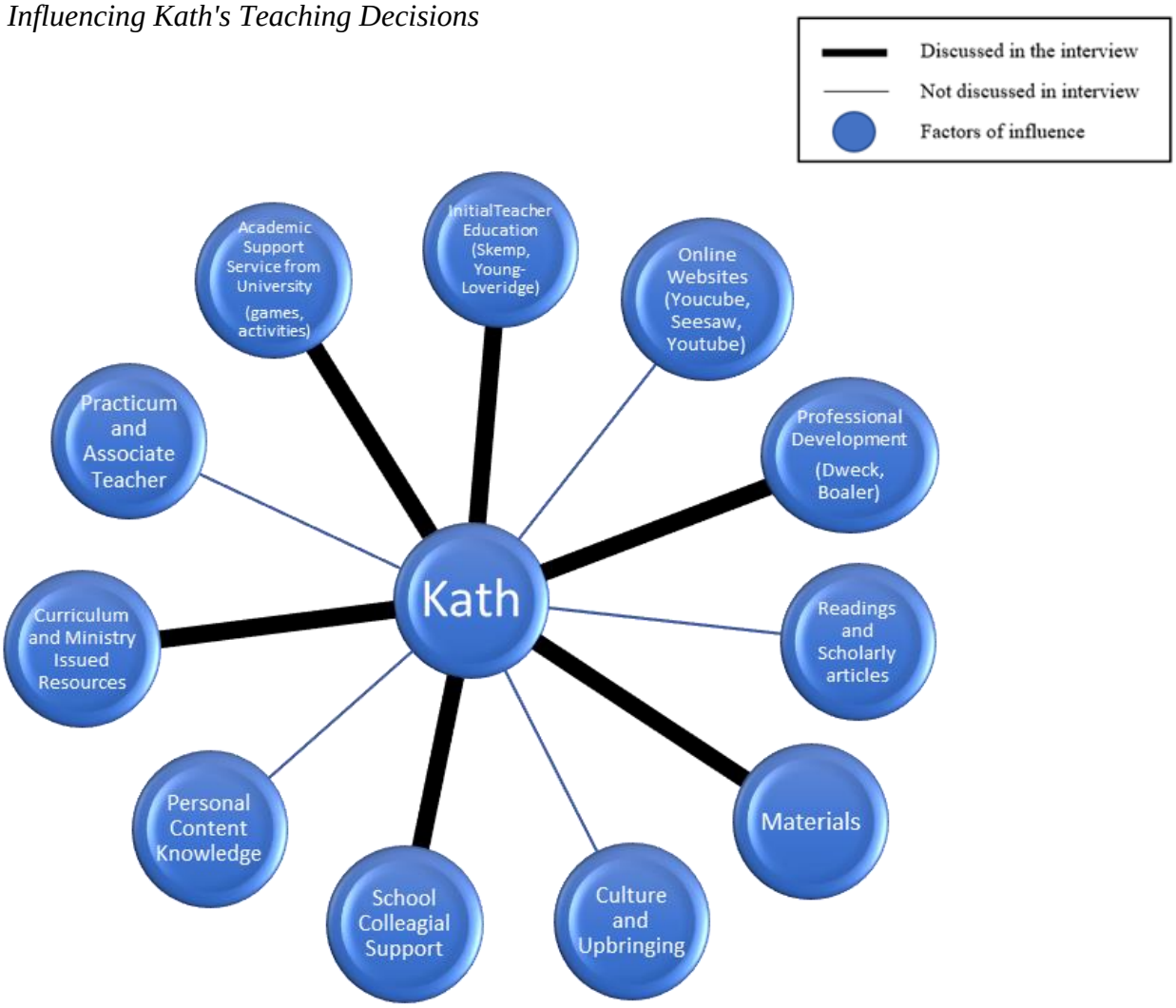
Principle	Teacher Participant's Response
5. Making connections	Kath mentions that she felt that she had not done this well as she was nervous that I was watching. She repeats her thoughts about the abacus but is worried she has not been explicit in making connections. And she mentions using the ten fingers for ten.
7. Mathematical Communication	Although Kath felt she had allowed the children to share in the lesson, she was also concerned that she didn't do more to react to child 4 in Critical Incident B.
8. Mathematical language	Kath was again worried that she had not met this principle in the lesson; however, she reflected that as they counted in tens, she tried to use and bring in language. Kath talked about making sure she was familiar with the language of the maths lesson before teaching it, and it was in her plans. She also talks about going back to documents support. *"I do that when I'm planning to make sure that I understand those languages and how they go back to the ministry documents to make sure. Young-Loveridge; I like her. I go back to her reading quite often to make sure, to refresh my mind how kids acquire number sense."*
9. Tools and representations	Kath was confident that she had used materials in the lesson to support the students. She said, *"because I have the abacus and using the fingers with ten, which everyone has. I like using fingers because it's one of those things that kids require to instantaneously recognise, whether it's five fingers or ten fingers. I wanted to give them more opportunities to practise that. And be able to speak out instantaneously; that's 7, that's 10, that's two hands - 20."*
10. Teacher knowledge	Kath believed she was conscious of meeting this principle. She talks about going back to Ministry of Education documents and readings for support. Kath said she is aware that as Year Ones, her students need to focus on the number knowledge a majority of the time to give them access to strategy and express what they're thinking mathematically to solve the questions during problem-solving. "I think it's a work in progress".

In Kath's responses to the Anthony and Walshaw (2009) framework, two underlining themes were emerging. First, she is highly critical of her practice. She was not comfortable identifying any positive, effective pedagogy from her lesson; instead, she used the research and the prompts to reflect on what she wasn't doing or how she could do better. After her initial response where she could not identify a principle from the framework in her lesson, she was able to continue and describe instances in her practice. Second, Kath's mathematical communication example (item 7 from the framework) identified centring the students and the need for student's voice; however, the evidence shows us Kath asked mainly closed, single answer questions and created a group of individuals with their own ideas rather than a collaborative group idea when they completed their mathematical tasks.

4.4.3 Kath's Influences Map

Figure 4

Factors Influencing Kath's Teaching Decisions



When we examine Kath's Influences Map, it is immediately apparent that she answered the Influences Handout with no influences scoring a five, the highest degree of value. Her highest ranking was a four. Kath identified 11 factors of influence but only discussed eight of them during the interview. She discussed her teacher preparation course (ITE) as well as the value she placed with the ITE provider's student support services which gave her opportunity to discuss matters at her own pace and supported her with readings. She also talked about the New Zealand Curriculum and Ministry of Education documents, her school colleagues, and the school about to start receiving professional development. Kath mentioned the importance of materials during her interview, which was not on the Influences Handout. Kath talked about her culture and upbringing regarding learning mathematics with some negative recollections. She talked of how her negative experiences in learning mathematics as a child would ensure she would be motivated to conduct her teaching more inclusively, and she rated this issue a four.

She rated her practicum experience, online websites, and her personal content knowledge as four but did not mention them in the interviews

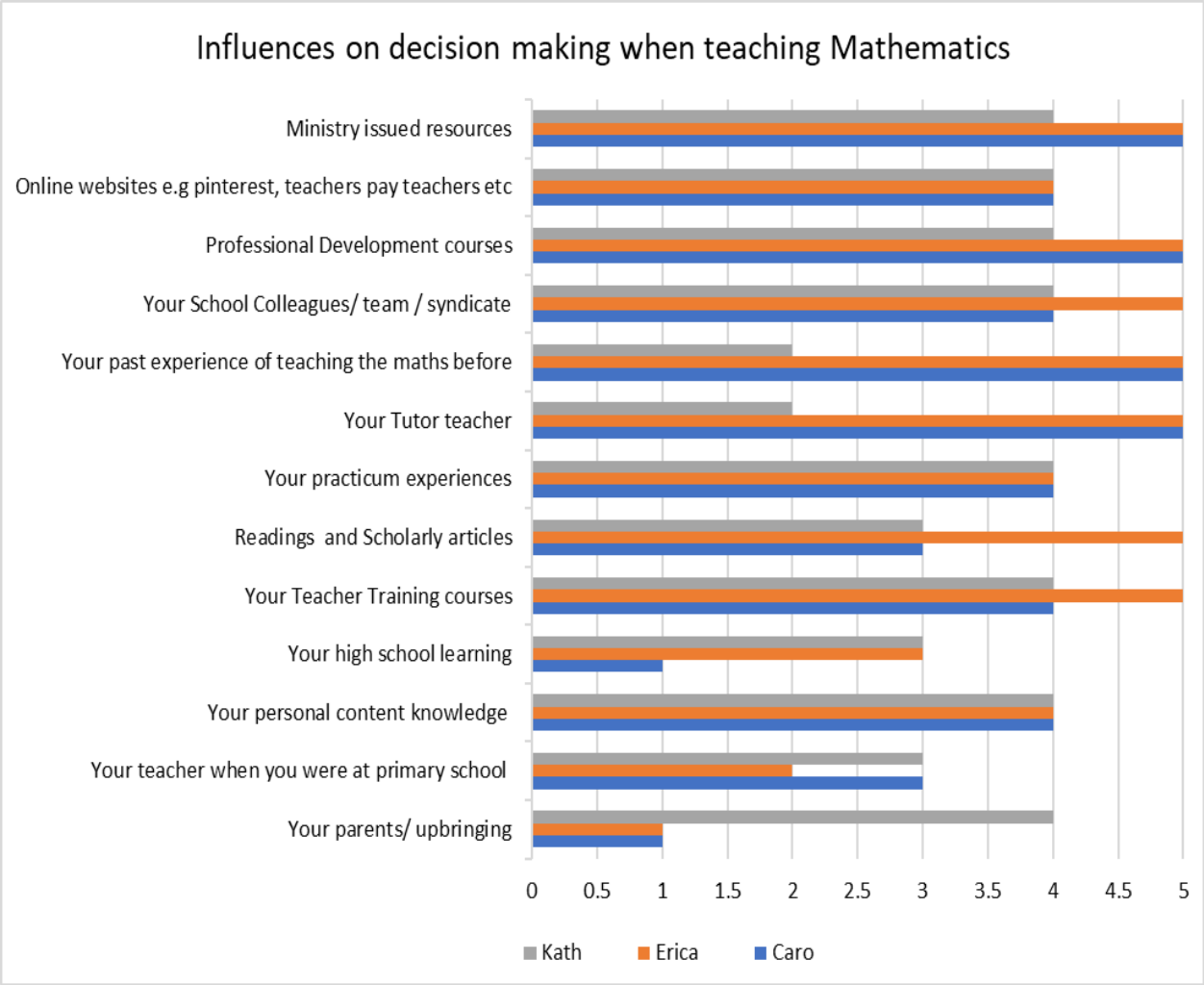
4.5 Combined Influences

A Combined Influences Chart was created using the ratings from 1-5 of all the factors presented in the Influences Handout. I combined the data to reveal any factors that influenced all three cases. The comparing of information from the three teacher participants allowed a holistic view of the data (Baxter & Jack, 2010). Although the study design was individual case studies, the research question is concerned with the overall relationship between theory and practice for early career teachers. Combining the data in this way provided a final perspective on the theory-practice links by 'zooming out' and looking across the three quite different teachers.

4.5.1 Combined Influences Chart

Figure 5

Factors Influencing All Teacher Participants Teaching Decisions



4.5.2 Combined Influences Chart Unpacked

When we examine the Influences Handout responses from all three participants, there are several notable responses.

Both Caro and Erica rated teaching mathematics before and support from their tutor teacher as definitely having an influence on their teaching, while Kath rated those same factors as probably not having any influence on her decision making.

All three participants had the same value of four out of five for the influences of online website support (Seesaw and Twinkl), their practicum experiences, and their own personal content knowledge.

Kath and Caro both rated their university teacher training preparation as probably having some influence, while Erica rated it as definitely having influence. And all three agreed that their practicum experience probably had some impact on their teaching decisions.

While Caro and Erica said their parents and upbringing did not have any influence on their decisions, Kath said it probably did, although it may be significant to note here that Kath was not raised in New Zealand, unlike the other two participants, so the impacts of her upbringing may have been more obvious to her because of contrasts with what she encountered in Aotearoa, New Zealand.

Overall, the highest-rated factors that influenced the decision the participants made were the Ministry of Education issued resources like the New Zealand Curriculum, nzmaths website, or Figure It Out books and Professional Development they received from their schools.

4.6 Summary

In this chapter, I have presented a case study of each of the three teachers. For each participant, I have presented a vignette, an interview and two critical incidents from their lesson. A theoretical framework prompt represents the participant's ideas about their theory in practice. I have shown their opinions from both the influences prompt in the form of a map as well as developing a Combined Chart from all three participants influences for a wider overview of the research.

The next chapter outlines and discusses emerging themes from the data, highlighting the relevance of these to the key research question.

Chapter 5: DISCUSSION

5.1 Introduction

The findings of the study, reported in the previous chapter, focused on the perceptions of three early career teachers about their use of theory within a mathematics lesson and whether theory was valuable in their mathematics teaching. In this discussion, I will review the findings to answer the question: How do early career teachers apply theories of teaching and learning mathematics in a classroom mathematics lesson?

This research focuses on what learning knowingly crosses the boundaries from ITE to classroom practice and what is valued in the classroom that may have unconsciously crossed the boundary or been actively encouraged in the school community rather than coming from ITE. This is a very complex phenomenon, and this study provides only a tiny window into how early career teachers use what they were offered in ITE when they teach their classes mathematics.

5.2 Using the Lens of Situated Learning and Boundary Objects

When I first started this research, I believed I would find that the early career teachers were using theory from ITE in their practice. I suspected that maybe they were not necessarily aware of where it had come from, but they would have incorporated theory from their ITE programmes into their teaching because it supported learning. When I examine the results, I can see that although the three teacher participants all said that they valued theory and felt there was a place for it in their practice, two of the teacher participants were unable to identify any of the theory or readings from their ITE experience. Kath was the only teacher participant to acknowledge that she used some of the readings and notes from her ITE experience when she felt she could not find any support within the school. This phenomenon can be explained by the 'situation' – contextual differences between the three teacher participants in terms of support/collegiality and professional development in their schools.

Caro and Erica were involved with school-wide professional development mathematics programmes when they started at their respective schools. This professional learning became the framework for their mathematics practice. Kath's school was only just beginning the process of transitioning to a school-wide mathematical approach, and therefore she felt unsupported and reached back to her ITE experiences to get support. Another important aspect to consider

is the ‘situation’ they came from. Caro is confident with mathematics, and she values resources and tools from her ITE and practicum programmes. Erica is less confident with mathematics but found that the collaborative approach used in her lectures resonated with her during her ITE development. She carried that over to her classroom philosophy. Kath is very reflective and critical of herself as a teacher, constantly feeling she could do better. This pursuit of improvement could motivate Kath’s reflective orientation, leading to engaging with research.

The evidence collected in this study clearly shows that very little from their ITE experience has consciously been carried over into the school setting. All three teacher participants acknowledged the importance of theory but could not expand further or deeper into pedagogical details. All three report that their readings were helpful in the University context but did not actively transfer into their practice. It seems that learning in ITE was situated in that context and did not fully cross the boundary to practice in schools.

5.2.1 What Boundary Objects were Identified?

Coming from a teaching background into a career in ITE, there are specific approaches I can recognise in the classroom that may have come from the teacher participants’ ITE experiences.

One of the key messages from ITE is the need to notice, recognise and respond (Bell & Cowie, 2001; Hattie 2009). How these concepts are applied through planning and actions is introduced in readings and assessments in the participants' ITE programme. The use of modelling books, planning a learning intention and use of materials were identified as approaches the teacher participants had encountered in ITE and used in their lessons. However, it is also evident when observing these lessons that they may be using these resources and approaches without understanding why they enhance the mathematics for the learner. For example, with the modelling books, the teachers used them more because they thought they should rather than doing it because they knew how it might help to teach or learn mathematics. These findings reproduced those of Jansen et al. (2017)’s study into the impact of mathematics ITE on teaching practices. In other words, these instructional practices are included as part of the lesson but are not fully developed with a mathematical focus in mind. Only superficial understanding of the practice of using modelling books has crossed into the primary school classroom setting: the teachers enact ‘modelling books’ rather than deliberately using them to develop mathematical concepts.

All three teachers said they use theory when planning, specifically identifying the NZ curriculum but did not expand on how they utilised it. The three participants were not conscious of any theory evident in their 'in the moment' teaching (Mason, 2015).

5.2.2 How did the Situated Nature of the Learning Impact the Teacher Participants?

Learning done 'in situ' in their school context seems more accessible for the teachers. The teacher participants' past learning appears to have stayed in the past unless they currently have nothing to support them, then they go back to their past support.

What began to emerge was although all three participants were teaching in the junior years, all three teachers and their schools encouraged different approaches or models. One teacher was heavily reliant on following the structure of a school-wide programme. One teacher used a semi-structured resource, and one teacher used what she identified the children needed and found guidance when she needed it. All teaching was grounded in a constructivist approach that encourages learners to construct their meaning of reality (Bruner, 1990). However, that is where the similarity ends; one teacher gave her groups an inquiry-based problem-solving question to explain. One teacher led a student-centred needs-based lesson with active teaching, and one led a more directed instructional lesson that reduced competition and encouraged conversation. This research does not judge which approaches are best but highlights how difficult it is for teacher educators to prepare teachers for school when schools all have different approaches and expectations.

5.3 Implications

This study highlights that while all three teacher participants went through the same training at the same facility at approximately the same time, they were all expected to operate their classrooms with different expectations, organisations, and support. These teacher participants felt theory was important but wasn't required or reflected on much once they graduated and started working. This finding has implications for how ITE should be structured.

ITE providers need to ensure that pre-service teachers' experiences examine a range of theoretical approaches rather than develop one perspective of good practice. Currently, there is little consistency amongst schools, or between providers and schools, about what the key practices for mathematics teaching are. If all ITE providers had consistent guidelines for pre-service teachers learning, newly graduated teachers would encounter the same preparation as

every other teacher. This preparedness would, in turn, enable newly graduated teachers to be more equipped for the teaching approaches their school may take. Having an agreement across the profession about what teachers should know and be able to do in teaching and learning mathematics is vital. The key principles needed may change as the curriculum is refreshed in 2022 and new professional learning is offered to schools. This study suggests that greater coherence could make preparation more useful for early career teachers' practice.

Overall, the participants seemed to remember some key names but not the theorists' fundamental theories or their implications for teaching mathematics. The participants also seemed to see theory as more relevant to planning than teaching. Knowing this could benefit ITE. Looking at what teachers are using and what information resonates with the pre-service teachers and is carried across into the classroom provides an opportunity for ITE to examine its practice and change. Zeichner (2010) refers to this as boundary-spanning. There is an option to improve ITE for the benefit of all involved to ensure that the core knowledge of mathematical teaching and learning is carried into the classroom, but this study suggests that this will not be simple or easy and will require deliberate attention by providers and schools.

In my view, the explanation for the present set of findings is that very little is carried across from ITE, and what is carried over is idiosyncratic. Some pedagogical understanding and theory are actively carried over, but it is only partial, derivative and shows limited conceptual understanding. This is not due to an absence of effort by the teachers, the schools or the ITE providers, but more a disconnect between the different learning and teaching situations.

Theories only help us to analyse or explain the teaching and learning situation. They rarely provide direct guidance for teachers' practices (Jaworski, 2006). Therefore, ITE providers need to develop programmes that explicitly connect practical classroom experiences and course content. The focus is no longer 'what is the best theory to present to pre-service teachers?' but 'what experiences should be presented to help pre-service teachers make connections to theory?' (Loughran et al., 2008). In practical terms, this means ITE lectures become smaller collaborative workshops that provide more student-based experiences that enable greater opportunity for pre-service teachers to enact responsive reframing and reflection (Rein & Schon, 2013). To maximise the chances of learning crossing the boundary between ITE and schools, content for these workshops should be developed in partnership with schools. One way to strengthen boundary-spanning is to partner with schools. This could be done as projects within a core subject by ITE or through a closer connection to practicum schools and the

activities set for pre-service teachers when they are participating in school practices. By working in partnership, the lines between ITE and classroom practice are narrowed rather than separated.

One such example to strengthen boundary spanning is for ITE practicum objectives to promote aspects of including, identifying, or observing theory inside practice. Making theory in practice more explicit will support pre-service teachers to have greater access to what theory in practice looks like and how to apply their theoretical understanding within a practical environment. Applying what has been learned in the ITE academic environment not only creates a more reflective practitioner but prepare the pre-service teachers for the reality of classroom teaching in the future.

It appears that understanding what boundary objects from ITE are crossing into schools could prompt changes to ITE and Schools. Establishing alignment between theory and practice is a definite challenge in the classroom. However, the idea of an educational divide between theory and practice may not necessarily be seen as a negative concept or fault in the system. It could be an opportunity for ITE to work with teachers in schools. An ITE / Schools collaboration would allow teachers to examine and reflect on their practice with support. Many teachers would benefit from the same support that pre-service teachers receive to examine their practices. This ITE / Schools collaboration gives current insight to ITE providers about what teachers value and could produce a ITE programme outline, while continuing to support newly qualified teachers in the classroom.

5.4 Conclusion

Teaching is multi-faceted. When we examine this research as an overview, it becomes apparent that there is more to how mathematics is taught by early career teachers than the difference between what ITE providers believe pre-service teachers need and what schools think ITE should be providing.

What has become most evident in this study is that all three teacher participants have recognised and continue to create child-centred authentic, real-life opportunities for the children to connect to each other in the structure of the lessons and the learning. Unfortunately, this also appears to be to the detriment of the mathematical concepts. Their focus on the well-being of the children seems to distract from the learning of the mathematical key idea. The teacher participants were able to introduce maths as word stories and problem-solving, use resources, encourage

collaborative thinking, and refer to the curriculum but had not fully developed the understanding of the key mathematical concept behind the activities, so they have created discourse patterns and an environment where those key ideas are included in the lesson, but they had not 'got to' fully develop the subject content matter (Loewenberg Ball, et al., 2008). In all three lessons, I cannot confidently say that the students learned anything new mathematically. They did; however, all have an opportunity to contribute and share their own ideas and thinking in an inclusive and risk-taking environment.

Theory is considered an important tool that guides and modifies our practice (Grossman, 2008; Korthagen & Kessels, 1999; McIntyre, 1995; Stigler & Hiebert, 1999). Understanding its value is especially important when theory and practice are deemed as different and contradictory. When theory and practice are seen as opposites, it is impossible to assimilate any theoretical knowledge into a teacher's professional actions (Franke et al., 2001). However, if teachers cannot explain their practice, they are unlikely to critique their thinking and are therefore limited to repetitive practice.

By examining my own teaching practice both in the classroom and in my ITE teaching, I recognise that theory-informed practice is paramount. Teachers who explicitly engage with theory in their teaching create a more critical and reflective practice. This reflective practice allows an approach to teaching that maintains teachers focus on students' learning and includes both the planning and implementation of their lessons. Theoretically informed practice supports teachers to understand the different pathways to learning for students. Theory engages teachers in classroom practice aimed at improving the content for students (Cochran-Smith et al., 2008; Hiebert et al., 2002; Jaworski & Gellert, 2003; Østergaard, 2013). Therefore, it is important that preservice and in-service teacher education in mathematics continues to strive for developing understandings of theory in practice.

Teachers who do not engage with theory may find they have a desensitised and procedural approach to classroom teaching that goes through the motions of what a good teacher might do but lacks the engagement and flexibility with different learning communities they may encounter. A prescriptive approach to teaching is constraining, as teaching is not a "one size fits all" activity. An arbitrary "hit or miss" approach cannot produce the results learning communities seek. Lack of theory can contribute to a narrowed curriculum where teachers may be ill-prepared to make responsive, at-the-moment teaching decisions and become entrenched in systematic habitual actions (Cochran-Smith, 2001; Darling-Hammond & Richardson, 2009;

Mason, 2015). This superficial compliance allows teachers to think they are meeting all the criteria for effective mathematics teaching but only on a surface level (Stigler & Hiebert, 2009, Wood et al., 1993). In the vignettes presented here, it seems the early career teachers have grasped responding to the learners but have not yet mastered responding to the mathematics and the learners together. The 'procedural' approach is not the approach to the mathematics; it's the approach to the interactions and lesson formats. The mathematical ideas seem to get lost amongst the enactment of the lessons.

The researcher suggests that ITE providers should be more deliberate in creating/identifying/finding boundary objects that build reflective practice like those described previously. Ensuring that the viewpoint of the ITE teacher educator, the teacher's and the pre-service teacher form a partnership that will create a more comprehensive, effective curriculum that will enable the closing of the theory – practice divide; an initial starting point to examine how the curriculum functions as a boundary object.

The community of practice framework used by teachers in schools could also be a key proposal in developing mathematical practice for the wider teaching and learning community, including ITE providers and policymakers. A well-funded initiative where ITE, schools and policymakers form a partnership, or third space, will ensure all theory is grounded in practice. Rather than a top-down structured approach to teacher education, a third space needs to be considered. This examination and reflection of practice may, in turn, promote more in-depth mathematical teaching.

It is necessary to consider whether ITE could continue to support newly graduated students in schools rather than leaving them to fend for themselves in a new environment. If ITE support crosses the boundary into schools, then the theoretical aspects of teaching can continue to develop in a practical classroom setting. This partnership might break the cycle of teachers working as mentors who are modelling instructional practice without links to theory, perhaps undervaluing, or at least not activating, ITE learning. With ITE support crossing the boundary into schools, current practising teachers can re-examine theoretical frameworks which could be beneficial to teachers, the subject matter, and the learners.

As I conducted this research, I was reminded of a poem from c1230. Its title was "For Want of a Nail". It tells us that a battle was lost for lack of a horseshoe nail. Its moral reminds us that seemly inconsequential acts can create unforeseen consequences in the future. This warning struck a chord with me as I reflected on how the smallest moments in teaching could have

negative implications in time to come. The nail that is ‘lost’ can be different for individual teachers; however, we can also view the nail as a systemic flaw. If ITE does not look at different approaches to connecting theory and practice that can cross the boundary into the school environment, then the key mathematical ideas may be lost. Alternatively, suppose ITE, schools and policymakers do not form a cohesive community and prioritize how theory and practice coexist. In that case, the battle of closing the gap will be lost.

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