The Association Between Teachers’ Knowledge of Fractions and Expectations in Teaching Primary Mathematics

Submitted by

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Index of Abbreviations

Abbreviation	**Explanation**
ACER	Australian Council for Education Research
AITSL	Australian Institute for Teaching and School Leadership
CCK	Common Content Knowledge
HCK	Horizon Content Knowledge
HREC	Human Research Ethics Committee
IEA	International Association for the Evaluation of Educational Achievement
IQ	Intelligence Quotient
KCC	Knowledge of Content and Curriculum
KCS	Knowledge of Content and Students
KCT	Knowledge of Content and Teaching
LANTITE	Literacy and Numeracy Test for Initial Teacher Education
MCK	Mathematical Content Knowledge
NAPLAN	National Assessment Plan for Literacy and Numeracy
OECD	Organisation for Economic Co-operation and Development
PCK	Pedagogical Content Knowledge
PLC	Professional Learning Community
SCK	Specialised Content Knowledge
SES	Socio-economic status
SMK	Subject Matter Knowledge
STEM	Science, Technology, Engineering and Mathematics
TEMAG	Teacher Education Ministerial Advisory Group
VCAA	Victorian Curriculum and Assessment Authority

Abstract

The type and depth of teacher knowledge needed for effective teaching have been the topic of much debate in educational literature and policy reform, particularly evident in the introduction of the Literacy and Numeracy Test for Initial Teacher Education (LANTITE) in recent years. While teacher knowledge influences student achievement, teacher expectations, which are broadly the beliefs teachers hold for their students' capability and achievement, are also considered to influence student achievement in large scale data research. However, research rarely considers the association between teacher knowledge and teacher expectations. As fractions is a challenging concept to both learn and teach, this study, through a small-scale approach, seeks to identify the influence, if any, teacher knowledge has on teacher expectations through the lens of primary teachers' mathematical content knowledge of fractions. Data were collected through questionnaires ($N = 34$) and interviews ($n = 6$) that explored primary teachers' mathematical content knowledge of fractions and their prioritisation of knowledge types. Participants also developed a timeline, placing their expectations for developing the concept of fractions along a continuum from the start to the end of primary school. Results were summarised in snapshots of each teacher's individual knowledge and expectations narrative, and then compared using thematic analysis. This study found that teachers' knowledge of fractions supported the literature. Additionally, participants placed a strong emphasis on knowing their students over knowing the content or other forms of teacher knowledge. Findings indicate an association between teachers' knowledge, expectations, beliefs about teaching and identity. Furthermore, teachers' awareness of their knowledge gaps and how they may respond to these highlighted the importance of teaching as a collaborative practice. This research contributes to understanding the importance of teacher knowledge and expectations as unique facets of each teacher's identity. Future research that considers the whole teacher framed by the teacher's voice and includes identity development would provide insight into why mathematics teaching is approached in a particular way. School communities and teacher education seeking to improve teaching practice must respect teachers as products of an identity informed by years of individual experiences and beliefs.

Statement of Authorship

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis accepted for the award of any other degree or diploma.

No other person's work has been used without due acknowledgment in the main text of the thesis.

This thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

Jarah M. Dennison, 30 September 2021

La Trobe University Human Research Ethics Committee approved all research procedures reported in this thesis: HREC Ethics Approval No. HEC19213.

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1. Introduction

Background: Concerns for Mathematics Teaching in Primary Schools

There is a long-standing and growing concern in educational research and society over the amount of content knowledge teachers should have to teach effectively (Beswick & Goos, 2018; Darling-Hammond, 2016; Hill et al., 2005; Shulman, 1986). The debate centres around whether teachers need a particular level of expertise in content knowledge or knowledge of how to teach. Further, the knowledge needed for effective teaching is often questioned (Askew, 2008; Shulman, 1986). Historically the discussion has distinguished between knowledge type and knowledge quality. Theorists such as Shulman (1986) and Hill et al. (2005) suggested that a variety of knowledge types are necessary for teachers to teach effectively. Other theorists such as Askew (2008) and Star (2005) suggested that the type of knowledge is less important for effective teaching; rather the possession of some form of deep knowledge or, at the very least, knowledge "sensibility" is required. For these theorists, what is deemed necessary is foundational knowledge combined with a curiosity and interest in the content being taught. This knowledge develops as and when needed. Both sides of the debate are well supported, and ultimately inconclusive; consequently, researchers have not come to a consensus about the extent of content knowledge teachers need.

The knowledge debate is particularly relevant to the teaching of mathematics, an often-misunderstood area of the curriculum. Teachers may struggle to teach mathematics or may lack the confidence to do so. Additionally, students often find mathematics difficult to understand (Bobis, 2011; Clarke et al., 2011). The debate on the type and quality of teacher knowledge in mathematics has often centred on the type of content and pedagogical knowledge teachers need and the depth of that knowledge. Within research literature, there have been two main types of knowledge in mathematics: conceptual knowledge which is the understanding of concepts or the "what to do and why", and procedural knowledge which is the understanding of how to perform mathematical procedures, also described as "the possession of a rule and ability to use it" (Skemp, 2006, p. 89; Star, 2005). Additionally, the quality of knowledge within these two types has been described as either deep or surface (Chue & Nie, 2017; Kilpatrick et al., 2001; Rittle-Johnson & Schneider, 2015; Star & Stylianides, 2013).

Mathematics has long been an area where teachers' knowledge is scrutinised. In part this has been due to frequent reports of studies undertaken by international organizations such as the Organisation for Economic Co-operation and Development (OECD) and the International Association for the Evaluation of Educational Achievement (IEA). These studies indicated that at least 30% of primary students in Australia fail to reach a proficient standard in understanding mathematics as set by the 2015 Measurement Framework for Schooling in Australia (Thomson et al., 2017). Though questioned in both primary and secondary classrooms, teachers' mathematical knowledge is particularly scrutinised in the primary classroom where Australian primary school teachers are not required to be subject specialists to teach (Brown & McNamara, 2011; Collins, 2016; Masters, 2009; Mills et al., 2020). Instead, primary school teachers in Australia operate from a generalist teaching model. While some institutions offer specialist training in various areas, teachers are generally trained as pedagogists and teach across all core areas of the curriculum with an emphasis on the teaching of mathematics and literacy (McMaster et al., 2018). As a result, primary teachers are not likely to possess expert content knowledge in all teaching areas. This is of concern in science and mathematics when primary teachers have an "underdeveloped content knowledge… in science and mathematics due to the curriculum demands of their generalist teacher role" (Mills et al., 2020, p. 2). As a result primary school teachers often lack confidence when teaching mathematics (Masters, 2009; Mills et al., 2020) and some suffer from mathematics anxiety which arguably influences their mathematical attitudes and beliefs (McCampbell, 2015) as well as the attitudes and beliefs of their students (Masters, 2009).

In terms of specific mathematics content knoweldge, fractions are described as one of the most challenging and complex mathematical concepts to learn and teach (Bobis, 2011; Clarke et al., 2011). Despite the concept being a vital part of day-to-day life and an expansion of the understanding of number, the literature indicates fractions are widely misunderstood by teachers and students alike (Behr et al., 1983; Bobis, 2011; Getenet & Callingham, 2021; Harvey, 2012; Lamon, 2007; Siemon et al., 2015). As well, many teachers express anxiety when confronted with teaching fractions (Porter, 2019). These perceptions of fractions are limiting considering the significant role that the concept of fractions plays in laying a foundation for proportional reasoning, which is then crucial for developing later concepts of mathematics such as statistics, trigonometry, algebra and probability (Siemon et al. 2015; Way & Bobis, 2011). A potential cause for this difficulty is that fractions are commonly taught in a procedural way, especially when teachers are not confident teaching the subject (Mills et al., 2020; Way & Bobis, 2011). Way and Bobis (2011) argue that the key to effective teaching of fractions is developing a "deep, conceptual understanding of what fractions mean in a range of contexts and how to manipulate fractions to solve problems in those contexts" (p. 7). Other researchers argue that it is essential for teachers to have both a deep conceptual and procedural understanding of mathematical concepts such as fractions for meaningful learning to occur (Rittle-Johnson & Schneider, 2015; Star & Stylianides, 2013).

Broadly speaking, the expectations people set and hold for those they interact with daily inform how they interact with their world. Likewise, these expectations produce a "self-fulfilling prophecy effect" in how others interact with us (Rosenthal & Jacobson, 1968). An expectancy or Pygmalion effect refers to when a person believes something to be true and then acts in ways that consolidates that belief. Psychologists first began to note the importance of self-fulling prophecies in research contexts, but the effect has been increasingly applied to various social equity settings. The Pygmalion effect and its influence is of particular interest in classrooms. Within a classroom, parents', teachers', other students' and the student's expectations influence how the student functions in the classroom (Rubie-Davies, 2014). Thus, it is widely argued that the expectations that teachers have about their students, influence student achievement. Studies into this phenomenon in the classroom context stem from an initial study conducted by Rosenthal and Jacobson (1968). They found that students whose teachers expected them to do well were more likely to do well than students whose teachers expected them to do poorly. More recently, Johnston et al. (2019) summarised several international and Australian studies into teacher expectations from the past decade and concluded that raising teacher expectations led to increased student outcomes in mathematics (Browne & Richard Wong, 2017; Bohlmann & Weinstein, 2013; Friedrich et al., 2015; Ritzema et al., 2016). Due to this influence on student achievement, much research has been done on what factors affect teachers' expectations.

The research unanimously agrees that students' characteristics play a significant role in influencing the expectations a teacher has for their students. For example, a student's gender, ethnicity, socioeconomic status (SES), personality, and many other student characteristics are all argued to influence teachers' expectations and go on to produce an expectancy effect on student achievement (Rubie-Davies, 2014). However, the influence of the teacher's characteristics on their own expectations is far less researched despite the potential impact depth of teacher knowledge, beliefs, and attitudes may have on teaching expectations.

Research Focus

There is a distinct lack of conclusive evidence to clearly outline the role teacher knowledge plays in setting teacher expectations. Much of the research into expectations in the classroom largely attributes the expectancy effects to factors outside the teacher's control, such as the school environment, knowledge community, curriculum, and the students themselves (Rubie-Davies, 2014; S. Wang et al., 2018). There is a lack of research outlining the influence of teachers' characteristics and qualities on their expectations in the classroom. Rubie-Davies (2014) and S. Wang et al. (2018) provided detailed accounts of literature into expectancy effects and noted a significant number of student characteristics influence a teacher's expectations. They noted only a handful of teacher characteristics, namely beliefs, personality, and motivation influenced teachers' expectations. Rubie-Davies (2014) concluded that an extensive review of the literature found "little research into the role of these personal [teacher] characteristics and beliefs in moderating the effects of teacher expectations" (p. 52). This is significant as meta-analyses revealed that expectation effects can account for between 3% to 60% of variance in student achievement (Johnston et al., 2019; Hattie, 2009). Therefore, a significant component of teacher expectations, namely, the teachers themselves, are largely overlooked in research.

Research into the influence of teacher knowledge on teacher expectations is scant even though teacher knowledge has been a significant concern within mathematics classrooms worldwide. Many countries report a growing "mathematics problem" where students entering tertiary education are increasingly less competent in mathematics (Fitzmaurice et al., 2019). This deficit ultimately creates a cycle where many pre-service teachers are entering the field with a lower standard of mathematics understanding than previous teachers, and their students consequently have a further reduced knowledge of mathematics (Fitzmaurice et al., 2019; Jensen et al., 2017; Roberts-Hull, 2017). This concern is apparent in Australian education policy reform with the introduction of the Literacy and Numeracy Test for Initial Teacher Education students (LANTITE) (Hall & Zmood, 2019). According to the Teacher Education Ministerial Advisory Group (TEMAG, 2014), effective teachers "need a solid understanding of subject content, pedagogy and pedagogical content knowledge" (p. xvii) and "high overall… numeracy skills" (p. 13). As a result, the Australian Institute for Teaching and School Leadership (AITSL, 2019) recommend in Standard 3.5 of *Accreditation of Initial Teacher Education Programs in Australia* that teachers "possess levels of personal literacy and numeracy broadly equivalent to the top 30 per cent of the population" (p. 14). This recommendation guided the development of the LANTITE which is used to assess teachers' content knowledge prior to teaching (Australian Council for Education Research [ACER], 2015). For primary teachers, it is essential to be confident in teaching content as "research shows that primary teachers who lack mathematics knowledge in a particular topic tend to avoid teaching that topic altogether" (TEMAG, 2014, p. 23). With this growing concern for teachers' mathematics knowledge, it is necessary to understand how this knowledge deficit impacts teachers' expectations for their students in mathematics classrooms. As subject content knowledge forms the basis of various other forms of teacher knowledge, teachers' mathematics content knowledge was chosen as the specific focus for this study.

Although mathematical content knowledge is the specific focus for this study, the entirety of content knowledge a teacher needs to teach mathematics is far too complex to be investigated in a single, short-term research project. Hence, this study sought to examine teachers' mathematical knowledge and expectations through the lens of a single mathematics concept—Fractions—outlined in the Victorian Curriculum (Victorian Curriculum and Assessment Authority [VCAA], 2019). Though numerous concepts could have been chosen, Way and Bobis (2011) identified fractions, along with the related areas of ratio and proportion, as "the most challenging and complex areas of mathematics to learn" (p.11). Tian and Siegler (2018) also argued that many children and adults struggle to understand fractions, and many students and teachers have been found to have limited knowledge of fractions. As mentioned previously, fractions are also considered foundational to understanding other aspects of mathematics introduced later in the curriculum (Bobis, 2011). As such, the concept of fractions was chosen as the specific knowledge focus of this study. This concept was also selected because it is primarily taught and understood as a "part of a whole." The other interpretations of fractions are underrepresented and typically misunderstood (Way & Bobis, 2011).

Critical to the design and purpose of this study is the position that teachers cannot teach something effectively if they do not know it—debated assumption without consensus. Understanding what content knowledge teachers need to teach mathematics, or specifically fractions, effectively and the potential influence this knowledge can have on expectations is, therefore, an area worthy of research and one that would contribute to the field. The concept of fractions provides a working example with which to discuss teachers' knowledge and expectations. This study reviewed the current research in the expectations and knowledge fields and examined the expectations and fraction content knowledge of a small sample of teachers.

The importance of research in the field of teacher expectations and knowledge becomes more evident when considering the lack of research in this area. Rubie-Davies (2014) highlights the lack of research examining the influence of teachers' characteristics when investigating teachers' expectations. A thorough review of literature of the past decade conducted by Johnston et al. (2019) revealed many quantitative studies into the relationship between teachers' expectations and student outcomes. Nevertheless, few qualitative studies outlined why and how this occurred. Current literature largely attributes the formation of teachers' expectations to student characteristics or factors extrinsic to the teacher, such as school composition or culture. Qualitative studies that explored intrinsic factors, such as knowledge, that influenced teachers' expectations and the subsequent influence of those expectations were scarce (Johnston et al., 2019). Therefore, research in this area has the potential to contribute to an underdeveloped literature and influence perceptions of how teachers know and teach mathematics. This carries ramifications for teachers' education and professional development.

Overall Aims and Individual Research Objectives

This research aimed to advance understanding of the association between teachers' knowledge and their expectations in the primary mathematics classroom environment. The following three overarching research questions were:

1. *How are fractions understood and represented by primary teachers?*
2. *What type of knowledge is prioritised by primary teachers when teaching fractions and what justifications do they have for this?*
3. *How, if at all, are expectations of what teachers want their students to achieve influenced by teachers' knowledge?*

Specifically, within the context of primary education, these questions dictated the objectives of this research which were to:

1. *Clarify what teacher knowledge and teacher expectations are according to relevant literature and identify what influences these characteristics.*
2. *Evaluate the current literature in teacher knowledge and teacher expectations and determine what issues and gaps are present.*

3. *Explore primary teachers' mathematical knowledge of fractions and teaching fractions and its influence on their expectations for what they want their students to achieve when learning fractions.*

4. *Formulate recommendations for teaching practice, teacher education and future research in the field of teacher knowledge and expectations.*

Due to the multifaceted and contextual nature of both teachers' knowledge and expectations, it was necessary first to define these attributes and explore some of the many facets that are known to influence them (Objective 1). Subsequently, it was necessary to appreciate and evaluate the current theories, models and studies related to these facets to contribute to current understanding (Objective 2). Although this literature informs current practice and policy development in education, it was also necessary to investigate the knowledge and expectations teachers believe they possessed and discuss how their knowledge may impact their expectations (Objective 3). Fundamentally, this research project aimed to contribute to current perceptions of teacher knowledge and expectations and make recommendations for further research, professional learning and teacher education (Objective 4).

Value of this Research

The value of this research will be threefold. Firstly, it will present literature that informs teaching practice, pre-service teacher education and professional development for practising teachers and educators. Given the practical influence that both teacher knowledge and teacher expectations exert over what occurs in the classroom context, this study will also highlight the importance of school culture and community as significant factors in developing and implementing effective teacher knowledge and expectations in the classroom. Finally, it will contribute to the research when combining both teacher expectations and mathematics content knowledge, providing insight into the complexity of both these teacher characteristics. This is significant as the two literatures are expansive and broach two different fields of research literature, namely education and psychology, and the association between the two is an underdeveloped area of research.

Research Methods

This study will investigate teachers' knowledge and understanding of fractions and how this knowledge informs their expectations. As a result, it will employ an interpretive design approach with a largely qualitative focus. Primary teacher participants will be invited to participate in a semi-structured questionnaire on their knowledge and expectations generally via a snowball sampling technique. These respondents will then voluntarily complete a semi-structured interview on their knowledge of fractions and their expectations of students when teaching fractions. Due to the semi-structured nature of both the questionnaire and the interview containing both open and closed questions, the findings will be analysed thematically, first according to a start list of descriptive codes based on the research questions and questions asked in each instrument, and later according to according to the additional themes raised through various phrases and key words (Miles & Huberman, 1994). These will then be organised into snapshots and compared to explore how teachers' knowledge influences their expectations.

Thesis Structure

Chapter 1 Introduction

Chapter 1 provides the reader with a *background/context* on the impact of teacher expectations and teacher knowledge in the primary classroom, including a description of some of the key issues in this field of study. The *focus* of this study is also discussed and justified, and the *overall research aim* is identified along with four *research objectives* for the study. The *value* of this research is then outlined, followed by a summary of the *research methods*.

Chapter 2 Literature Review

Chapter 2 *defines* teacher knowledge and teacher expectations, discusses both in the context of primary classrooms, identifies the types of studies that have been undertaken, and highlights the emerging gaps and silences in teacher knowledge and teacher expectations. Then presents a *justification for further research* on the influence of teacher knowledge on teacher expectations.

Chapter 3 Research Methodology

Chapter 3 outlines and examines the study's proposed methodology and research design. It details the selection of participants and study tools, as well as establishing the validity, reliability, and rationale for the research design based on the complexity of teacher knowledge and teacher expectations.

Chapter 4 Study Results

Chapter 4 collates the *responses of the interview participants* and *summarises the findings* of the study. The responses of participants were collated into brief snapshots. Within each snapshot participant's responses are broken down into background information; attitudes and beliefs towards mathematics and teaching mathematics; stated expectations for their students; and ideas regarding what factors influence their expectations. A summary of responses for both Artefact 1 and 2 along with questionnaire responses are included.

Chapter 5 Discussion

This chapter *discusses* the ramifications of the research outcomes addressing teachers' knowledge in this study and the emphasis they place on various forms of knowledge. Then, participants' representations of fractions and their expectations for their students in relation to fractions are compared to current literature. Finally, the association between teacher knowledge and perceived expectations is examined.

Chapter 6 Conclusion

This final chapter *summarises* the key outcomes of this study. It provides a brief response for each of the research questions guiding the study, briefly notes the implications of the study's findings on education research and teaching practice, concludes with the limitations of this study's design, and outlines recommendations for future research.

This chapter provided background and context of teacher knowledge and expectations in a primary classroom context. It also outlined the research focus, aims, and objectives of this study. The next chapter—Chapter 2 Literature Review—investigates and evaluates current literature relevant to the overall aims of this study, beginning with a clarification of what is meant by, and encompassed within, teacher knowledge and teacher expectations in the education context.

2. Literature Review

This chapter outlines the research on teacher knowledge and expectations to identify how these attributes influence each other and teaching practice in primary mathematics classrooms. The review addressed the context of the primary mathematics classroom in Australia and the influence of various extrinsic factors on teachers' knowledge and expectations. The literature provided an overview of the many forms of teacher knowledge, how multiple intrinsic factors influence these forms of knowledge and their subsequent impact on student learning. How and to what extent teacher expectations affect mathematics teachers and their pedagogy, and the influence of various extrinsic and intrinsic factors on these expectations were also explored. Given the concept of rational numbers or fractions was identified as an area in primary mathematics considered challenging to teach, the literature shows that many teachers and students often hold misconceptions about fractions despite them being fundamental to higher mathematics success. Finally, gaps and silences within the literature were summarised.

The Context of this Study

Teachers are important. Various studies and meta-analyses indicated that up to 30% of the variance in student achievement in mathematics should be attributed to the effect of the teacher (Hattie, 2004; Hattie, 2009; Lamb & Fullarton, 2002). Apart from the students themselves, the teacher is the greatest factor affecting student achievement (Hattie, 2012). In turn, there are several factors that influence teachers in primary mathematics classrooms and promote or discourage deep conceptual and procedural student learning, which also impacts student achievement. According to studies included in Hattie's (2009) meta-analysis and research reviewed by Bobis et al. (2012), intrinsic teacher characteristics such as knowledge, expectations, attitudes, beliefs, and self-efficacy all impacted the quality of mathematics teaching and learning in the classroom. Several studies also indicated that extrinsic factors such as teaching style, social determinants, policy, and curriculum impact mathematics learning (Hardy, 2018; Hattie, 2009; Opdenakkera & Van Damme, 2006; Xie et al., 2015).

When combined with various other elements such as beliefs, attitudes, and teaching philosophy, knowledge and expectations are two key components that significantly inform teaching practice. These components were explored throughout this chapter and study: here, some preliminary working descriptions are offered as a starting point. In this study, teacher knowledge broadly indicates teachers' understandings related to both content and pedagogy. This description is limited, however, and will be expanded upon throughout the chapter to include the complexities of teacher knowledge, including knowledge of students, curriculum, beliefs, attitudes, etc. Likewise, teacher expectations are broadly the beliefs the teacher holds about their students' capabilities and achievement. This definition lacks the appropriate complexity to capture the various aspects that comprise teachers' expectations. Teachers' expectations are not limited to the beliefs held about their students' capabilities and achievements. They include an intricately interconnected web of factors that includes beliefs for themselves and their capabilities as teachers and their beliefs about the environment they teach in, the parents/guardians of students they teach and the societal expectations they believe to be in place. In this sense, teachers may perceive certain expectations placed on themselves from various stakeholders and respond by teaching and subsequently forming expectations for their students based on the school context. Teachers' expectations for their students have a dynamic relationship with their expectations for themselves, either reflecting their expectations for themselves and the school community they are in or being heavily influenced by them. Similarly, this definition of teacher expectations is added to and, where necessary, clarified throughout the chapter. As both teacher knowledge and teacher expectations are nuanced to individual teachers and their situations, the literature used in this review draws upon studies from both school and classroom contexts and studies that broached the field of psychology.

Mapping the Terrain

Primary School Mathematics education in Australia is set in a social and political context. It is a scene of a broad global context of high-stakes international competitive summative testing of numeracy and a finer-grained setting of the demands placed upon classroom teachers by school communities. These broad contexts are discussed in this section.

Australian Primary school teachers are expected to be able to teach many, if not all, subjects, ranging from physical education and the arts to mathematics and science. This is because most primary schools in Australia employ a generalist teaching model (Brown & McNamara, 2011; Hiebert & Lefevre, 1986). This approach differs from the model used internationally by countries such as China, where primary teachers specialise and teach only one or two subjects[1] (Khamid, 2016; Walker, 2007). Additionally, to become teachers in Australia, pre-service teachers are required to fulfil the requirements of the LANTITE, which positions teachers' levels of personal literacy and numeracy to be broadly equivalent to those of the top 30 per cent of the population (ACER, 2015).

High-stakes Testing, Prescribed Curriculum, Standardised Testing, and the Datafication of Teaching

According to S. Ball (2015), teachers are increasingly governed and influenced by the "tyranny of numbers" (p. 299). This tyranny is constantly present in national statistics like that of the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), as well as localised data produced by competitive testing such as the National Assessment Plan for Literacy and Numeracy (NAPLAN). Roberts-Holmes (2015) argued that high stakes testing regimes such as these often result in the "datafication" of teachers and teaching where pedagogy is reduced to producing test results and the teacher's child-centred approach is "challenged, disrupted and undermined," particularly in literacy and mathematics (p. 302, 313). A study conducted in the UK on the impact of increased policy standards in the early years of education found that teachers struggled to maintain meaningful, child-centred learning due to increasing accountability policy shifts and competitive assessment policies (Roberts-Holmes, 2015). Likewise, research from the US called into question whether quality teaching and learning are based on the processes and practices used by teachers or by the learning outcomes produced (Valli et al., 2012). Valli et al. found that local and federal policies significantly influenced what is taught and the teaching style in the classroom. They found that teachers felt pressured to prepare students for standardised tests, often teaching procedurally by "teaching to the test" (Valli et al., 2012, p. 16). These findings indicate that teaching practice is heavily influenced by high stakes testing and policy regardless of the knowledge teachers may bring to the classroom.

In the Australian context, Smyth et al. (2014) addressed high stakes testing and prescribed curriculum using a collection of research from the past 50 years. They argued that Australian education is leaning towards a "banking approach" to teaching, which narrows teaching to merely "method, technique, and content" and glosses over the "broader intellectual, contextual, moral and ethical purposes of teaching" (p. 107). They

[1] This is generally the case however individual schools and initial teacher education programs within these contexts may take a different approach.

also argued that this resulted in teachers becoming policy implementers rather than true educators due to feeling disempowered, "demoralised… increasingly de-skilled and de-professionalised" (p. 99). Additionally, Hardy (2018) found that teachers were heavily influenced by national assessment practices, particularly in the case of NAPLAN. NAPLAN has influenced curriculum, and literacy and numeracy are reportedly "[taught] to the test" (p. 329) to maximise NAPLAN performance (Rogers et al., 2016). These studies indicate that teaching practice and the quality of knowledge taught and learnt in Australian classrooms are impacted by the broad contexts of high-stakes testing, curriculum and policy.

Curriculum and standardised assessment also strongly influence teaching and learning within a classroom, affecting teachers' expectations. A study conducted over 50 years ago by Rosenthal and Jacobson (1968) pointed to the significant effect of teachers' expectations on student learning and achievement. Although this study sparked a series of controversies, it has remained a substantial cornerstone in teacher expectation research for the past five decades and is referred to in greater detail later in this chapter. Kellaghan et al. (1982) reviewed the impact of Rosenthal and Jacobson's Pygmalion effect in light of standardised assessment and found that test results contributed significantly to teachers' expectations, which impacted students' achievement, particularly among students classified as middle-class. More recently, Rubie-Davies (2014) argued that test results could form teachers' expectations before they have even met the student in person. Regarding curriculum, Rubie-Davies (2014) found that teachers in the UK and the US had vastly different expectations for students at an equivalent level and suggested that curriculum differences were a key cause of the varied expectations. This indicates that teachers' expectations are influenced by curriculum expectations that dictate what students can achieve by a certain level.

Few studies have been conducted on the influence of standardised testing on teacher expectations within Australia; however, NAPLAN could be argued to influence teacher expectations, either from expecting students to achieve the level dictated by the test or from the results received. With some schools, the expectation is for performing well in NAPLAN. NAPLAN performance, however, ought to be the product of high expectations, not the expectation itself. It is probable that both the national curriculum used in Australia and various state curricula influence teachers' expectations in similar ways to the curriculum influences found by Rubie-Davies (2014) in the UK and the US.

Change and Reform in School Systems

Change and reform in the immediate school environment impact teachers' knowledge. Research has shown that school change and teacher knowledge shared a reciprocal partnership (Frey & Fisher, 2004). Frey and Fisher (2004) argued that school reform without teacher knowledge development diminished the effectiveness of both. Likewise, knowledge development without school reform produced a similar diminishing effect. This impact was explored further in a study on the influence of add-on programs and the inclusion of students with disabilities in the classroom (McLeskey & Waldron, 2002). The results of that study found that teachers were significantly affected by the changes to school settings due to the implementation of add-on programs. Teachers found that they had to make significant changes to instruction methods, grading, classroom expectations, and student grouping, which impacted the quality of teaching and learning that occurred in the classroom. Although that study looked at one possible effect of the school environment on teachers, it indicated the potential influence of the school environment on teachers' classroom practice. A further narrative inquiry by Craig (2012) revealed that reform in a school environment, whether it be changes in school staffing, teaching practices or policy reform, influenced both teachers' knowledge and professional learning communities. Though changes in schools are unavoidable, particularly in reforming policy, curriculum and best practice, these changes cannot be ignored when considering the various extrinsic factors that influence teacher knowledge.

The community in which a school is situated plays an essential role in influencing teaching expectations and student achievement. Weinstein (2002) described the vast differences between schools, including neighbouring communities, and how these differences influence expectations for teachers and students. It was claimed that community, in addition to family and school influence, shapes expectations. Weinstein (2002) stated, "in the real world of schooling, the full power of expectancy effects lies at this interface" between family, school, and community influence (p. 293). Rubie-Davies (2014) supported this, positing that expectations need to be considered through an ecological framework where the immediate classroom environment of the teacher and student is regarded as an influence on expectations along with the broader school community and neighbouring community. Rosenthal and Jacobson's (1968) original expectations study drew parallels between school community factors and teachers' expectations, particularly SES. They observed that teachers situated in schools with a low SES failed to set standards and expectations as high as those situated in middle-class schools (Rosenthal & Jacobson, 1968). Likewise, Solomon et al. (1996) examined the impact of teachers' beliefs and practices in schools of varying SES. They found significant correlations between the SES of a school and aspects such as teacher beliefs and attitudes, which, in turn, impacted expectations. More recently, Timmermans and Rubie-Davies (2018) found that aspects of a teacher's background, like gender, ethnicity and SES, had little effect on expectations. Instead, they discovered that the SES of schools significantly impacted teachers' expectations, with teachers in high SES schools tending to be low differentiating. In contrast, teachers in middle to low SES schools tended towards high differentiating teaching practices. Consequently, the middle to low SES schools had greater expectancy effects, meaning that the effect of teacher expectations, whether high or low, were more salient and therefore more impactful.

A study by Sarra et al. (2020) identified three relationship spheres in which high expectations can be cultivated in Australian classrooms: the personal sphere, the school sphere and the community sphere (p. 34). High expectations relationships were established by Sarra et al. as a component of the Stronger Smarter Approach for Indigenous education in Australia, an area often conditioned to have low expectations. Sarra et al. argued that this approach could be applied broadly to facilitate high expectations as it identifies high teacher expectations to be: the product of the teacher themselves (personal); the colleagues and fellow teaching staff (school); and the community the school is situated in, including parents and carers of students. Sarra et al. (2020) argued,

> When the thinking, conversing and behaviours that build high-expectations relationships become cultural practices within a school, the quality of collegiate staff environments, strong teacher-student relationships and relationships with parents and community are all enhanced. In doing so, this provides the essential, underlying basis for the culturally responsive learning environments needed to support the performance outcomes of high expectations. (p. 41)

Although these researchers found the community and school context influenced expectations, this area of research was limited in this review.

Teachers and their Families

Student achievement is widely argued to be influenced by the classroom environment (Barrett et al., 2017) which in turn is influenced by teacher knowledge (Traise, 2015). Beyond this, family and parental beliefs influence teachers' knowledge, motivation and confidence in teaching mathematics (Jay et al., 2018). Van Voorhis and

Anglin (1994) conducted a study on pre-service teachers, investigating the influence of family on teaching knowledge and practice. They found that teachers were positively influenced by their family members who encouraged them in mathematics learning and made them aware of the importance of mathematics in everyday life (p. 412). Van Voorhis and Anglin argue that this is encouraged through valuing and using mathematics practically in family life, and concluded that parents and families should be made aware of their influence on their children's mathematics understanding and confidence. Likewise, a more recent study by Blömekea et al. (2012) examined the various influences on primary mathematics teachers across 15 countries and found that gender often influenced achievement in school, which later impacted teaching confidence and motivation. Blömekea et al. argued that gender inequity was often due to less support and encouragement for female students from parents. In their study on parental involvement in mathematics, Jay et al. (2018) observed that mothers often expressed concern that they would pass on their anxieties about mathematics to their daughters in particular. Interestingly, most of these studies did not report a significant influence on students' and teachers' knowledge and beliefs when the family influence was negative. However, these studies reported a significant impact when the family influence was encouraging and positive.

The classroom environment impacts the teacher, affecting teachers' attitudes and classroom management (Horne Martin, 2002). Beyond this however, the way in which the classroom functions is a further influence on teacher expectations. One way in which many classrooms differentiate is via grouping. Rosenthal and Jacobson (1968) criticised this method stating that once students were placed into a particular ability grouping, they tended to stay in that group. They went on to argue that "membership in a given group or track, like membership in a disadvantaged group, or like a particular IQ score, is a source of teachers' expectations about a pupil's intellectual ability" (p. 58). Not only does this grouping influence teachers' expectations, but it often directly communicates to students the positive or negative expectations of their teachers (Rubie-Davies et al., 2015). Rosenthal and Jacobson (1968) observed that students who were expected to make gains in achievement and did so were viewed favourably by their teachers. Conversely, students who were expected to achieve poorly and made significant gains regardless were viewed unfavourably by their teachers (pp. 179-182). If the classroom functions through ability grouping, there is a danger of teachers holding negative views towards students who achieve unexpectedly. This impacts both the students' academic performance and their relationships with their teachers. Likewise, whether it be supportive or not, the classroom community can be seen to influence both teachers' expectations and students' achievement (Weinstein, 2002).

Professional Learning Communities

The community a teacher is situated in, namely the teacher colleagues and various stakeholders within a school, impacts the knowledge possessed and utilised. Borko and Koellner (2008) and Horn (2005) argued that mathematical knowledge is deepened from interaction in strong professional learning communities (PLCs) that encourage teachers to reflect on practice and share ideas and resources. Golding (2017) defined PLCs as a group of teacher colleagues and various stakeholders within a school "sharing goals focused on student learning, professional practice, vision, and values…" (p. 513). Golding (2017) argued that these PLCs, when effective, promote teacher development and equip them to teach with deep subject-specific knowledge. Golding (2017) concluded that with the constant changes and developing knowledge surrounding best practice for mathematics teaching, an individual teacher's "good intentions [to change and improve], even when accompanied by extensive knowledge and substantial experience, are fragile" (p. 515). Golding (2017) went on to argue that teachers need to be nurtured by effective PLCs. Vescio et al. (2008) reviewed several US and UK based studies and concluded that when teachers engage in PLCs, teaching practice improves and student achievement increases. Askew (2008) conjectured that students were likely to make gains if the "professional community of teachers" is open to sharing knowledge and expertise. Nevertheless, if the community a teacher is situated in expects teachers to work as individuals and collaboration is not encouraged, weak discipline knowledge is exposed and results in poor student achievement. Likewise, Sarra et al. (2020) pointed out that some school environments disempower teachers and lower teacher expectations for students. Some teachers engage in deficit conversations where they vent their frustrations about students with their colleagues. The research unanimously agrees that the teaching community impacts individual teachers' knowledge and expectations and subsequently impacts teaching and student achievement.

The research reviewed above indicates many embedded contextual factors that influence teachers' knowledge and expectations. These factors are numerous and complex in their own right and, consequently, both teacher knowledge and expectations are multifaceted. The following sections will define, describe and further discuss both teacher knowledge and teacher expectations.

Teacher Knowledge

In reviewing the literature in this area, it is essential to consider the Australian Primary School context in which teachers typically operate as generalists (Brown & McNamara, 2011). This model caters for greater teacher-student relationships but does not generally allow teachers to develop expert knowledge of their teaching subjects. This context can result in a cycle where teachers with superficial knowledge produce students with surface knowledge resulting in a further generation of teachers with superficial knowledge (Fitzmaurice et al., 2019; Roberts-Hull, 2017). Therefore, subjects requiring teachers to have a strong understanding of fundamental concepts such as mathematics, science, and literacy are in some cases taught by teachers who do not have the depth of knowledge required (Jensen et al., 2017). With this context in mind, this section addresses three elements that constitute a teacher's approach when teaching mathematics: intrinsic factors influencing teacher knowledge, type of knowledge preferences, and quality of knowledge (Star & Stylianides, 2013). It also addresses an alternative approach to understanding teacher knowledge and, finally, outlines research into teacher knowledge specifically related to understanding and teaching fractions.

Factors Affecting Teacher Knowledge

The first element that constitutes a teacher's approach to teaching mathematics is the factors that affect teachers and their knowledge. Intrinsic factors include the teacher's beliefs, self-efficacy, and attitudes towards mathematics and the teaching of mathematics, and extrinsic factors include social determinants, policy, and curriculum. All these factors play a pivotal part in influencing teaching and learning within the classroom, which points to the subsequent complexity of teacher knowledge (S. Ball, 2015; Bobis et al., 2012; Chan et al., 2018; Cross Francis, 2015; Dever & Karabenick, 2011; Hurst, 2017; Jong & Hodges, 2015; McCampbell, 2015). The context of primary mathematics teaching in Australia has already been addressed in the previous section outlining the various extrinsic factors within the global, local and classroom context that influence teachers' knowledge. This section will address the intrinsic factors that influence teachers' knowledge, namely, teacher beliefs, attitudes and self-efficacy,

Numerous studies have examined the importance of teachers' beliefs and the subsequent impact on teaching practice (Beswick & Chick, 2019; Cross Francis, 2015; Liu & Bonner, 2016; Philipp et al., 2007). Teachers' beliefs are the perceptions of oneself and the perceptions of the surrounding world, either conscious or unconscious, and inform teachers' knowledge (Bobis et al., 2012; Cross Francis, 2015, p. 175). In mathematics, these beliefs are how the teacher perceives mathematics teaching: constructivist, as an active process of sense-making, or traditional, a process of teachers giving and students receiving information. These beliefs are also how the teacher perceives mathematics: procedurally, as facts and procedures that need to be memorised and reproduced, and conceptually, as concepts that require students to problem solve, explain and justify their reasoning (Cross Francis, 2015; Liu & Bonner, 2016). In a three year case study focused on two early years primary mathematics teachers in the US, Cross Francis (2015) observed that teachers' beliefs about mathematics and mathematics teaching did impact learning and achievement. These beliefs did not always translate to teaching practice due to personal factors such as self-efficacy and external, school-based factors, time constraints, testing concerns, and parental expectations (Cross Francis, 2015). A study conducted by Liu and Bonner (2016) among seventy-eight in-service and preservice teachers had similar results. They found that, though most teachers endorsed constructivist teaching beliefs, many reverted to traditional instructional practices. Both studies pointed out that it was due to the interaction between beliefs about teaching and learning and beliefs about mathematics that created the most significant impact on teaching practice.

According to White et al. (2006), teachers' attitudes and beliefs are connected; every belief comes with a corresponding attitude (p. 34). Unlike beliefs, teachers' attitudes towards mathematics and mathematics teaching are less cognitive and more likely to develop over time and with experience (Philipp et al., 2007). Jong and Hodges (2015) further described these attitudes as "ways of feeling and thinking about mathematics" (p. 410). They argued a clear distinction between teachers' attitudes about mathematics as a student of the subject themselves and teachers' attitudes toward teaching mathematics. In other words, though a teacher may see mathematics as a valuable and worthwhile subject, they may lack confidence in teaching the subject and, as a result, have a negative attitude towards teaching the subject. In a study conducted on over 100 primary pre-service teachers in the United States, Jong and Hodges found that both types of attitudes towards mathematics are strongly affected by the teacher's own experiences with mathematics (p. 407). When the pre-service teachers with negative attitudes towards mathematics were exposed to meaningful mathematics instruction, their attitudes towards the subject improved dramatically. Conversely, an alarming study by Young-Loveridge et al. (2012) in New Zealand among 319 preservice primary teachers found most participants expressed an unenthusiastic attitude towards mathematics. They found that fewer than half of the participants in the study stated they liked mathematics. This is concerning as numerous studies in this area revealed that teacher attitudes strongly affect teachers' instructional practices towards students and student achievement (Celik, 2017; Chamberlin, 2010; Jong & Hodges, 2015; Philipp et al., 2007; White et al., 2006).

McCampbell (2015) emphasised the importance of teacher self-efficacy and argued that teaching with positive self-efficacy is an essential element in effective mathematics teaching (p. 6). Self-efficacy is defined as the perceptions one has of their own ability to execute courses of action appropriate to given circumstances (Bandura, 1982). Teachers' self-efficacy is then teachers' beliefs about their capability to affect what and how students learn and is argued to influence instructional practices and affect teachers' cognition, motivation, and choices (Cross Francis, 2015; McCampbell, 2015). A study conducted in the US of almost 400 undergraduate teaching students found that a teachers' self-efficacy for teaching mathematics was often predicted by the teachers' own self-efficacy in doing mathematics and notions about what they know and believe about teaching the topic (McCampbell, 2015). Other studies found teachers who maintained high self-efficacy reported higher classroom standards, clearer expectations and more on task behaviour than teachers with low self-efficacy (Rimm-Kaufman & Sawyer, 2004). Teacher efficacy accounts for almost 10% variance in student achievement in mathematics classrooms, according to a study conducted by Tella (2008) in Nigeria. In addition to this, Rimm-Kaufman and Sawyer (2004) suggested that self-efficacy is bidirectional, meaning teachers feel positive self-efficacy when their students do well, and students do well when their teachers feel positive self-efficacy (p. 322).

Each of these intrinsic teacher characteristics significantly impacts the knowledge teachers bring and employ in the classroom. As a result of these factors woven into teacher knowledge, studies on teacher knowledge frequently address these aspects.

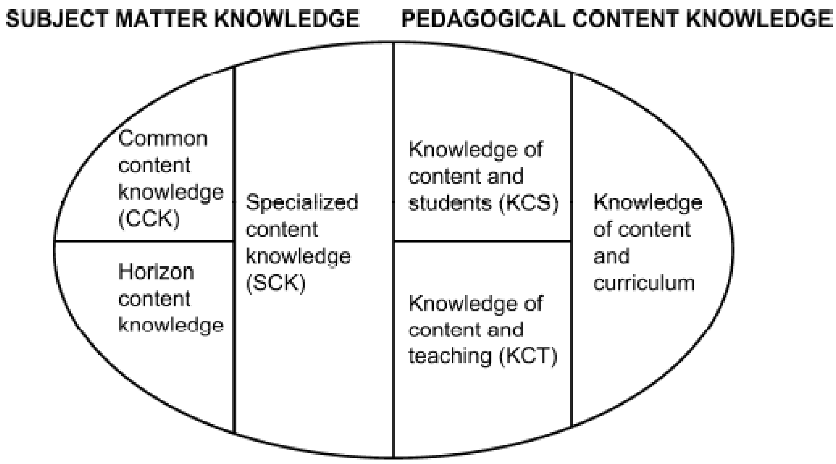
Types of Teacher Knowledge

The second element of a teacher's teaching approach in mathematics is the type of content knowledge possessed by the teacher (Rittle-Johnson & Schneider, 2015). The influence of various forms of teacher knowledge on classroom practice and student achievement is established, and it is widely understood that knowledge is critical for effective teaching (D. Ball et al., 2008; Bobis et al., 2012; Chan et al., 2018; Hill et al., 2008; Hill et al., 2005; Hurst, 2017). This section will address the various types of teacher knowledge presented in the literature, particularly that of Shulman (1986) and subsequent research that has resulted from Shulman's model of knowledge types. It will also address the conceptual and procedural content knowledge debate outlined by Star (2005) and the impact of teacher knowledge on student achievement and student learning.

Much of the research in this area has developed out of the research and theory developed by Shulman (1986), which proposed three categories of content knowledge required by teachers to teach effectively: Subject Matter Knowledge, Pedagogical Content Knowledge and Curricular Knowledge. Shulman's theory has created debate as to whether all these forms of knowledge are required for teachers to teach effectively. Bobis et al. (2012) suggested that teacher knowledge must consist of both content and pedagogical knowledge to be effective and argued that teacher knowledge is heavily influenced by the beliefs and attitudes of the teacher.

D. Ball et al. (2008) and Hill et al. (2008) suggested six forms of teacher knowledge fit under Shulman's Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK) umbrella. They indicated that mathematical knowledge for teaching (MKT) comes in the various forms shown in Figure 2.1 (D. Ball et al., 2008, pp. 399-403).

Figure 2.1
Framework of Mathematical Knowledge, proposed by D. Ball et al. (2008, p. 403)



D. Ball et al. defined each of these components as the knowledge of how to perform mathematical problems correctly (Common Content Knowledge [CCK]); the knowledge of how mathematical concepts "are related over the span of mathematics" prescribed in the curriculum (Horizon Content Knowledge [HCK], p. 403); the mathematical skill and knowledge unique to teaching which enables a teacher to represent mathematical ideas accurately (Specialised Content Knowledge [SCK]); the knowledge that combines knowledge about students and knowledge about mathematics to meet learning needs (Knowledge of Content and Students [KCS]); the knowledge that combines knowing about teaching and knowing about mathematics (Knowledge of Content and Teaching [KCT]); and finally, they place Shulman's Curricular Knowledge underneath Pedagogical Content Knowledge as knowledge of content and curriculum [KCC]. Essentially, D. Ball et al. (2008) argued that SMK is purely mathematical knowledge and excludes knowledge of students or pedagogy. In contrast, PCK is comprised of the teacher's knowledge of their students and how to teach. The distinction between these forms of knowledge can be seen in the example of a teacher analysing a student error. The teacher can look at the error mathematically, considering what steps were made, which depends on SMK, or by looking at the error as a common mistake students make based on experiential knowledge of content and students, which is dependent on PCK. Darling-Hammond (2016) took this further, suggesting that teacher knowledge, whatever the form it takes, should support complex, strategic learning.

An argument that has stemmed from the knowledge type debate is presented by Star and Stylianides (2013), suggesting there are two types of mathematical content knowledge: conceptual and procedural. In the early 1940s, Brownell stated that arithmetic should be meaningful and proposed that "[meanings and concepts] grow only as the result of appropriate experiences" (1944, p. 486). This idea eventually developed into two key understandings suggested to be necessary for mathematics to be taught meaningfully: relational and instrumental understanding; these are defined respectively as the "what to do and why" (Skemp, 1978, p.9) and the ability to possess and use a rule in mathematics. These understandings underpin the National Research Council's definition of conceptual understanding as "the integrated and functional grasp of mathematical ideas" and procedural fluency as knowing when and how to use procedures "flexibly, accurately, and efficiently" (Kilpatrick et al., 2001, pp. 118, 121). The former is often described as knowing "what to do and why," while the latter is the ability to use rules appropriately (Kilpatrick et al., 2001; Skemp, 2006, p. 89). Though both definitions denote meaningful, deep learning in some form, which type of content knowledge is more conducive to meaningful learning is debated.

Regardless of which model is used, most researchers agree that the combination of multiple forms of teachers' knowledge makes the definitive difference to students' learning (Hurst, 2017). Numerous studies supported the argument that teacher content knowledge significantly impacts student achievement and quality of mathematical learning (Chan et al., 2018; Hill et al., 2005). In a yearlong study conducted in over 100 American schools, teacher knowledge positively affected student gains in mathematics, even in classrooms requiring only basic mathematics content (Hill et al., 2005). Likewise, in a series of pilot studies conducted across Australian, Portuguese and American schools, the teachers' knowledge of content and pedagogy specific to the task at hand resulted in a variance of effective instruction (Chan et al., 2018; Clarke et al., 2015; Roche et al., 2016). Hence, teacher content knowledge is important as it equips teachers to identify student misconceptions and provide students with the depth of knowledge necessary to understand mathematical concepts (Hurst, 2017).

Mathematical Content Knowledge

Mathematical content knowledge is the final component of a teacher's mathematics teaching approach. Foundational studies by researchers such as Marton and Säljö (1976) and Biggs (1979) suggested that there are two approaches to learning: a deep approach, concerned primarily with rich understanding and meaning, and a surface approach, associated with the memorisation of facts and procedures (Chue & Nie, 2017). Star and Stylianides (2013) suggested that these approaches can be applied to mathematics teaching and teacher knowledge. If a teacher's knowledge is superficial, it is likely that their student's knowledge is likely also to be superficial (Chan et al., 2018).

Studies suggested a clear correlation between deep and surface learning approaches and academic achievement (Biggs, 1979; Chue & Nie, 2017; Dinsmore & Alexander, 2012; Marton & Säljö, 1976). According to Chue and Nie (2017), "a deep learning approach is characterised by an intention to seek understanding and meaning" and is concerned with finding connections between previously known and new knowledge (p. 77). On the other hand, a surface learning approach is primarily concerned with the rote memorisation of facts and procedures. In mathematics, conceptual knowledge is often assumed to be deep, and procedural is thought to be surface with various studies in the past suggesting that conceptual knowledge was richer when compared to supposedly superficial procedural knowledge (Chue & Nie, 2017; Hiebert & Lefevre, 1986; Liu & Bonner, 2016; Star & Stylianides, 2013). However, neither of these approaches has consistently been found to influence academic achievement beneficially or, conversely, produce a negative influence on student achievement (Chue & Nie, 2017; Dinsmore & Alexander, 2012). Instead, results indicate that both approaches should be used in the classroom to promote meaningful learning. A body of research presented by Star and colleagues suggested that both forms of knowledge are pivotal for teaching and learning (Star, 2005; Star & Rittle-Johnson, 2009; Star & Stylianides, 2013). Thus, distinctions can be made between the type of mathematical content knowledge and the quality of knowledge, as seen in Figure 2.2. They posited that both forms of knowledge could be equally superficial or meaningful and stressed the importance of developing both forms of knowledge equally (Reys et al., 2012; Rittle-Johnson & Schneider, 2015; Star & Stylianides, 2013).

Figure 2.2

Types and Qualities of Procedural and Conceptual Knowledge, proposed by Star (2005, p. 408)

Knowledge Type	Knowledge Quality	
	Superficial	Deep
Procedural	Common usage of *procedural knowledge*	?
Conceptual	?	Common usage of *conceptual knowledge*

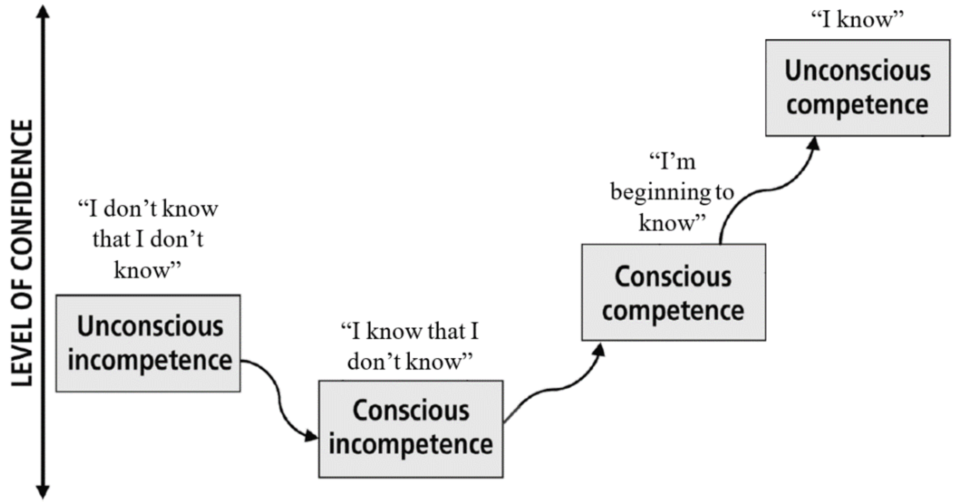
Likewise, a study conducted in Singapore found that deep learning was more indicative of academic achievement, although not entirely conclusive (Chue & Nie, 2017). As a result, Chue and Nie (2017) argued that deep conceptual understanding is essential for positive academic achievement. However, they also argued that both conceptual and procedural knowledge must be developed deeply for meaningful learning to occur. Therefore, meaningful mathematics learning is most likely to occur when both conceptual and procedural knowledge types are not only utilised and developed in the classroom, but also developed to be rich in connections and relationships among concepts.

Knowing "what I don't know"

A further knowledge type that teachers may possess and put into practice when they teach is knowledge of their knowledge gaps or knowing "what I don't know". In response to this, Hansen (2013) adopts Howell's (1982) Levels of Competence Model and refers to four stages of competence for teaching in reference to how pre-service teachers address gaps in their knowledge. These stages are summarised in Figure 2.3. In the unconscious incompetence stage, the individual is not aware of their knowledge gaps, while in the conscious incompetence stage, the individual is aware of their knowledge gaps. The third and fourth stages involve resolving the knowledge gaps, first learning it and later becoming competent. In the conscious incompetence stage, individuals know what they do not know (i.e., are conscious of their incompetence). The individual can then respond to this conscious incompetence by addressing the knowledge gap and turning their conscious incompetence into conscious competence (Hansen, 2013, p. 35).

Figure 2.3

Four Stages of Competence for Teaching Knowledge, adapted from Hansen (2013, p. 35).



Mathematical Sensibility: A Knowledge Capacity Alternative

It is generally believed that a mathematics teacher would need to have sufficient knowledge, understanding or sensibility of the discipline to teach it effectively (Askew, 2008). As a result, research into the type and quality of knowledge required of primary mathematics teachers is common, and there are generally two sides to the debate. The first side of the debate argues that teacher must have a deep and connected understanding of the content to teach it effectively. This knowledge is typically described as deep Mathematical Content Knowledge (MCK). Conversely it is argued that extensive knowledge of mathematical content is unnecessary if there is knowledge of how to teach the content. This is typically described as deep PCK. Askew (2008) proposed a third argument suggesting teachers develop mathematical sensibility, which is also addressed in this section.

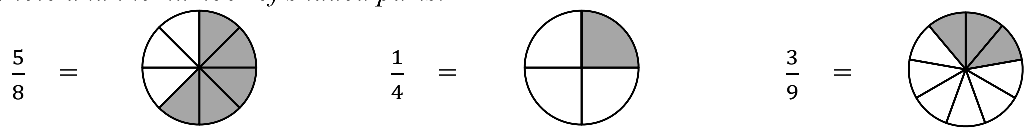
Pointing to the complexity of teacher knowledge, Askew (2008) questioned whether MCK and PCK can be distinctly separated. He argued that it is unrealistic to expect primary teachers to enter the profession with a thorough and expert understanding of all the MCK and PCK needed to teach mathematics proficiently. He stated that this expert knowledge expectation leads to a deficit model of teachers' knowledge where research often focuses on the negative rather than the positive (i.e., what teachers do not know as opposed to what they do). This model typically assumes that greater content knowledge leads to more proficient teaching and learning despite a scarcity of research that suggests this (Askew, 2008). Despite this, Askew (2008) did not suggest that teachers possessing a certain threshold of content knowledge be abandoned altogether. Studies showed that, up to a point, increased content understanding among teachers leads to student gains (Gess-Newsome et al., 2019; Hill et al., 2005). Though research suggested that less knowledge of mathematics on the teacher's behalf is connected to lower student achievement, little research suggests that teachers who obtain more subject knowledge produce greater student achievement. As a result, Askew (2008) suggested that a more reasonable expectation would be that teachers develop a mathematical sensibility, capable of teaching the curriculum but remaining flexible to change; a foundational knowledge of mathematics remaining curious and developing as, and when, needed. Davis (2011) supported this idea with a similar recommendation arguing that teachers' mathematics knowledge be "viewed as a learnable disposition rather than an explicit body of knowledge" (p. 1507).

Based on his review of research, Askew (2008) suggested three key elements of mathematical sensibility for primary teachers adapted from Whitehead (1967): precision, generalisation and romance. The first, precision, involves the need for teachers to be precise in their teaching of mathematical concepts. In part, this involves accuracy (getting the right answers), but beyond this, it involves "precise language in describing mathematical action" (Askew, 2008, p. 23). An accurate answer is found, and precise language used to specifically demonstrate the part-whole model of fraction understanding in the example below as illustrated in Figure 2.4. There is no muddling of concepts or sub constructs "through inappropriate marrying up of words and actions" (p. 23).

Figure 2.4

Example of a Precision Question in Teaching Fractions

Question: Write a fraction to represent the pies below, showing the number of equal parts in a whole and the number of shaded parts.

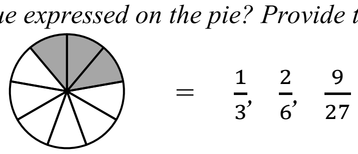


The second element, generalisation, finds the specific result, but goes beyond that and sees "the general-in-the-specific" (p. 25). It asks the "if… then what about…?" questions and facilitates curiosity and inquiry in the classroom. The language is still specifically targeting part whole understanding of fractions in Figure 2.5 and an accurate response is found, but generalisations are then made to extend understanding.

Figure 2.5

Example of a Generalisation Question in Teaching Fractions

Question: In the pie below, three parts are shaded out of nine equal parts. What fractions could be used that represent the same value expressed on the pie? Provide three examples below



The third and final element, romance, implies both care and curiosity for mathematics and mathematical concepts. Askew (2008) recognised that not all primary teachers will care *for* mathematics but suggests that they have a duty to care *about* mathematics (p. 26). A way to promote this care is through the development of curiosity, not only in students' responses and thinking, but curiosity about mathematics itself (Askew, 2008). This romantic approach to mathematics shifts attention from *what* teachers need to know to *why* mathematics concepts are taught; a shift from an individualistic view of teachers and the knowledge *in* their heads to recognising the knowledge of mathematics to be communal and distributed throughout the knowledge community.

Most of this review and subsequent study focused on the individual teacher's knowledge and expectations; however, it is recognised that shared responsibility and knowledge sharing plays a pivotal role in the primary mathematics classroom. There are many studies and theories presented in this section on teacher knowledge. Knowledge is complex, and various elements must be considered when examining the knowledge teachers have and use when teaching mathematics.

Teaching the Mathematical Concept of Fractions

This section of the literature identifies fractions or rational numbers as a particular mathematical concept taught throughout primary school where teacher knowledge appears to be lacking and where misconceptions are common. Emphasis on why this concept is important for understanding mathematics, why it is under-researched, and why it is used to study teachers' knowledge and expectations are pertinent to this study.

The concept of fractions, particularly rational number, is essential as it extends to understanding whole numbers and, in turn, extends in later mathematical learning into understanding algebraic variables (Way & Bobis, 2011). Furthermore, a strong understanding of fractions builds multiplicative reasoning which is "foundational for understanding… proportionality, algebra and probability" (p. 14). The teacher with a strong conceptual understanding of this concept and its related subconstructs can help their students to understand this concept deeply (Jensen et al., 2017; Way & Bobis, 2011). According to Lamon (2007), fractions:

> hold the distinction of being the most protracted in terms of development, the most difficult to teach, the most mathematically complex, the most cognitively

> challenging, the most essential to success in higher mathematics and science, and one of the most compelling research sites. (p. 629)

Others describe fractions as relational numbers that "express a mathematical relationship between two discrete or continuous quantities" (Bobis, 2011, p. 12). This relationship is multiplicative and foundational for success in understanding higher-level mathematics concepts deemed the most difficult to learn and teach, such as proportionality, algebra and probability (Bobis, 2011). Way and Bobis (2011) outlined a series of fraction subconstructs, initially proposed by Kieren (1976), that further clarify the complex nature of fractions, namely fractions as a part-whole comparison, a quotient, a measure, an operator, and a ratio. When applied to D. Ball et al.'s (2008) knowledge types, these subconstructs could be considered specialised content knowledge necessary to teach fractions effectively.

Despite the importance of this concept, Lamon (2007) echoed an argument made by Behr et al. in 1992, pointing to a lack of research into effective teaching and learning of fractions compared to the apparent importance of this concept. Zazkis and Mamolo (2016) highlighted that out of a hundred psychology mathematics studies reviewed that focused on fractions, over a third addressed teachers' knowledge and particularly knowledge gaps related to this concept. Additionally, many of the studies addressed in this paper identified fractions as an area of content knowledge deficit among many pre-service and in-service teachers. This finding was the motivator for using fractions as the lens through which to study teachers' content knowledge (D. Ball, 1990a; D. Ball, 1990b; Chinnappan & Forrester, 2014; Mays, 2005, as cited in Young-Loveridge, 2012; Liu & Bonner, 2016; Tirosh, 2000; Young-Loveridge, 2012).

The concept of fractions also applies to the three elements of mathematical sensibility proposed by Askew (2008) and the types of mathematical content knowledge presented by D. Ball et al. (2008) summarised earlier in this chapter. Precision appears similar to both CCK and SCK as it is concerned with "getting the right answers" and the mathematical language unique to teaching, enabling a teacher to accurately represent mathematical ideas (Askew, 2008; D. Ball et al., 2008). Likewise, generalisability lends itself to developing horizon content knowledge that understands how mathematical concepts in the curriculum are related and connected. The final element, romance, is described as an overall positive attitude towards mathematics. Taken together, mathematical knowledge or mathematical sensibility would need to be examined through a mathematical concept where teachers and students struggle with misconceptions, runs counter to precision and generalisability, and where mathematics anxiety is common, which is counter to the romance described by Askew (2008). Fractions is such a concept as it is widely considered to be an area where teachers often struggle with misconceptions in their understanding and where teachers' attitudes are often expressed as mathematics anxiety and a lack of confidence (Behr et al., 1983; Bobis, 2011; Getenet & Callingham, 2021; Harvey, 2012; Lamon, 2007; Siemon et al., 2015; Zazkis & Mamolo, 2016).

Consequently, fractions were used in this study to examine both teachers' knowledge and expectations due to the importance and relative difficulty of this concept, the lack of research in this area, and to the extent in which fractions tie well into both mathematical sensibility (Askew, 2008) and types of mathematical content knowledge (D. Ball et al., 2008).

Teacher Expectations

This section of the literature review examines research on teacher expectations and further defines teacher expectations. It summarises teacher expectation research, outlining the overall influence of teacher expectations on student learning and performance. Throughout, it is important to remember that Australian primary teachers are not always experts in the disciplines they teach. Further, primary teachers do not come into the field with the experience to moderate their expectations of students. Teacher knowledge and expectations are a part of the teacher's professional development with time and experience. Hence, governments generally provide teacher pay scales where teachers are paid a higher salary the longer they are employed as a teacher. As they gain experience, teachers typically become more aware of their expectations of students and more realistic in the setting of their expectations. Despite this, there is insufficient evidence to suggest that more teaching experience results in more positive teacher expectations (Agirdag et al., 2013; Riegle-Crumpet & Humphries, 2012; Rubie-Davies et al., 2012; S. Wang et al., 2018). In view of this context, this section will address three aspects that influence a teacher's expectations: student characteristics, teacher characteristics, and relationships. These aspects will be addressed generally and then specifically with attention to mathematics teaching.

Teachers' achievement expectations are described as teachers' beliefs regarding their students' capabilities and achievement levels (Peterson et al., 2016). Timmermans et al. (2015) added to this, describing teachers' expectations as the "inferences made by teachers with respect to students' potential to achieve" based on "the teacher's current knowledge about those students" (p. 406; Timmermans & Rubie-Davies, 2018, p. 242). Rosenthal and Jacobson (1968) revealed the important influence teachers' expectations have on student achievement in their foundational study. They examined the effect of teacher expectations on students within an elementary setting in the US by using a randomised control study in a single low SES school where teachers were informed that randomly selected students would blossom intellectually. Their study found that when teachers had positive expectations of students, students showed significant gains in Intelligence Quotient [IQ] compared to the remaining students who had no assigned expectations from the teacher. While this study was challenged due to ethical concerns and the study's conclusion that expectations influenced IQ, a review of later studies supported the role expectations have on teaching and learning. As a result, teacher expectations are said to have a self-fulfilling prophecy effect on students' socio-psychological factors (such as self-efficacy, expectations for self, motivation, etc.), learning behaviours and achievement (S. Wang et al., 2018).

Student Characteristics as Influential Factors on Teacher Expectations

Teachers' expectations for students' achievement and ability are rarely based on direct or indirect assessment alone. Instead, it is established in the research that students' characteristics may positively or negatively influence teachers' expectations. These can include students' attitudes or perceived effort, ethnicity, SES, gender, diagnostic labelling, behaviour, personality and friendliness, sibling success, and their name's commonality or association. These factors can then, resultingly, provide students with an advantage or disadvantage (Rubie-Davies, 2014; Rubie-Davies, 2015; S. Wang et al., 2018). Many studies on teacher expectations examined the characteristics of students that may influence teachers' expectations, and gender and ethnicity are two of the most attributed factors to influence teacher expectations (Jamil et al., 2018). Rubie-Davies (2014) explained that in the same way teacher expectations affect performance, the student's behaviour and prior performance impact teachers' expectations. As a result, the salient expectations of teachers and students' performance are likely to be caught in a cycle that, without intervention, can result in significant expectancy effects.

Teacher Characteristics as Influential Factors on Teacher Expectations

The dominant notion in expectations research is that students' characteristics influence teacher expectations and subsequently impact achievement. Research also concentrates on the classroom environment and instructional behaviours. This review found limited research that focused on the individual teacher characteristics and how teachers differ (Rubie-Davies & Peterson, 2010; Rubie-Davies, 2015; Timmermans & Rubie-Davies, 2018). As a classroom is a social community, the students' characteristics are not the only characteristics that will contribute to the classroom's socioemotional environment and instructional climate. Rubie-Davies and Peterson (2010) explain,

> One question frequently pursued in the research on teacher expectations is: What is it about students that means their teacher has high or low expectations for them? However, when expectations are viewed in relation to teacher rather than student characteristics, the question becomes: What is it about teachers that means they have high or low expectations for students? (Rubie-Davies & Peterson, 2010, p. 136)

Rubie-Davies (2014; 2015; 2018) and a small group of other researchers (Babad, 2009; Weinstein, 2002) have begun to draw attention to some of the teacher characteristics that have been found to impact their expectations, such as pedagogical beliefs, bias, differentiation, and teaching behaviours. A systematic review of teacher expectation literature over the past thirty years has indicated that "the area of teacher factors as influencing their expectations is vastly under-researched compared to student factors as potential sources of expectations" (S. Wang et al., 2018, p. 133).

Though the research on the impact of teacher characteristics and the subsequent impact on expectations is limited, several studies have shown that certain intrinsic teacher characteristics impact expectations of students' academic and social outcomes and the communication of those expectations to students. These, in turn, may have an expectancy effect on students' achievement. These characteristics, namely pedagogical beliefs, bias, and differentiation will be addressed in this section.

According to S. Wang et al. (2018), "not all teachers are influenced by potentially biasing information to the same degree, and not all teachers treat high- and low-expectation students differently" (S. Wang et al., 2018, p. 139). A significant characteristic that influences how teachers set and communicate expectations is belief; it may be beliefs about the discipline they are teaching, beliefs about pedagogy or beliefs about themselves. According to Bohlmann and Weinstein's (2013) study, teachers who held "traditional" views of teaching mathematics tended to view mathematics as "a static body of knowledge" (p. 289). This led to beliefs that the teacher should control the classroom environment, and knowledge must be transmitted from teacher to student.

Teachers who held these beliefs were less likely to promote environments where students felt safe to take risks and did not encourage student autonomy. Teachers with these "traditional" beliefs also placed a greater emphasis on performance outcomes. As a result, students with lower teacher expectations within this study tended towards detrimental self-perceptions, resulting in achievement gaps. Madon et al. (2001) found that mathematics teachers' beliefs impacted expectations, which had a subsequent impact on students' self-perceptions. Likewise, Rubie-Davies and Peterson (2010) showed that teachers with high expectations for their students typically had pedagogical beliefs that were more positive regarding assessments, class climate, and teacher-student relationships when compared to low-expectation teachers. As a result, Rubie-Davies et al. (2018) argued that "teacher beliefs moderate teacher expectation effects" (p. 235). When teachers believe that mathematics is not simply fixed, static knowledge, but a malleable way of thinking and believe that students can make significant learning gains and achieve highly, their expectation effects are more positive. Essentially, teachers' beliefs and pedagogical practices lead to different outcomes, reinforcing their beliefs and leading to high or low expectations (Rubie-Davies et al., 2018).

Teacher bias is another factor that has been found to affect teachers' expectations significantly. Babad (2009) researched teachers and their expectations and found that teachers fell under two labels: bias and no-bias. Bias here could be described as having inaccurately low expectations of a particular group of students (Rubie-Davies et al., 2018). Those falling into the first category were typically more easily influenced by false information about their students, were more rigid and authoritative, and tended to stereotype students. Teachers in this category tended to differentiate treatment based on their expectations both in learning and emotional support. On the other hand, no-bias teachers tended to provide learning support for students having difficulty rather than by expectation. Early research by Archer and McCarthy (1988) examined biases held by teachers regarding assessment and found that students' gender, physical attractiveness and teachers' prior knowledge of a student all played a part in teacher expectations. Like many other researchers, Gershenson and Papageorge (2018) also observed racial bias among teachers and found that it influences their expectations. Gender bias is a particular problem for teachers in mathematics, with parents and teachers tending to stereotype mathematics as a male domain (Pesu et al., 2016, p. 64). Furthermore, Rubie-Davies et al. (2018) argued that "students' prior achievement information is not necessarily an indication of students' futures" (p. 237) as gains in learning can be accelerated and conversely delayed and warn against teachers setting expectations based solely on prior achievement. This would suggest that teachers and policymakers put in interventions to reduce disparities in expectations, which may reduce gaps in particular student group outcomes.

How teachers differentiate instruction has been shown to impact expectations. Weinstein (2002) conducted similar studies to Babad's (2009) bias study and divided teachers into either a high or low differentiating group. Low differentiating teachers tended to treat all students similarly, differentiating based on learning needs, and this differentiation was not apparent to the classroom. On the other hand, high differentiating teachers tended to discriminate how they treated students based on expectations. As a result, expectancy effects were more evident in high differentiation classrooms (14% variance) and were barely recognisable in low differentiation classrooms (3% variance) (Timmermans & Rubie-Davies, 2018, p. 244). According to Timmermans and Rubie-Davies (2018), these two types of teachers differ significantly in bias and beliefs. High differentiating teachers tended to place students into fixed ability groupings with little room to move when student performance changed, discouraged student interactions and lent towards negative, reactive behaviour management strategies and extrinsic rewards. On the other hand, low differentiating teachers differentiated through interest-based, mixed-ability groupings, peer support and cooperation and were inclined to use positive, preventative behaviour management strategies and intrinsic rewards (p. 244). Low differentiating teachers were also more likely to alter their expectations (Rubie-Davies et al., 2018). This was supported by McKown and Weinstein (2008) who concluded that all students benefit when they are in classes with low-differentiating teachers.

Notably, these studies do not discourage differentiation in the classroom. Instead, they encourage differentiation based on a growth mindset. Fixed ability groupings, little to no student collaboration and reactive behaviour management are typically based on preconceived expectations and do not prove effective differentiation tools. They are likely to make the teacher's expectations salient. Rather, differentiation should consist of flexible groupings, collaboration and preventative behaviour management that targets students' learning needs.

Apart from the various intrinsic factors that influence teaching practice and the expectations that teachers set, many extrinsic contextual factors influence a teacher's expectations and, as a result, impact students' social and academic achievement. While the local context, school environment, and students' parents/family are extrinsic factors closer to the teacher, the demographic makeup of a specific classroom and curriculum are overarching extrinsic factors that also influence teachers' expectations.

Relationships as an Influential Factor on Teacher Expectations

Research shows a child's relationship with their teacher plays "a critical and central role in motivating and engaging students to learn" (Wentzel, 2012, p. 19). Furthermore, much of the research into teacher expectations show a clear correlation between teachers' expectations and academic achievement and shows a correlation between teachers' expectations and the teacher-student relationship (S. Wang et al., 2018). In some cases, it has been suggested that the teacher-student relationship impacts the effectiveness of the influence of expectations (Wentzel, 2012). One person's expectations or predictions about another individual are a significant factor in determining another person's behaviour and, in turn, the relationship between the two (Rosenthal & Jacobson, 1968). More recently, studies have found that teacher behaviour is influenced by their expectations. Teachers often provide more learning opportunities and praise for high expectation students and ignore and more frequently criticise low expectation students (Rubie-Davies, 2014; Rubie-Davies & Peterson, 2010). Similarly, students with high expectations placed upon them often received more emotional support than those students who had lower teacher expectations, despite teachers reporting the opposite (Rubie-Davies et al., 2015). Rubie-Davies and Peterson (2010) indicated that teachers are generally more supportive of high expectation students, engaging with them more constructively, developing warmer teacher-student relationships and managing student behaviour more positively when compared to low expectation students. Further, students, from an early age, can determine whether teachers have high or low expectations of them (Peterson et al., 2016), which in turn impacts the teacher-student relationship. In some ways, this teacher-student relationship is influenced by the social skills and personality of the student. If the student has good social skills, they tend to relate more to the teacher, which typically results in a good personal relationship with the student. This relationship can cause teachers to overestimate students' achievements, set higher expectations and assign students' grades above what they deserve (Rubie-Davies, 2014, p.31). A similar effect occurs when the teacher and student come from similar backgrounds.

Teacher expectations are not the only expectations that influence student achievement, nor is the teacher-student relationship the only relationship that affects teacher expectations. Research on teacher expectations also discussed the often overlooked impact of parental and familial expectations, beliefs, and biases and the significant role they play in influencing achievement (Pesu et al., 2016). Parental/familial expectations are likely to affect both student achievement and teacher expectations. Expectations also encompass the expectations of the parents/families of students in a classroom, families of teachers and teachers' expectations of their students' parents. A study conducted by Pesu et al. (2016) found that, although the effect size was small, parents' expectations influenced their children's achievement, particularly in the first few years of schooling. Often, objective feedback such as school grades informed parents' expectations and perceptions of their child's abilities. Weinstein (2002) argued that parents' expectations resulted in students achieving far above the expectations of school and society. Weinstein (2002) further posited that the expectations of parents have a reciprocal relationship with the expectations of teachers. This occurs when the "professional" dictates what the child is likely to achieve, influencing the parents' expectations. The parent, whether directly or indirectly, passes that expectation on to their child, which informs the teacher's expectations, completing a cycle of expectations. Rubie-Davies (2014) argued that parents' aspirations for their children form one of the key influences of teachers' biased expectations. Additionally, the characteristics of a teacher, such as beliefs and attitudes, are influenced by parental and familial support and attitudes which go on to influence teacher expectations (Rubie-Davies, 2014).

Each of the factors mentioned have a significant effect on teacher expectations, and in many cases, teacher expectations have a subsequent impact themselves. Fulfilled expectations often reinforce teacher beliefs, bias, differentiation and teaching approach. Despite this, the effect of the depth and quality of teachers' discipline knowledge on expectations is not significantly explored in literature.

Topics Requiring Further Research

Teaching mathematics meaningfully and effectively is a challenging task. The research reviewed in this chapter clearly shows numerous factors, both internal and external, that affect teachers' knowledge and expectations. Research into teacher attitudes, beliefs, self-efficacy, and knowledge present as well researched and supported with numerous studies. Likewise, there is extensive and growing research examining teacher expectations. In this section, research topics in this literature that require further research regarding the quality of mathematical knowledge and the various factors impacting teacher expectations are noted and recommendations made for future research.

The following statements encompass the five recommendation topic areas that require further research with the aim of improving teacher education:

- Teachers need greater knowledge capacity or stronger knowledge sensibility to improve their teaching practice
- Teachers need to possess a particular type of teacher knowledge or greater knowledge quality to produce greater student achievement
- Social factors external to the teacher influence teacher knowledge and teacher expectations
- The concept of fractions is considered fundamental for understanding higher-level mathematics, but it is widely misunderstood by students and teachers
- Teacher characteristics, like student characteristics, have a significant impact on teacher expectations for students

This review found literature dealing with teacher knowledge stemming from influential researchers like Shulman (1986) and Skemp (1978); research which was further expounded upon by recent studies on the importance of teacher knowledge. Subsequently, research on teacher knowledge and its various complexities appeared well established. Additionally, an alternative argument that surfaced was Askew's (2008) recommendation for teacher "sensibility", arguing that instead of expecting teachers to enter the profession with a thorough knowledge of every discipline they teach, teachers should instead be encouraged to have a basic knowledge that can expand as, and when it needs to. This recommendation proposed that less expectation be placed on teachers' content knowledge and more on their pedagogy, however, a counter argument could be made that less content knowledge impinges on a teacher's ability to facilitate deep, conceptual knowledge. Askew's (2008) recommendation compared to its counterargument needs to be studied if it is to be applied to guide current teacher education programs and teacher practice.

The type versus quality debate regarding conceptual and procedural mathematical knowledge appeared inconclusive in this review. Though numerous studies have been conducted in these areas (D. Ball et al., 2008; Bobis et al., 2012; Star & Stylianides, 2013), a single unanimous direction was not identified as to what types of teacher knowledge are more important than others, whether PCK, MCK, conceptual knowledge or procedural knowledge. Also, there was no consensus as to the necessary quality of these forms of knowledge for teachers to teach effectively. Though much of this research recommended a form of knowledge over another or a balance of knowledge types, how this should be translated into practice was not seen in the literature. Further research should examine whether one form of deep knowledge or a balance of deep conceptual and procedural knowledge results in greater academic achievement among students and what this would look like when teaching.

Among the literature reviewed, the impacts of social determinants on teachers and teaching practice generally seemed to centre on Science, Technology, Engineering and Mathematics [STEM] education. Research into what external factors influence teachers, specifically regarding knowledge and expectations within a mathematics context, would be beneficial. This review found that research on the impact of social determinants on teacher expectations, although present, was limited, particularly concerning the influence of local community, family influence, curriculum and standardised assessment such as NAPLAN. These and the influence of the media on classroom expectations could be further investigated. This review recognised that, though there was research on the effect of standardised assessment on teaching practice, further research could be done into how curriculum impacts teaching practice and how teachers interpret curriculum to inform their mathematics teaching and expectations in the context of Australian primary classrooms.

Fractions is an area of mathematics where misconceptions abound among teachers and students (Behr et al., 1983; Bobis, 2011; Getenet & Callingham, 2021; Harvey, 2012; Lamon, 2007; Siemon et al., 2015). Although studies have suggested various models and subconstructs for understanding fractions, how these explicitly translate to effective classroom practice is not clear in the literature. Given the foundational importance of teaching fractions for higher-level mathematics, teaching practice would greatly benefit from increased study into direct guidance for teaching fractions more effectively at a classroom level.

It is worth noting that “teacher expectancy effects are not seen in every classroom” but are highly dependent on context (Bohlmann & Weinstein, 2013, p. 295). Despite this, when they are observed, expectations have a significant impact on achievement. Much of the current expectations literature in education provided evidence for how students’ characteristics impact teacher expectations, further impacting student achievement. A gap appeared linking teacher characteristics, particularly of knowledge, beliefs, and biases, with teacher expectations. Although this study will examine the latter of these gaps, educational and sociological research would benefit from further research into all these areas. It will enable various educational stakeholders to improve policy, practice and contribute to the approach teachers take to teaching mathematics.

Why It Matters

In this final section, conclusions are made about the significance of this research on both teacher knowledge and expectations. Attention is drawn to how teacher knowledge and expectations influence teaching style and teacher behaviour resulting in a self-fulfilling prophecy effect, particularly in primary mathematics classrooms. These conclusions justify the study proposed in the next chapter.

A factor that is significantly impacted by teacher knowledge is the style of teaching practised in the classroom. In educational literature, evidence exists to suggest that teaching style plays a substantial part in students' learning by influencing student achievement and attitudes towards learning (Dever & Karabenick, 2011; Mosston & Ashworth, 2008; Ngware et al., 2014; Opdenakkera & Van Damme, 2006). Mosston & Ashworth (2008) introduced a model of teaching styles, originally for teaching physical education, that they titled the Spectrum of Teaching Styles. According to this model, eleven styles are divided into two thinking capacities: the capacity to reproduce known information and the capacity to produce new knowledge (Mosston & Ashworth, 2008, p. 16). Dever and Karabenick (2011) presented a somewhat simpler teaching style model based on studies into parenting styles (Baumrind, 1971). As seen in Figure 2.6, this model states that there are only four teaching styles: authoritative, authoritarian, permissive and neglectful. According to Dever and Karabenick (2011), these teaching styles can be used as models to predict student achievement and describe teaching events.

Figure 2.6
Model of Teaching Styles, by Dever & Karabenick (2011, p. 131-132)

	CARE	
DEMAND	Authoritative – High Care & High Demand	Permissive – High Care & Low Demand
	Authoritarian – Low Care & High Demand	Neglectful – Low Care & Low Demand

Numerous studies reported direct correlations between teaching style and variance in classroom practice (Dever & Karabenick, 2011; Ngware et al., 2014; Opdenakkera & Van Damme, 2006). In Dever and Karabenick's (2011) study conducted in almost 200 middle and high school mathematics classrooms in the US, teaching style influenced students' interest and achievement gains in mathematics. Likewise, a study of 132 mathematics classes in Belgium found that teachers who employed a learner-centred teaching approach had better relationships with their students, reported greater student interest and saw higher mathematics achievement than teachers who employed a content-centred teaching approach (Opdenakkera & Van Damme, 2006). As a result, teaching style is essential to meaningful learning because it cultivates interest in mathematics and facilitates more robust relationships between the teacher and student.

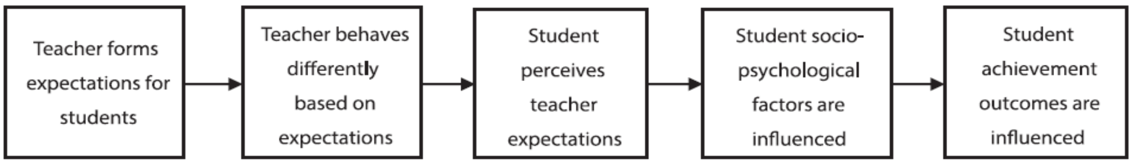
Teacher behaviours, which are like teaching style in many respects, are influenced by, and influence, teacher expectations. Teaching behaviours are often the product of teachers' expectations but they in turn influence expectations. Expectations usually become noticeable through the teacher's behaviours, both verbal and non-verbal, resulting in greater expectancy effects. Brophy (1985) found that teachers who had high expectations for particular students "paid more attention to [them]…, waited longer for them to respond to questions, smiled at them more, and praised them more" than they did with low expectation students (as cited in Rubie-Davies, 2015). In Harris and Rosenthal's (1985) study, teachers created a warmer classroom climate for students for whom they had high expectations. Teachers typically taught high expectation students more concepts at a greater difficulty and faster pace than students for whom the teachers had low expectations. Ultimately, this means that low expectation students learn less because they are taught less.

Weinstein (2002) argued that students learn about teachers' expectations through six areas of instruction: ability grouping, learning experiences, evaluation, motivational strategies, teacher versus student control over instruction, and relationships. All these areas of instruction are said to influence the classroom environment in different ways. For example, when teachers group students according to perceived or expected ability, students are more likely to notice the high or low expectations their teacher has for them and, as a result, achieve poorly. This result, in turn, impacts the teacher's future expectations and grouping. Timmermans and Rubie-Davies (2018) also argued that student progress is constrained where expectations were portrayed "through a more structured class environment, where the focus [was] on performance, and [where] learning activities [were] sharply differentiated" (p. 258). Alternatively, in a classroom where a teacher promotes student autonomy, provides leadership opportunities to all students, and encourages students to take control of their learning, the teacher's expectations, whether good or bad, are less noticeable and, therefore, do not have as much an impact on expectancy effects.

Teacher expectations are essential as they can disadvantage students. The “soft bigotry of low expectations” (Washington Post, 2000), initially coined by US President Bush regarding racial and socioeconomic discrimination, has been used in expectations literature to refer to disadvantage caused by low teacher expectations and is often communicated through the teaching style or behaviour displayed by the teacher due to their expectations. As indicated by Figure 2.7, when teachers have low, negative expectations for students, they are likely to interact with their students in ways that result in poorer performance, and their expectations are more likely to become realised (S. Wang et al., 2018). This is the self-fulfilling prophecy effect. This effect also works oppositely, meaning that teachers with high, positive expectations of students often reflect greater student performance (Rubie-Davies et al., 2015).

Figure 2.7

Flow Chart of the Mediation Mechanism of Teacher Expectation Effects (S. Wang et al., 2018)



In mathematics teaching, Rubie-Davies et al. (2015) showed that a self-fulfilling prophecy occurred when teachers’ expectations over- or under-estimate achievement. In their study, 90 teacher participants were divided into two groups, with the experimental group randomly assigned to a teacher expectation intervention program. The participants attended professional development workshops, implemented the practices from the workshops in class, self-analysed video data of their teaching practice and participated in follow up meetings with the researchers. Participants in the control group were not required to do any of these. Although students of both the control group and the experimental group improved over the year-long study, the students of the experimental group of teachers performed better (Rubie-Davies et al., 2015, p. 80). Likewise, Jamil et al.’s (2018) longitudinal study examined the impact of teacher expectations on students’ achievement in mathematics over the first nine years of students’ schooling. This study found that teacher expectations could predict student achievement two to three years into the future in the early years, and these effects grew substantially for students as they matured, particularly for students typically stigmatised in the mathematics classroom (p. 83). Students whose teachers’ expectations underestimated their performance made smaller gains in achievement when compared to students who had been overestimated (p.

74). As a result, teachers' expectations have been found to affect short-term achievement and have a long-term effect that students carry into future academic experiences.

Teacher knowledge was chosen as a primary focus of this study due to its role in shaping teaching practice and influencing student learning. It is also due to the significant influence of teacher expectations on student achievement outlined in this chapter supporting why teacher expectations were chosen as a focus for this study. Though widely researched as separate factors influencing teaching practice and student learning, these two factors have not been clearly addressed as affecting each other. Further, mathematics was frequently mentioned in the literature as an area where teacher knowledge and teacher expectations have a significant influence. Within mathematics, the concept of fractions is commonly addressed as a concept where teachers and students lack fundamental knowledge and where misconceptions and mathematics anxiety are common despite the critical role fractions play in scaffolding higher mathematics understanding. As a result, the following chapter proposed a study examining these complex factors among a small group of primary teachers in varying school contexts.

This chapter summarised current literature relevant to teacher knowledge and teacher expectations in the education context. The next chapter—Chapter 3 Research Methodology—outlines and examines the study's proposed methodology and research methods, outlining the participants, study tools, validity, reliability, and the method by which data were analysed. A clear rationale for these is provided based on the complexity of studying teacher knowledge and teacher expectations outside of the classroom environment.

3. Research Methodology

This chapter provides an overview of and justifies the interpretive research methodology used in this study. The methodology outlined in this study was designed to understand better the association between teachers' knowledge and the expectations[2] they hold for their students in primary mathematics classrooms. It was tailored to explore primary teachers' mathematical content knowledge of fractions to identify how this knowledge was associated with teachers' expectations for student achievement when learning fractions. The structure of this chapter is divided into three sections each of which follows the process of description then an explanation of why—a justification. Firstly, the methodology of the study is discussed as a foundation for the study design. Secondly, the data collection in this study is outlined incorporating an explanation of the population sample, sampling method and instruments used, the data analysis approach and the snapshot form of interpretive enquiry utilised. Finally, the reliability, validity and ethics of this study are addressed.

Methodology

Since research is driven primarily by its purpose (Cohen et al., 2018), this overview of methodologies begins by restating the questions that drive this research project, namely:

1. *How are fractions understood and represented by primary teachers in this study?*
2. *What type of knowledge is prioritised by primary teachers when teaching fractions and what justifications do they have for this?*
3. *How, if at all, are expectations of what teachers want their students to achieve influenced by teachers' knowledge?*

The questions at the centre of this research required evidence that indicated both teachers' knowledge and understandings, and how these understandings influence

[2] In the literature, the influence of teacher expectations has been referred to using many terms (Babad, 1982; Brophy & Good, 1970; Gentrup et al., 2020; Hornstra et al., 2018; Rosenthal & Jacobson, 1968; Rubie-Davies, 2014). It is important to specify the language used in this study and its intended meaning to avoid confusing or contradictory statements. In this study, expectancy implies "the state of teacher thinking" broadly while expectation(s) implies "the specific content of that thinking" (Murdock-Perriera & Sedlacek, 2018, p. 694). In other words, a teacher's expectancy in mathematics might be high (e.g., I expect all my students to achieve above standard by the end of the year), but their specific expectations may be low (e.g., none of my students will be able to understand how to add fractions. Subsequently, this study will employ the term "expectation(s)" when referring to the nature of teachers' specific expectations in this study and will only use the term "expectancy" when referring to the broader state of teacher thinking.

expectations of students' outcomes. This purpose was complex due to the unique complexities of both teacher knowledge and teacher expectations. The complexities were clarified by drawing on research paradigms to organise the research plan (Cohen et al., 2018, p. 9). There are several competing views through which teacher knowledge and teacher expectations could be examined. Literature in these areas indicated some studies investigating teacher expectations that approached these topics with a scientific positivist lens. These studies present teacher knowledge and expectations similarly to the natural sciences, and therefore, can be determined and regulated by universal laws of individual and social behaviour (Peterson et al., 2016; Timmermans et al., 2015). Other studies approached these topics with an interpretive lens, seeking to explain, but emphasising how individuals differ from each other and natural phenomenon (Chan et al., 2018; Cross Francis, 2015). As a result, the complexities of researching teacher knowledge and expectations will be briefly reviewed here, along with the positivist and interpretive paradigms typically used to examine teacher knowledge and expectations. This section will then justify the interpretive approach used in this study design.

According to Y. Wang (2020), the positivist paradigm situates the researcher as an objective observer of participants' behaviours. Positivism encapsulates knowledge as being "based on sensory experience and can only be advanced by means of observation and experiment" (Cohen et al., 2018, p.10). Scientific method is used first to observe behaviour and formulate a generalisable law or rule that explains that behaviour. This often utilises a controlled, measurable, and predictable approach to research design and often generates large scale quantitative data adhering to normative laws and rules of behaviour (p. 51). Positivistic research places strong credence on observed phenomena and empirical evidence (Hammersley, 2013) and situates "the social scientist is an observer of social reality" (Cohen et al., 2018, p.10). This paradigm provides an objective perspective of the subject matter being studied which is less effective in the study of human behaviour, particularly in classrooms. Teachers are human beings with agency, individuality, and moral responsibility. They construct theories about themselves, their students and act on those theories. Positivism fails to fully capture the individuality of each teacher, their unique knowledge and expectations. An often restricted, simplified and controlled approach to these individual variables generates findings of little practical value to the teachers for whom they are intended (Cohen et al., 2018).

An interpretive paradigm has a greater capacity to gain insight into aspects of an individual's understanding and experience than more normative approaches. The interpretive process is more concerned with finding meaning, purpose and understanding the individual (Cohen et al., 2018). Individuals make sense of the world on their own terms based on contexts and attempts to "investigate the interpretations of the situation made by the participants themselves, to understand their attitudes, behaviours and interactions" (p. 20). This anti-positivist paradigm rejects the central principles of positivism and addresses the intention behind the individual's behaviour and endeavours to understand the world through the eyes of the participant (Hammersley, 2013). Applying Rubie-Davies's (2014) suggestions, teacher expectation research would address the unique contextual contributors to teacher expectation effects, including "instructional and psychosocial environments of individual classrooms" (p. 13). Likewise, given that teacher knowledge, like teacher expectations, is influenced by the teacher's beliefs, attitudes, and self-efficacy (S. Ball, 2015; Bobis et al., 2012; Chan et al., 2018; Cross Francis, 2015; Dever & Karabenick, 2011; Hurst, 2017; Jong & Hodges, 2015; McCampbell, 2015), studies that investigate teacher knowledge require a similar focus on the individuality of the teacher and classroom.

The extent, quality and types of knowledge (D. Ball et al., 2008) required by teachers to teach effectively is debated in the literature. It is noted that various intrinsic and extrinsic factors influence teacher knowledge and further contribute to the complexity of a teacher's knowledge. Consequently, teacher knowledge is often examined by both quantitative and qualitative means and through both positivist and interpretive paradigms. Some studies aim to quantify the types and depth of teacher knowledge using positivist methods such as knowledge assessments, surveys and experiments, viewing teacher knowledge as something to be observed and quantified (e.g., Liu & Bonner, 2016; Wilkins, 2008). Other studies examine teacher perspectives with interpretive research tools such as classroom observations, interviews and teacher accounts in light of teacher knowledge's complex, personal nature (e.g., Chan et al., 2018; Cross Francis, 2015; Hammersley, 2017). It is a combination of tools from both approaches that constitute studies into teacher knowledge, initially quantifying *what* knowledge teachers might have, then moving towards *why* certain types of knowledge are prioritised and *how* they impact learning (Bobis et al., 2012). This study maintained a similar focus in that it not only asked what knowledge teachers have but questioned why they have this knowledge and how this knowledge may have influenced their expectations. Teachers who have agency, individuality and moral responsibility, construct and act on theories about themselves and their students. They prioritise knowledge, however why they prioritise forms of knowledge, and how this knowledge interacts with their expectations is unique to each teacher. This makes a positivistic lens inappropriate in this context. For this reason, this study employs a qualitative research design.

Teacher expectations, unlike teacher knowledge, are often examined through positivist, experiment-based paradigms. The field of expectations research began by Rosenthal in response to the hypothesis that experimenters could influence their subjects to obtain the results they were expecting (Rubie-Davies, 2014). This led to the foundational study into teacher expectations from Rosenthal and Jacobson (1968) in an experimental design study where teachers were given false information about students. The effect of this information on students' IQ was monitored, ultimately concluding that positive expectations had a positive impact on student achievement. This approach was used due to the observable nature of expectation effects, but Rubie-Davies (2014) criticised this positivist approach, indicating that only positive expectations can be manipulated in an experimental study and, as such, assumptions cannot be made as to the effect of negative expectations. Rubie-Davies (2014) argued that experimental controls are challenging to manage in a classroom setting. Conducting the experiment in a laboratory setting to mitigate this challenge would not apply to "real" classroom situations. In response to this, some researchers have employed more naturalistic approaches, observing teacher expectations in a typical classroom environment. This allowed "evidence of both negative and positive interactions and effects on student performance to be systematically recorded and described" (Rubie-Davies, 2014, p. 13). When Rubie-Davies's (2014) and S. Wang et al.'s (2018) reviews of expectations literature are considered with subsequent literature reviews of teacher expectation research, qualitative approaches appear less frequently than quantitative approaches in the teacher expectations literature, creating a research gap. A qualitative approach to teacher expectation research is further justified by research where teacher expectations are influenced by each individual teacher's attitudes, beliefs, and circumstances (Babad, 2009; S. Wang et al., 2018; Weinstein, 2002). Therefore, the influence of, and influences on, teacher expectations lend themselves toward a qualitative methodology rather than an experimental quantitative approach.

Design

This study was concerned with the individual teacher. It asked about the knowledge and expectations of teachers and sought to understand the unique contexts of each participant. Given the examination of the influence of teacher knowledge on teacher expectations, the goals differed considerably from other teacher expectation studies, which investigated the effect of teacher expectations or teacher knowledge on student achievement. The interpretive paradigm, which attempts to understand the subjectivity of the individual's experiences, was applied to this study to address teacher knowledge and teacher expectations in an individual case-by-case manner.

This study is not alone in its methodological approach. Other studies have employed similar interpretive methods to gain insight into teachers' conceptual and procedural knowledge and understanding with some success (Gunstone et al., 2009; Mulhall & Gunstone, 2008). Gunstone et al. examined eight high school science teachers' knowledge of the concept of direct current electricity. This concept was chosen as it was "seen as a central area of physics/science curricula at all levels of education" where teachers and students often hold misconceptions leading to difficulties in explicit teaching and learning (Gunstone et al., 2009, p. 516). In that study, teachers were interviewed to assess their understandings and examine their perceptions of direct current electricity. The focus and justification provided a mirror to this study's intended knowledge focus, where primary teachers' understanding of fractions as a concept is argued to be foundational yet misunderstood and difficult to learn and teach. For these reasons, the design within this study employed similar methods to the Gunstone et al. (2009) study and utilised a similar interview structure and questions to those designed for the Gunstone et al. study.

Participants

The participants in this study were practising primary teachers with a range of experience teaching primary mathematics. Primary teachers teach students between five to twelve years of age. Convenience sampling (Cohen et al., 2018; Miles & Huberman, 1994) was initially used to select questionnaire respondents through an online questionnaire. The details of the study were distributed via printed cards containing a link and QR code to the online questionnaire. These cards were distributed to primary teachers at a primary mathematics teaching conference in Victoria, Australia in June 2019. The respondents of the research were recruited voluntarily.

Within the online questionnaire, respondents were asked to participate in a semi-structured interview in a second stage of the research. While teachers at the conference showed interest in the study, this convenience sampling failed to produce respondents willing to participate in the online semi-structured questionnaire nor a semi-structured interview on their knowledge and expectations regarding teaching fractions. Subsequently, snowball sampling (Atkinson & Flint, 2004; Parker et al., 2019) was utilised to recruit respondents and participants for both the online questionnaire and semi-structured interview. Sampling involved the researcher approaching individuals interested in the content of the study (school principals, university lecturers, colleagues, etc.) to recruit potential participants who may be interested in participating. At the conclusion of the online questionnaire data collection and interview recruitment stage, 34 primary teachers participated in the online semi-structured questionnaire, and six of these agreed to participate further in a semi-structured interview. Demographic details of these participants are included in the table below. Pseudonyms have been allocated to each to maintain anonymity:

Table 3.1
Interview Participants' Demographic Details.

Interview Participant	Participant Details
Damon	• 2 years teaching experience. • Independent Denominational P-12 school in rural area. • Worked in mining, truck driving, building and hospitality prior to teaching.
Eric	• 3 years teaching experience. • Single sex independent school in metropolitan Melbourne. • Experience in daily organiser role • Worked as an electrician prior to teaching.
Annie	• 3 years teaching experience. • P-6 Denominational Independent school in suburban Melbourne. • 2 years teaching experience in relief teaching role. • 1st career teacher.
Cathy	• 8 years teaching experience. • P-6 Government school in outskirts of Melbourne. • Completing post graduate qualification. • 1st career teacher.
Terry	• 9 years teaching experience. • P-6 Government school in rural area. • Previous experience teaching in Government and Independent education in urban and rural areas. • Grade Leader • Worked as a charity worker prior to teaching.
Penny	• 11 years teaching experience. • P-12 Special school in suburban Melbourne. • Experience working as an assistant principal. • Worked in commerce prior to teaching.

It is essential to acknowledge that the sampling used in this study was voluntary and respondents chose the extent to which they participated. This sampling limited the purposeful selection of participants for the semi-structured interviews and subsequently limited the generalisability of the sample. It is recognised that, given the study's focus on mathematics participation, it is likely that many respondents who participated in the questionnaire did so due to being, at the very least, comfortable teaching mathematics and therefore comfortable participating in a mathematics study. This sampling may not represent the general population of teachers given very few respondents indicated a strong dislike or anxiety regarding mathematics. Rather, most respondents indicated value in the teaching of mathematics. Among the participants who undertook the interview, three of the six participants stated they were confident in and enjoyed mathematics, a further two said they had grown to understand and appreciate mathematics since studying to teach it and only one stated a negative attitude towards mathematics. This sampling, albeit limited in generalisability to represent all primary teachers, suggests that more confident teachers are more likely to participate in a mathematics study voluntarily.

Data Collection

This research aimed to capture qualitative data regarding the knowledge and expectations of individual teachers within their respective contexts. In this section, the data collection instruments of semi-structured questionnaires and interviews will be explained and justified within the context of similar interpretive and qualitative study designs.

The data produced from this study are mainly qualitative. A small amount of quantitative data were collected pre-interview to identify respondents' contexts. This research design utilised a semi-structured questionnaire carried out online via Qualtrics (see Appendix A), followed by a semi-structured interview (see Appendix B). Many expectations studies compare questionnaire data with students' achievement data; however the studies referenced in this section examined the effect of teachers' expectations on students' achievement as they interact with mathematics. This study did not compare teacher data with student achievement data. Instead, this study analysed the impact of teacher content knowledge *on teacher* expectations rather than the effect of the teacher's knowledge or expectations *on students*. As a result, this section will employ and review research design elements of other studies, namely the questionnaire and semi-structured interview, in the field of teacher expectations and teacher knowledge. This section will then justify using these study tools in the unique, teacher-facing context of this study.

Semi-structured Questionnaire

The use of questionnaire-based surveys in education research is well documented in studies seeking to measure teachers' expectations in both pre-service and in-service teachers (Liu & Bonner, 2016; Mizala et al., 2015; Peterson et al., 2016; Timmermans et al., 2015; Turner et al., 2015). Liu and Bonner's (2016) study explored pre-service and in-service teachers' mathematical content knowledge and its relationship with teachers' beliefs about learning and teaching using a series of questionnaires. The questionnaires provided the demographic information of the participants, their teaching experience and their level of comfort working with mathematics. Likewise, Turner et al.'s (2015) study examined the expectations of 15 secondary mathematics teachers to ascertain whether students' ethnicity influenced their expectations and how this subsequently impacted students' achievement. Their study employed both questionnaires and semi-structured interviews, collected and analysed student achievement data, and found a series of factors that affected teacher expectations. Peterson et al.'s (2016) and Timmermans et al.'s (2015) studies employed questionnaires to measure teachers' expectations in both primary and secondary school settings. Like Turner et al.'s (2015) study, they used students' achievement data and compared it with the questionnaire responses to ascertain the expectations of the participating teachers and the impact of these expectations.

Cohen et al. (2018) states "the semi-structured questionnaire sets the agenda, but does not presuppose the nature of the response" (p. 475). As a result, the semi-structured questionnaire was used in this study to examine teacher knowledge and teacher expectations in addition to effectively removing the researcher from influencing respondents towards a particular response. According to Cohen et al. (2018), this instrument is convenient and accessible for teachers. It also typically results in higher response rates than other research instruments, particularly when the questionnaire is carefully designed for ease and brevity. The questionnaire used was designed with this in mind containing 18 questions and taking no more than five minutes to complete. It provided quantitative and qualitative first stage data on participating teachers.

The questionnaire in Appendix A was designed for this study for a variety of purposes. The questionnaire was carried out online through Qualtrics with open-ended and rating scale questions making it easily accessible to respondents and allowing for convenient storage of survey responses. Questions were designed to collate general information about respondents, focusing on opinions about what is considered important knowledge for mathematics teaching and whether teachers see themselves as typical primary mathematics teachers. Additionally, these questions were designed in response to specific aspects of the literature, allowing contrasts and comparisons to be made between responses and previous studies (Cohen et al., 2018). The online questionnaire was designed to assess teachers' expectations in a limited capacity, asking teachers to outline how they see their current students achieving in mathematics.

The first section of the questionnaire, Demographic Data (Q. 1-6), was designed to gather data about respondents including their teaching experience and previous occupational experience as some research indicates that coming into teaching from a previous career is a significant variable affecting teacher knowledge (Chambers, 2002). The second section, Knowledge and Expectations, was designed to gain insight into respondents' and participants' perspectives of mathematics broadly, reflecting on both the influences and experiences contributing to their attitudes towards mathematics and rating their perception of difficulty in teaching and learning specific mathematical concepts (Q. 7-12). These questions were included to confirm the findings of other studies that stated fractions was the most challenging concept to learn and teach in primary education (Way & Bobis, 2011). Additional questions specifically targeted towards fractions were not included in the questionnaire to allow for a specific challenging concept, such as fractions, to emerge as a lens through which to examine teacher knowledge and expectations without presuming the nature of responses (Cohen et al., 2018). Teachers were asked to rate the order of importance of various types of knowledge used to teach mathematics effectively (Q. 13). This question was included to gain insight into what forms of knowledge teachers prioritised when they taught (D. Ball et al., 2008; Star & Stylianides, 2013). A further two questions probed teacher expectations:

Q. 14. How do you, as a primary teacher, differentiate students' learning needs when teaching mathematics?

Q. 15. How far do you see your current students achieving in mathematics?

These questions prompted participants to indicate how they differentiate student needs and how far they anticipated their students to achieve. These questions were included because research showed a link between teacher expectations and how they differentiate their students' learning needs (Weinstein, 2002). Additionally, they were included to gain perspective as to whether teachers were high or low differentiating in their practice as this can significantly influence the effect of teacher expectations (Timmermans & Rubie-Davies, 2018). The final question in this section, *Q. 16. How have you grown in your teaching of mathematics since you started as a teacher*, was included to prompt discussion on how experience influences teaching practice. The final section of the questionnaire (Q. 17-18) was designed to determine how participants were recruited and whether they were interested in participating in the next interview research stage.

Semi-structured Interviews

The use of semi-structured interviews was due to both the research designs of similar studies and the rich qualitative data that are obtained from interviews, used to enhance the questionnaire data (Cohen et al., 2018; Hochschild, 2009; Gunstone et al., 2009; Mulhall & Gunstone, 2008). Though semi-structured interviews are a standard research tool within educational research and often used to study teacher knowledge, they are not commonly used to assess teacher expectations (S. Wang et al., 2018). Rubie-Davies (2014) explored the history of research into teacher expectations and recalled how often observation-based, experimental study tools and models, like those used in the Rosenthal and Jacobson (1968) study, are used to examine and measure teacher expectations, despite the limitations that experimental studies have on internal and external validity (p.12). This lacking does not posit that interviews should not be used to examine teacher expectations; rather research into teacher expectations has employed semi-structured interviews with some success, as indicated by Turner et al.'s (2015) study.

Semi-structured interviews are useful as they are structured to address specific elements of the research problem while allowing space for participants to build in new meaning (Galletta, 2013; Mills, 2001; Partington, 2001). Studies such as Gunstone et al. (2009), utilised a semi-structured interview design when researching teachers' knowledge and understanding. Interview designs utilised by Gunstone et al. (2009, p. 533-534) and Turner et al. (2015, p. 61-64) guided the design of the semi-structured interviews for this research project. During the interview, participants created two artefacts. The first was a detailed description of how participants' students would approach a specific fraction question. The second required participants to place their expectations for developing fraction understanding along a continuum from Foundation to Year 6.

The interview schedule was divided into four sections: Introduction, Knowledge, Expectations, and Concluding (Appendix B). The introduction section explained the study and the participants were asked to talk about themselves and their current teaching roles. Through this approach, participants were put at ease at the start of the interview and additional demographic data were provided for the study (Cohen et al., 2018; Patton, 2002).

The Knowledge section closely followed the structure and nature of questions used by Gunstone et al.'s (2009) interview schedule. The similarity was due to the aligned focus of the studies in probing teacher understanding of a specific concept. In Gunstone et al's (2009) case the focus of teacher knowledge was direct current, whereas in this study, the focus was fractions. Initially, a question was asked to create a general discussion about the participant's attitude toward and perceptions about mathematics (i.e., *What are your perceptions of mathematics as an individual?*). This broad question was used to facilitate discussion about the participant's background and experiences with mathematics and investigate how personal perceptions of mathematics may differ from perceptions of teaching mathematics. Then, the participant was explicitly asked about their perceptions of teaching fractions (i.e., *How would you rate the difficulty of teaching fractions?*) followed by a further question addressing whether or not their perception of fractions was consistent with the literature (i.e., *Research shows that fractions is often a concept area that is widely misunderstood by teachers and students. How do you feel about this?*) At the end of this section of the interview, participants completed Artefact 1, stating how they would expect their students to approach the following question:

> *James had a bag of marbles. There were 56 in the bag. He gave away 3/8 of them. How many marbles were left?*

This question was designed to address the participants' understanding of fractions, drawing on the fraction subconstructs of part-whole comparison, quotient, measure, operator, and ratio subconstructs presented by Way and Bobis (2011). The question enabled identification of the approach used by teachers and to some extent revealed their knowledge of fractions and expectations for what understanding was expected from their students.

The third section, Expectations, employed a "funnel" approach to questioning (Matsumoto et al., 2015). It began with a broad question regarding participants expectations for students and how these expectations were set (i.e., *In mathematics, what do you expect from your students, and how do you set those expectations? How do you as a teacher set expectations for your students?*). This included prompting questions surrounding what factors influenced their expectations and clarifying the expectations participants held for their students compared to the expectations they held for their pedagogy (i.e., *How do your expectations for your students differ from your expectations for your teaching? What do you think influences your expectations? What has the greatest influence? How has your own experience of teaching mathematics influence your expectations?*). This broad question led to Artefact 2 of the interview schedule. Participants were asked to create a timeline indicating what fraction concepts could be taught across the primary curriculum. On this timeline, participants plotted when each fraction concept would be taught and how they would introduce each, indicating their specific expectations for students. The approach was used to elicit understandings and experiences from participants that would be difficult to reach through purely linguistic dimensions (Bagnoli, 2009). A timeline was also used as participants were typically familiar with curriculum continuums and would be able to shape their responses accordingly. The development of this artefact shaped the remainder of the interview.

Finally, the Concluding section posed two closing questions. The first (i.e., *Do you see yourself as a "typical" primary teacher?*) probed whether participants viewed themselves as a typical primary teacher, particularly concerning their knowledge of mathematics and their expectations for their students. Gunstone et al. (2009) posed a similar question in their study regarding the perceptions of physics teachers as "typical" in their field or not. This question clarified participants' background, experience and whether they identified as traditional or non-traditional teachers. Insight was provided into how teachers viewed their colleagues in contrast to themselves in terms of normality. The final question (i.e., *Has this interview changed your thinking about teaching mathematics or setting expectations generally in any way? Is there anything you would like to add?*) closed the interview and encouraged the participant to reflect on the discussion. Participants were given an opportunity to contribute any additional thoughts or insights that they believed influenced the discussion. Given Gunstone et al. found that many participants' perceptions of their understanding changed throughout the interview, the final question addressed changes in perception.

Data Analysis

The data collected were designed to be qualitative and supported by the quantitative data produced from the online questionnaire. The quantitative questionnaire data collected by questions 1-8 and 10-12 respectively were organised in Qualtrics into representations that summarised the data collected according to responses then analysed using descriptive statistics. These representations were analysed for relationships between data sources to inform the interview data collected.

As the questionnaires were carried out first, followed by the interviews, the 21 questionnaire responses were analysed first, excluding the six participants' responses. The knowledge prioritisation data retrieved from the questionnaire were represented in two ways. Firstly, data were represented using a stacked column graph, summarising respondents' prioritisation of knowledge types. This summary was used to identify any emerging themes. The excluded interview participant responses were clarified throughout the interview. The data from the interview participants were represented in a radar chart representative of each participant. Each radar chart presented a "fingerprint" of that individual participant's knowledge prioritisations. The "fingerprints" were analysed by comparing them to the respondents' data and the participant's responses throughout the interview.

The remaining qualitative questions from the questionnaire (Appendix A: Questions 7-9, 14-16) and the interview data (Appendix B) required categories for analysis. A thematic content analysis approach similar to what both Gunstone et al. (2009) and Turner et al. (2015) employed, was used, which sorted the qualitative data from the questionnaire and interviews into themes which were reviewed and summarised. In the Gunstone et al. (2009) study, participant results were sorted as different "views" or "understandings" then broadly grouped while frequently referring to transcript excerpts for findings. Likewise, in the Turner et al. (2015) study, results were categorised according to varying teacher "beliefs" and grouped according to similarity. This study utilised the same approach where respondent and participant responses were sorted into categories for teachers' "understandings" and "beliefs." Inferences were made, and potential explanations for the interview responses were posited (Cohen et al., 2018).

For reliability within the data analysis, data were categorised according to the themes of the interview structure and according to participant responses. The categories were: the participant background, attitudes towards mathematics, expectations, perceived influences on expectations, responses to Artefact 1 (Appendix D), responses to Artefact 2 (Appendix E), and finally, knowledge prioritisations. Each theme was discussed in context before drawing conclusions. This study avoided categorising themes using word frequency as frequency of occurrence is not always indicative of significance and can result in decontextualization of words which can be misinterpreted and ambiguous (Cohen et al., 2018; Feng & Behar-Horenstein, 2019; Saldaña, 2021). Other analytical categories were defined after the data were reviewed to allow emergent themes that may not have aligned with the researcher's pre-existing theories or categories presented in the interview schedule.

In both Gunstone et al.'s (2009) and Turner et al.'s (2015) studies, conclusions remained specific to the context and phenomena observed rather than generalising results to the broader population. Likewise, in this study, neither the quantitative data collected in the questionnaire, nor the remaining qualitative data were generalised to represent the wider population. Instead, a final design choice in the analysis of results was to collate the thematic responses of participants into a series of snapshots. This form of interpretive enquiry is defined by Cohen et al. (2018) as the "analyses of particular situations, events or phenomena at a single point in time" (p. 292). In this study, the snapshots described the events of each participant interview according to the themes of the interview questions and artefacts, outlining the participants' context, knowledge, and expectations. These snapshots were then analysed, discussed, compared and contrasted, and conclusions were drawn. This method of interpretive analysis was used the unique and individual contexts of the participants in this study, which are not generalisable to all primary mathematics teachers. Instead, these snapshots provided insight into the knowledge and expectations of each participant their individual contexts and complexities.

Reliability and Validity

This study was intentionally designed to be qualitative; it addressed the complexity of the participants' contexts by seeking to see the problem through the participants' eyes. This created an issue of validity and reliability, which will be briefly discussed here.

Validity is often a concern in qualitative research when employing an interpretive paradigm. "Authenticity" and "understanding" can be used to replace validity in qualitative research (Guba & Lincoln, 1989; Maxwell, 1992;). This study did not aim to generalise the findings to the contexts of all primary teachers but to represent the participants' perspectives in this study in their contexts. The validity of this research project relies on "understanding" through interpretive validity. Validity in this form required the researcher to subjectively interpret and make meaning from the semi-structured interviews and aspects of the semi-structured questionnaire (Cohen et al., 2018). The approach relied on "fidelity", requiring the researcher to, as honestly as possible, report the findings of the study as true to the responses of the participants (Blumenfeld-Jones, 1995). It also required the researcher's view as part of the world being researched. Though this validity issue was to be anticipated in an interpretive paradigm, a way in which validity was maintained in this study was through a clear audit trail of questionnaire responses, audio recordings of interviews and transcripts of interview responses, which are provided in Appendix C. The research findings and interpretations were also compared and contrasted with findings of previous studies and reviewed and evaluated by academic peers throughout the research process.

Reliability was also a concern in this qualitative research. Both online questionnaires and interviews were used, resulting in a subjective interpretation of responses, which led to concerns with reliability. The questionnaire faced a two-fold reliability concern. Firstly, whether responses were honest and "true" or simply "desirable" and secondly, whether respondents understood questions correctly (Cohen et al., 2018, p. 277; Fowler, 2009). Within the interview, potential inaccuracies were more prevalent because of issues of bias and leading questions. To mitigate these reliability concerns, the questionnaire was kept anonymous, encouraging greater honesty and the responses of a portion of the respondents were validated in the semi-structured interview. Additionally, this research used the questionnaire and the interview together with the two artefacts developed in the interview. Data from all tools were compared to identify common responses, detect any contradictions and aid in mitigating reliability concerns. All prompts were indicated in the interview schedule (Appendix A) and these and the questions used in the interview, including the artefacts, were trialled with two peers to develop uniformity wording that reduced issues of inconsistency and reliability.

Ethics

Each of the participants involved with the interview component of this study were full-time teachers working in their respective school communities. This research required teaching professionals to participate in questionnaires and interviews to share their knowledge, expectations, and information about their beliefs. This could have been an inconvenience and possibly an uncomfortable experience for participants. Therefore, it was essential that participants felt as comfortable as possible. Mills (2001) argues, location is considered a variable of the semi-structured interview. The interviews were conducted in local coffee houses of the participant's choosing to ensure a location that they were familiar with and to mitigate concerns of inconvenience and unease. This research design, according to the *National Statement on Ethical Conduct in Human Research* (2018), was considered low risk. This study obtained approval from the La Trobe Human Research Ethics Committee (HREC; Ethics Approval No. HEC19213). Via an online questionnaire, consent forms were provided to respondents and responses were de-identified. Each interview began with a consent form provided to participants and an elaboration of the nature of the study. Interviews were audio-recorded then transcribed. The questionnaire and interview data were separated from participants' contact details and participants were allocated pseudonyms so that anonymity could be maintained.

This chapter proposed a methodology and method for this study with a rationale for these in studying teacher knowledge and teacher expectations. The next chapter—Chapter 4 Study Results—collates the responses of the interview participants and summarises the findings of the study. The responses of participants are collated into brief snapshots. Within each snapshot, participants' responses are broken down into background information; attitudes and beliefs towards mathematics and teaching mathematics; stated expectations for their students; and ideas regarding what factors influence their expectations. A summary of responses for both Artefact 1 and 2 along with questionnaire responses is included.

4. Study Results

This chapter collates the responses of the questionnaire respondents and interview participants involved in this study. The questionnaire responses are summarised and divided into three categories: respondents' attitudes and beliefs towards mathematics, respondents' knowledge of mathematics and teaching mathematics, and respondents' expectations of their students and their teaching. The participant responses for the interviews are then summarised as snapshots in an order of least to most teaching experience. A participant's teaching experience was considered to be a combination of the number of years they had taught, and the diversity of teaching environments experienced. Responses are then addressed according to the background information provided, attitudes and beliefs towards mathematics and teaching mathematics, stated expectations for their students, and ideas regarding what factors influence their expectations. The summary includes each participant's written response to a fractions-related problem and how they would teach this problem (Artefact 1 – Appendix D) and a participant's stated expectations for students when teaching fractions drawn along a continuum from the start of primary through to the end of Year 6 (Artefact 2 – Appendix E). Finally, each participant was required in the online questionnaire to assign varying degrees of importance to the types of knowledge needed in teaching mathematics. Online questionnaire responses were reviewed and compared to each participant's interview responses.

Questionnaire Results

Respondents involved in this study were required to complete an initial questionnaire with questions divided into three headings: beliefs and attitudes towards mathematics, knowledge broadly and in specific regard to mathematics, and expectations for students learning mathematics. Respondents then had the option to opt for a further interview. This section summarises the questionnaire responses of all respondents involved in this study.

Demographic Data

There were 34 respondents who completed some or all of the questionnaire with varying response rates for each question, as seen in Table 4.1.

Table 4.1
Demographic Details of Questionnaire Respondents

Variable	Number of respondents	Percentage (N = 34)
Gender		
Male	10	29%
Female	24	71%
Sector of Employment		
Public	13	38%
Independent	9	26%
Catholic	7	21%
Special School	4	12%
Did not indicate sector	1	3%
Location of Employment		
Melbourne or surrounding suburbs	29	85%
Rural Victoria	3	9%
Did not indicate location	2	6%
Years of Teaching Experience		
More than 5 years teaching	23	67%
Less than 5 years teaching	7	21%
Did not indicate teaching experience	4	12%
Year Level Teaching Experience		
Kindergarten	14	41%
Year 1	19	56%
Year 2	21	62%
Year 3	28	82%
Year 4	23	68%
Year 5	22	65%
Year 6	21	62%
First or Second Career Teaching		
First Career Teacher	22	65%
Second Career Teacher	11	32%
Did not indicate first or second career	1	3%

Of the respondents, 24 were female and 10 were male. This distribution is typical given the average male to female ratio of teachers in Australian schools (Australian Bureau of Statistics, 2020). These teachers were working in sectors including public, independent, Catholic and special school settings, with 13 (38%) coming from public schools, nine (26%) coming from the independent sector, and seven (21%) from Catholic schools. There were four respondents (12%) working in special school settings. One respondent did not indicate his sector of employment (3%). Most teachers surveyed were working and teaching in and around Melbourne suburbs (29 [85%]), and three respondents stated more rural work in Victorian cities (9%). Two respondents did not indicate what region they were teaching in (6%). Most teachers surveyed had over five years of teaching experience (23 [67%]) with some teachers having up to 26 years' experience working as a teacher, while the remaining respondents indicated less than 5 years' experience (7 [21%]) or did not indicate their experience (4 [12%]).

A wide range of experience teaching different year levels was present among the respondents. A slight majority had taught the middle years of primary (Years 3 & 4, 28 and 23 respectively) while slightly fewer respondents had taught the early and later years of primary (Years 1 & 2, 19 and 21 respectively; and Years 5 & 6, 22 and 21 respectively). Fewer surveyed teachers had experience teaching Foundation (14).

Teachers were surveyed about whether they were a first career teacher or if they had worked in an occupation other than teaching. Teaching was their first career for 22 teachers (65%), while the remaining 11 stated that they had worked in at least one other occupation before working as a teacher (32%). One participant did not provide this information (3%). Previous occupations varied from trade work such as hospitality and electrician to business and finance careers.

Attitudes and Beliefs about Mathematics

The attitudes and beliefs teachers held about mathematics showed that teachers' thinking about mathematics was occasionally influenced by parents (2), friends (2), and professional development (3). Most teachers surveyed attributed significant influence to teachers (17) and other work colleagues (20)[3].

When teachers were asked how their own experiences of mathematics impact their teaching practice responses were divided into two types: positive and negative learning experiences. Of the 25 respondents who responded to this question, those who indicated a positive experience (8 [32%]) stated that, as learners, they had a positive attitude towards mathematics, they were confident with it and were passionate about it. These respondents typically noted that this had a positive impact on their teaching with one participant stating "I was always confident when learning mathematics so feel confident teaching it" and another stating "I had positive experiences therefore it comes out in my teaching". They reflected a mathematics positivity when they taught, stated they were confident teaching it, and endeavoured to pass on their passion for mathematics. Respondents who had a negative experience (9 [36%]) in general said that they, as a learner, had a negative attitude towards mathematics, felt nervous and unsure when working mathematically and found mathematics uninteresting. One respondent stated "[my experiences] definitely made me more empathetic and understanding as [I] had a teacher who was really unsupportive and condescending" while another stated, "I always found certain topics in mathematics difficult… therefore, when starting to teach mathematics, I always felt a bit

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[3] Survey respondents were given the opportunity to list multiple influences.

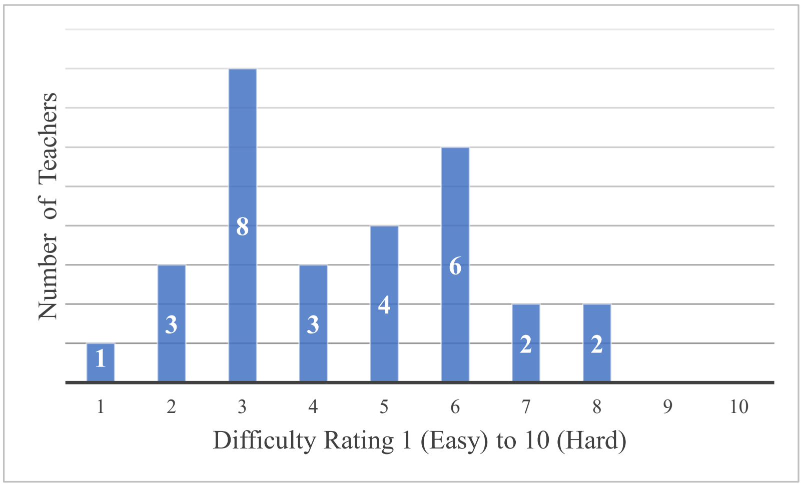
nervous and unsure”. They then endeavoured to make their students’ experience of mathematics counter to their own by making it more interesting and fun. These respondents reflected that they were often able to empathise with students’ misconceptions and simplify their mathematics teaching to make it easier for students to understand. Where teachers felt that they were taught mathematics in a closed or single faceted way, they strove to teach mathematics in many ways. A few respondents (8; 32%) indicated a neutral narrative and stated that they taught mathematics how they learnt it best. One respondent stated, “I learnt mathematics best through rules and procedures, therefore I introduce rules and steps,” while another respondent indicated that mathematics was not understood through algorithms but “needs to be hands-on” and experienced through real-world tasks. Ultimately, all respondents indicated that their experiences with mathematics in the past had a significant impact on the way they taught it, their attitude towards it, their background knowledge, and their need for Professional Development (PD) and resources.

Knowledge

The questionnaire asked respondents to answer several questions about their knowledge broadly and their mathematics knowledge—the first of these questions (Q.7) required respondents to indicate which subjects they found most challenging to teach. Largely the 28 respondents who responded stated mathematics, reading and writing, or science was most challenging. The majority (10 [36%]) noted that mathematics and particularly fractions were the most challenging subjects compared to reading/writing (7 [25%]) and science (4 [14%]). All other subjects noted by teachers as challenging had a less than 10% response rate (Inquiry, Digital Technology – 2 [7%]; Visual Arts, Sex Education, Behaviour Management – 1 [3.6%]).

Respondents were requested to rate the difficulty of teaching mathematics on a scale between one and ten, with one being not difficult at all and ten being extremely difficult as indicated in Figure 4.1 (Q.10). The responses to this question varied, with some teachers assigning relatively low scores (one) and others scoring very high (eight). The average difficulty fell to the middle of the scale at four and a half out of ten.

Figure 4.1
Respondents' Ranking of the Difficulty of Mathematics



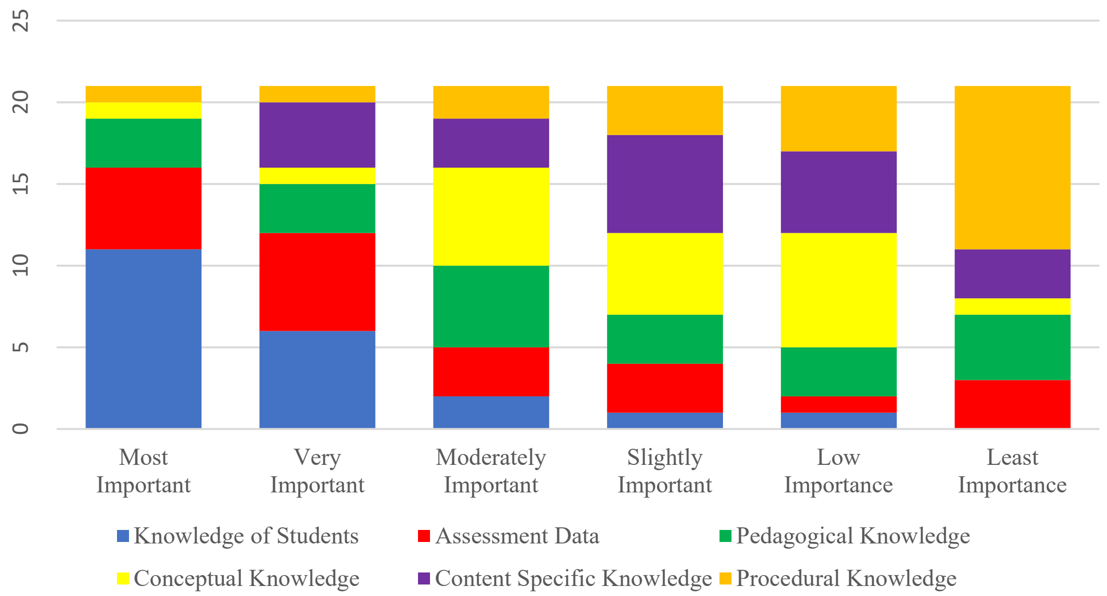
Respondents also indicated a particular mathematics strand from the Australian curriculum that they believed was both most challenging for students to learn (Q.11) and for teachers to teach (Q.12). Among the 28 and 26 responses respectively, fractions and decimals were considered the most difficult to learn and teach (21 & 9 [75% & 35%]). Geometric reasoning was identified as equally challenging to teach (10 [38%]). Shapes (0 [0%]), Chance (2 [7% & 8%]) and Data Representation (2 & 0 [7% & 0%]) were identified as rarely challenging to learn and teach.

When asked to indicate which forms of knowledge were most useful when planning for and teaching mathematics, as shown in Figure 4.2[4], most respondents indicated that knowing their students was the most crucial form of knowledge. Assessment Data was also revealed to be very important for planning and teaching mathematics, with many respondents ranking it as most to moderately important. Pedagogical knowledge, conceptual knowledge and content-specific knowledge were very close in their allocations. On average, respondents assigned the same or similar values to each form of knowledge. Most respondents indicated procedural knowledge was only slightly, low, or of least importance as a form of knowledge for teachers when teaching mathematics.

[4] Note that Figure 4.2 does not include the prioritisations of the interview participants as the respondents merely indicated their prioritisation whereas the interview participants, while completing the same questionnaire, expanded on their prioritisations during the interview. Thus, the interview participants' prioritisations of knowledge are included as knowledge "fingerprints" in each respective snapshot in the Interview Findings section.

Figure 4.2

Surveyed Teacher Respondents' Prioritisations of Knowledge



Teacher respondents indicated they had grown as teachers with increased experience in the teaching field. Respondents stated attributes of increased confidence, greater understanding of the curriculum, increased content knowledge and stronger understanding of how students learn and develop misconceptions. Experience equipped teachers with different strategies to teach the same thing, better understanding of how to make teaching more relevant to students and increasing discovery of what does not work when teaching various concepts. A greater horizon knowledge and awareness of what needs to be taught before a concept and what can be taught after to build understanding was also presented. Further, teachers indicated a greater awareness and appreciation of resources, professional development, collaboration and idea-sharing, and the sequence of learning as they gained experience in the teaching field.

Expectations

The final element of the questionnaire required respondents to answer several questions related to their expectations—the first of these concerned how teachers differentiated their teaching to meet students' needs (Q. 14). The respondents responded in various ways that were broadly divided into two categories of differentiation: resources and strategies. Those under the resources category referred to specific resources that aided in differentiation. For example, they stated that various forms of assessment, continuums, open and teacher-designed tasks, anecdotal notes, personalised plans and data helped inform the differentiation of their teaching. An example of this was provided by one respondent who stated, "use a variety of teaching methods, including technology, hands on games, materials, worksheets and YouTube videos" and other respondents who simply suggested, "open ended tasks" as a means of differentiation. Within the strategies category, reference was made to classroom practices or teaching strategies for differentiation. Teachers commented upon multiple types of strategies. For example, one respondent stated, "work with a focus group, do rotation groups, allow more confident students, when appropriate, to help those who are not confident" and others suggested regular conversations with each student, grouping or streaming students, providing clear learning intentions and success criteria, and guided teaching groups. All these strategies were used to differentiate classroom practice and meet students' varying learning needs.

When the issue of expectations respondents currently had for their students was raised (Q. 15), a few respondents' expectations were long term with tertiary education in view. Most respondents stated expectations for their students to achieve a year's growth in a year or according to their perceived ability stating, "a year's growth in the 12 months span", "at least a year's growth" or simply "at standard. Others said they were unsure what their expectations were or simply that they expected growth of any kind with one respondent suggesting, "I always feel that my students can achieve to the level above where they are – at the very least show improvement on what they currently know". Few teachers indicated low or limited expectations for their students. One respondent stated that students' interest and subsequent growth would drop as they are being "pumped" with content and that "its [mathematics] is not relative to their interests and it is not applicable in the real world." Another teacher said that while there may be growth in her class, it would be limited as students did not have the basics they needed to progress.

Interview Findings

In this section, the findings of the participant interviews are summarised and presented in snapshots in order of the participants' teaching experience beginning with the least teaching experience. The names of participants were changed to a pseudonym to maintain anonymity.

Damon: "everything about maths is discrete…."

Background

Damon (Interview D)[5] is a male teacher (late-20s to mid-30s) at a fast-growing P-12 religious school in a rural Victorian city. He had two years of teaching experience in Years 1, 2, and 3 at the time of the interview. Before teaching, Damon had worked in various other occupations, including mining, truck driving, building and hospitality. He indicated that these work experiences encouraged him to prepare students for the many challenges they may face in life and gave him discernment and a critical eye when new theories and ideas are introduced.

> [6]*I guess I've seen a lot of uni students who've come straight out of school and go into university and I guess that's all they know and whatever their lecturer says, that's probably what they're going to teach and how they're going to teach. I guess I've been around, seen a lot of things, experienced a lot of things, been underestimated by lots of people. Going back into teaching with all of my experiences in mind, thinking "how did I respond to those things and those people and how am I going to make it different for my kids if I can…?"*

Attitudes

Damon's attitude toward mathematics has significantly shifted as he has moved through life. His perceptions of mathematics in school, in his other occupations and before university were largely negative. He hated mathematics because he could not see how it was relevant and described his understanding of mathematics as "discrete."

> *I guess they've* [my perceptions] *changed since I've come to uni and started learning about teaching mathematics. I guess my perceptions when I was at school and pre-university, pre-teaching were that maths is pretty discrete. Everything about maths is discrete. You have to know a specific formula and there is only ever one way to solve a problem and those specific answers are often very difficult or almost impossible to find.*

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[5] At the beginning of each snapshot in this section, the relevant interview located in Appendix C is included for ease of reference. The snapshots occur in order from least to most experience however Appendix C lists the order the interviews took place.

[6] Throughout this section, various quotes from the interviews will be included to reinforce the results presented. *Italics* will indicate these quotes.

Damon stated that there are still parts of mathematics that he struggles with, things he does not remember, some mathematics he still finds difficult, and some answers in mathematics he feels are unattainable.

> *I still feel like maths sometimes is a little difficult and some of the answers are a little bit unattainable if you don't have certain strategies.*

After going to university to study teaching, Damon stated that his attitude towards mathematics changed; he now saw mathematics as less discrete with many ways to find answers. His job as a teacher was essentially to demystify mathematics and reduce mathematics anxiety.

> *I guess I can see now that there is lots of different ways to find answers and it's my job to demystify the process of maths for my students.* [There is] *a lot of maths anxiety out there; I think a lot of the issues with kids being engaged in maths is anxiety. I've seen that in my class.*

Damon confidently stated that he does not let his students know that there are difficult parts of mathematics. By teaching with relevance and multiple exposures to concepts, Damon said that he believes mathematics is not as daunting as many students might think.

> *But I'm trying; I definitely don't let my kids know that I think that there's parts of maths that are difficult… There's lots of different ways to solve the answer, lots of different processes and tools and strategies you can use in maths and it's not as daunting as most people think and it probably shouldn't be as daunting.*

Expectations

Damon's expectations were primarily based on effort and behaviour rather than attaining a specific standard. When asked what his expectations were, Damon explained that he expects students to "*listen, participate, have a go and not give up*" if they are struggling. At other times during the interview, Damon also expressed an expectation that students would try different strategies to solve problems and enjoy the subject.

> *I really reward kids who struggle through it. Looking for different ways and looking, oh okay, that way didn't work for this one but I'll try something else…*

He said that many children are anxious about mathematics, and ideally, he wants them to become better versions of themselves through his teaching rather than better versions of him.

> *I guess my teaching is motivated by wanting to see children excel and learn and become better versions of themselves, not better versions of me which is something interesting to think about when you're teaching. This is what I would do and this is how I would do it so I want you to do it just as good as that but that's not how it works*.

However, Damon was hesitant to assign specific content expectations on students. He stated that placing an expectation of what students at a particular level can and cannot achieve limits the students' potential.

> *Look, no, if I go into my classroom next week and teach a unit that we haven't taught yet, and I've already got this in mind* [Artefact 2's continuum of expectations], *I'm kind of limiting what they can and can't achieve and I've got preconceptions on their ability and I'm not really giving them… they're starting off with the worst chance possible because the teacher says, "Oh, they probably won't be able to get that."*

His expectation for his teaching was not to let students know that he might find some mathematics hard. He also stated an expectation to make mathematics real and relevant to the students. Damon explained that teaching should not be a "*copy and paste*" or "*it worked for this, so it will work for that*" practice. He argued that students should be exposed to both correct and "*not correct*" language in mathematics so that they are equipped to handle mathematics in all areas of their lives; so that *"they still know what it is."* He emphasised an effort on his behalf of being encouraging and excited when teaching mathematics.

Though Damon's stated expectations for his students were very open and positive, one statement he made early in the interview revealed a perspective some students may have towards mathematics.

> *I hated maths* [in school], *not because I was a dummy; just because I don't think things were presented to me in a way that made it interesting, fun and engaging and with the real-world connections. So much of what I remember at school, especially maths was just, "Why am I working out the area of a circle? I don't care. I'll never use this again so I don't bother remembering it."*

Influences on Expectations

Damon emphasised that his own beliefs and attitudes influenced his expectations, attributed to his own experiences with mathematics as a subject and school generally. He also stated his parents' expectations for him and their example as "*hard workers*" who "*pushed me hard*" have influenced his beliefs and attitudes and, ultimately, his expectations. Damon explained that university and his experiences also played a part in how he sets expectations. Early on at university, he took everything on board, but he took a more critical look at things as he matured and made connections and experienced teaching in different ways.

> *I guess in the first few weeks or months of uni, I took everything as gold and once you have a few experiences and make connections to your own personal experience and what you see and hear and you tend to think, "well, I appreciate what you're thinking and I'll write it down and submit the assignment, but I don't know that I'll use that all the time" Yeah, my experiences influence my expectations, not just what someone tells me.*

Beyond these influences, Damon stated that broader statistics and data showing the level of the typical Australian student influenced his expectations.

> *I guess where students are at, not just my students but, I guess, it sounds weird, humanity, where the general Australian student is at; that pushes my expectations a little bit.*

He stated the curriculum had an impact but more in what he must cover and how quickly.

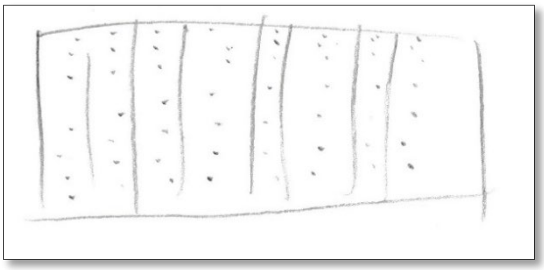
> *There is the expectation of the curriculum which I find is almost a bit… there is just not enough room in the day to do things nicely and have good reflections and good conversations. It's just quick, quick, quick, rush, rush, rush. We only get a week on each topic, two weeks if we're lucky. So the curriculum tells me how fast I have to work and what I have to get through.*

Artefact 1

When Damon was given the activity for Artefact 1, he explained that his first expectation of his students would be that they have a go at drawing the question or using some counters to represent the problem physically. Damon then explained the problem, illustrating the part-whole model in Figure 4.3. He divided the rectangle into eight parts and placed a dot in each region until he reached 56 and then counted how many dots were in each region—seven.

Figure 4.3

Damon's Response to Artefact 1

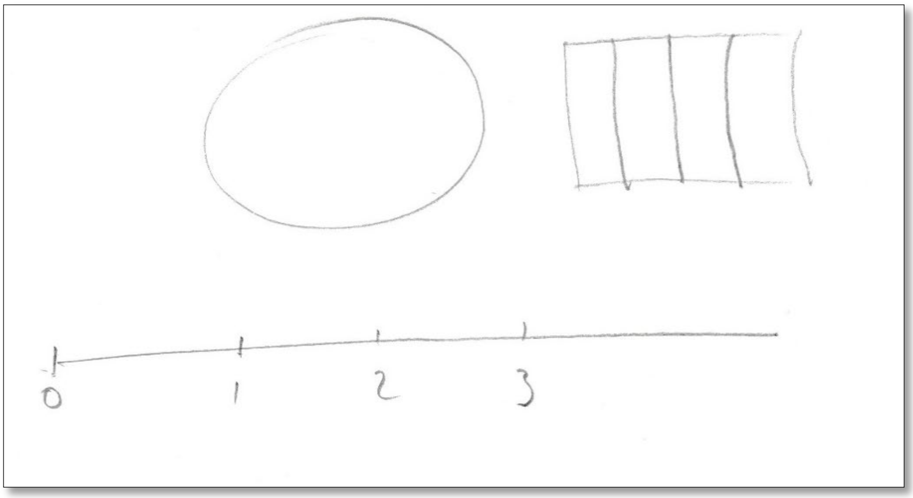


Note: Damon's rectangle divided into eight parts with dots in each part.

Damon explained that he realised halfway through what the answer was going to be and stated that some students could use multiplication and division facts to solve the problem but continued in his explanation regardless. Damon did not conclude the problem but instead inferred that the final steps would provide the answer: "*seven eights are 56 and seven threes are 21, give away… yep.*" Damon noted that using a fraction wall could help solve this problem as the answer would be just over half of the whole, and students would be able to see the link between halves, quarters and eighths.

Additionally, when asked to differentiate between representing a part of a whole and a part of a collection, Damon drew the shapes in Figure 4.4. He explained that he would start with a shape like a rectangle or a circle. He would divide it into five parts and explain that one of those parts is a fifth. He also drew a number line (between zero and three) and divided that up. He admitted that this is tricky for students because many students understand fractions as "*cutting*" something (e.g., half of an apple = cut the apple in half; a quarter of a pizza = cut the pizza in quarters). When students deal with collections where they are not necessarily "*cutting*" things up but dividing things, many students get confused. Damon explained that a key, he believes, in being successful in this regard is the language used: "*Show me half of the collection, don't show me half of the object.*"

Figure 4.4
Damon's Representations of Fractions



Artefact 2

Throughout the interview, Damon made several statements about the importance of not generalising in education:

> *I'm not all teachers. It's really hard to make generalisations in education. And I guess generalisations are general so for most or many but I haven't been in most or many classrooms.*
>
> *These questions have been very difficult. Education is based on mind and experience and humans; it's not a machine. Some students in Year 2 could understand fifths and eighths and they could be able to divide any object into eight equal parts but other students in Year 6 are still struggling with halves.*
>
> *But you know, when we're teaching, we're teaching for the individual and not the Australian population so, I don't know, I'm doing what you've asked me to do and put where I think we should be teaching but it doesn't really work.*

Damon repeatedly asked whether he needed to note his expectations or the expectation of the curriculum. He began Artefact 2 by stating that education is not a machine, and some students in Year 2 could achieve way above what might be expected. On the other hand, other students in Year 6 could still be struggling with foundational concepts. He then went on to vaguely circle and note some general expectations as summarised in Figure 4.5. As he did this, he explained that he was reluctant to "*limit [his] kids by what [he] thinks they can do*" and argued that teaching should be specific to the individual, not the Australian population. He stated that he was doing what he was asked to do by filling out Artefact 2 but does not believe in it. He promptly put the pencil down and said, "*that's as* *far as I'm going to go because I just don't think… yeah.*" He explained that if he goes into a class with an idea in his head of what the students should be able to do or not do at a particular stage, he is limiting what they can and cannot do. He argued that he is giving them the worst possible chance by implying, "*Oh, they probably won't be able to get that.*"

Figure 4.5

Damon's Expectations Compared with the Vic F-10 Curriculum Expectations

Damon's Expectations

Start of Foundation	Half Quarters	1/3, 1/5 Part of whole Collections	Decimals to Fractions	**End of Primary**
	Concrete Manipulatives			
	Below Curriculum (red)	**At Curriculum** (yellow)	**Above Curriculum** (green)	

Vic F-10 Curriculum's Expectations

Start of Foundation	Sharing	Whole Half	Quarters Eighths Collections	Model/ represent unit fractions: 1/2, 1/3, 1/4, 1/5 and their multiples	Equivalent fractions Count by 1/2, 1/3, 1/4 and mixed numbers Number line Decimals to Fractions Intro. Tenths and Hundredths Worded Questions	Add/subtract fractions w common denominator Place value beyond hundredths Compare, order and represent decimals	Fractions w related denominators on a number line Add/subtract fractions w related denominator Multiply/ divide decimals Percentages	**End of Primary**

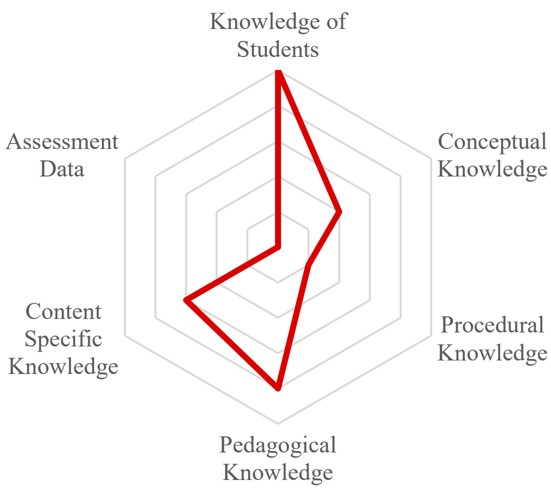
Decimals are expected at Grade 4. Damon does not mention several concepts as he expressed some discomfort in listing his expectations and promptly discontinued his annotations.

Knowledge Types

When organising knowledge types in order of importance for mathematics teaching in Figure 4.6, Damon placed the most importance on the teacher's knowledge of students, followed by pedagogical and content-specific knowledge. He put less importance on conceptual and procedural knowledge and assessment data. Damon's previous interview responses indicated a strong belief in person-centred education and teaching to the individual's needs. His emphasis on the knowledge of students supported this belief. Damon's discomfort at discussing generalisations in education and teaching also indicated his priority of knowing students. Damon supported his emphasis on pedagogical knowledge as important through his frequent focus throughout the interview on how he taught rather than what he taught. Damon's low priority towards assessment data was reflected in his interview responses, where he rarely mentioned the use of assessment data to inform his teaching or provision of assessments for students. Instead, Damon referred to students' effort and behaviour and becoming "*better versions of themselves*."

Figure 4.6

Damon's "Fingerprint" of Knowledge Priorities



Eric: "I'm not the Messiah of maths teaching but…."

Background

Eric (Interview A) is a male teacher (late-20s to mid-30s) at a school in metropolitan Melbourne and teaches a boys' Year 6 class in a single-sex school where the class is capped at 20 students. He had three years of teaching experience at the time of the interview, all of which were teaching in Year 6 at the same school. He was also working in a daily organiser capacity. Before becoming a teacher, Eric worked as an electrician. He stated that he believes the experience of working in another profession gave him a passion for teaching how mathematics is relevant to real-world situations. Eric is a first in family teacher.

Attitudes

Eric stated that he enjoyed mathematics, felt confident in it, and enjoyed teaching it. He confessed that English is the area he finds most challenging.

> *I love maths, and I love teaching it and so that probably, unfortunately, I could be in the minority.*

He implied that typical teachers do not love mathematics nor enjoy teaching it. On the other hand, he stated that he, although not "*the Messiah of teachers*" or "*the Messiah of maths teaching*", believes every student is capable.

> *I think some teachers go in, and maybe they get previous year's data and go, "Oh, gee, Tommy's no good at maths, so that'll be a hard slog this year" then that kid has got no hope, you're already defeated… I'm not perfect, I'm certainly not the Messiah of teachers, but I'd… be like, "right, what can we get for Tommy this year" but… I think you see it as a challenge as a teacher to drive you…*

When asked to rate the difficulty of teaching fractions to students, Eric described it as a five out of ten, neither easy nor difficult. Eric also explained that he believes that "*some of it* [mathematics] *is just memory-based*", and a good memory is needed to succeed. Eric stated that "*genetics plays a role*", and some students with "*stronger memories*" or "*more number sense*" are "*predispose*[ed] *to achieve higher*" in mathematics. When asked about his attitude towards mathematics, Eric used the words "*confident*", "*successful*", and "*comfortable*" to describe his experiences.

> *I've had a reasonably successful background in mathematics… in primary school, I always got good grades… I always felt confident with numbers… I've always felt comfortable with maths and been able to recall numbers and mental computation with numbers has always been good.*

Expectations

When describing his expectations for students, Eric listed a series of understandings that he wishes his students to have. These included "*mental computation*", number sense, an understanding of "*the four processes*" (add, subtract, multiply, divide; at least in fractions), an ability to see the "*relevance*" of tasks and apply their understanding to the real world, and that they would have a "growth mindset" as opposed to a fixed, results-based mindset. Eric described this idea of a growth mindset in terms of expecting growth from students between the pre-test and post-test rather than expecting them to meet specific achievement standards, such as a particular grade on an assessment. Eric described expectations for himself very similarly: for students to have a "*growth mindset*", he too needed to have a growth mindset for both his students and himself.

> *Let's not worry about what he can't do, let's worry about what he can do. And I think if you can get parents on board with that, that builds a growth mindset, that builds confidence… you can't expect your kids to have a growth mindset if you don't have one.*

For students to apply their understanding to the real world, Eric stated a need to build relevance into his teaching. He also claimed his approach to teaching mathematics follows the gradual release model of "I do; we do; you do". He pre-tests, models a task, works through a task with students, and then allows students to solve problems independently before finally post-testing. According to Eric, his job when teaching Year 6 mathematics is not about teaching an understanding of concepts but about teaching processes.

> *… a lot of our boys have that understanding* [of the actual breaking down and understanding] *and then its more teaching the processes.*

Influences on Expectations

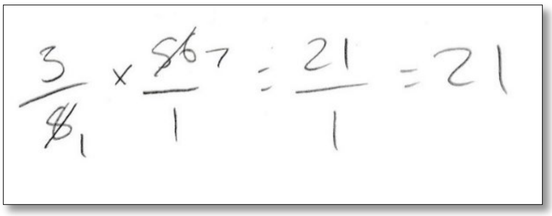
Eric referred to the teaching environment as a major influence when asked what influenced his expectations for both his students and himself. The attitude(s) of teachers and staff he works with and their willingness to collaborate and the school and community expectations and pressures, particularly in a school "*when you're asking for the school fees that we ask for*", push Eric to set high expectations. When teachers were willing to help each other improve, shared resources and engaged in professional conversations, the knowledge community grew and improved individual teachers. Eric also described parents' expectations as a significant influence on expectations, at least at his school, as they have high expectations of results from both students and teachers. Eric ascribed the previous year's data as an essential element in setting expectations for students. However, he stated he was wary of "*the vicious cycle of reporting*" where a teacher may place students as achieving higher or lower than they are to avoid any ramifications from a student being above or below the standard.

Artefact 1

Later in the interview, when asked to show how he would expect his students to solve a worded problem involving fractions, Eric wrote "*3/8 x 56/1*" as illustrated in Figure 4.7. He proceeded to cross out the denominator "*8*" and replace it with "*1*". Likewise, he crossed out numerator "*56*" and replaced it with "*7*". As a result, the problem read "*3/1 x 7/1*". He then wrote the answer to the problem "*= 21/1 = 21*".

Figure 4.7

Eric's Response to Artefact 1



The method used to find the solution does not clearly reveal a conceptual understanding of what is being done in the problem, apart from the ability to set up the calculation from a worded problem. This approach may leave many questions in students' minds. In addition to this, Eric initially did not solve the problem and provide the final, correct answer: 35. For a moment, Eric explained that he would expect his students to solve the problem in the same way before adding the final step: subtracting 21 from 56 to get 35.

Artefact 2

During the last activity of the interview, Eric was asked to label a line graph with the concepts he would introduce when teaching fractions in primary and when each concept would be introduced and how. Eric's expectations, summarised in Figure 4.8, appeared to be slightly higher than the standard set by the Victorian F-10 curriculum, in some areas only marginally above, and in other areas, way above (e.g., adding and subtracting fractions in Year 3 instead of Year 5). The only exception is when indicating when the teacher would introduce worded, real-world questions, Eric stated this should occur in Year 5 but according to the curriculum, should typically occur a year or two before.

Figure 4.8

Eric's Expectations compared with the Vic F-10 Curriculum Expectations

Eric's Expectations

Start of Foundation	Sharing	Whole Half Quarters	Eighths Sixths	Decimals Number Line Adding/ Subtracting (Physical)	Decimals to Fractions Intro. Dividing/ Multiplying (Physical) Adding/ Subtracting Decimals	4 Processes Decimals Worded Questions Decimals to Fractions 4 Processes Intro (Fractions)	4 Processes Decimals Percentages 4 Processes (Fractions) Worded Questions	**End of Primary**
	Below Curriculum			**At Curriculum**			**Above Curriculum**	

Vic F-10 Curriculum's Expectations								
Start of Foundation	Sharing	Whole Half	Quarters Eighths Collections	Model/ represent unit fractions: 1/2, 1/3, 1/4, 1/5 and their multiples	Equivalent fractions Count by 1/2, 1/3, 1/4 and mixed numbers Number line Decimals to Fractions Intro. Tenths and Hundredths Worded Questions	Add/subtract fractions w common denominator Place value beyond hundredths Compare, order and represent decimals	Fractions w related denominators on a number line Add/subtract fractions w related denominator Multiply/ divide decimals Percentages	**End of Primary**

Multiplication and division of fractions is not expected until Grade 7. Eric's response is very detailed.

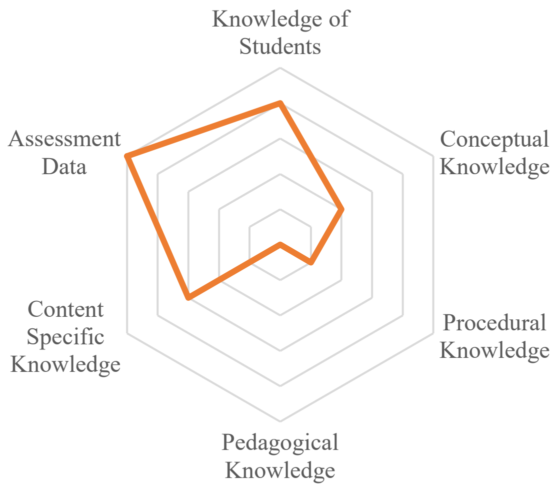
Knowledge Types

When rating knowledge types from most important to least in the questionnaire, Eric placed assessment data, knowledge of students and content-specific knowledge as most important, as seen in Figure 4.9, and conceptual, procedural and pedagogical knowledge as less important. This prioritisation of knowledge forms, particularly assessment data, was apparent in Eric's interview responses, as Eric often mentions testing and planning for assessment. He also mentioned that he prioritises teaching algorithms over real-world tasks but questioned whether this was the best way to teach students. This preference towards algorithms initially contradicted his prioritisation of conceptual knowledge over procedural. However, his reflection on this practice and questioning reinforced his priority of conceptual understanding over procedural.

> *…we structure our units in a way that we always pretest to measure growth and then… I don't know if it is the best way but we always teach more algorithm based, more short answer and then lead through to more worded questions to finish with so that hopefully by then the boys will have an understanding of the four processes and they can transfer that knowledge to real world tasks.*

Figure 4.9

Eric's "Fingerprint" of Knowledge Priorities



He also regularly referred to "*the boys*", his students, and their varying abilities and the teaching methods they seemed to respond to which indicated, to an extent, his emphasis on knowing his students. This is seen in the following excerpt:

> *So, I'm a big one with, my boys love being the teacher so a lot of the time, I just have Textas up the front and once I've shown them how to do it really explicitly, I'd put three up there and I'd think, "right who's the teacher?" Then I just throw the Textas around cos they like that, then I go and sit in one of the seats and they pretend "I'm the teacher" and talk them through it and then get them to, "hang on, break down, why are you doing it like that, hang on, you can't just cancel that one out and not tell me why" and get them to repeat the language back so they're obviously summarising but I'd say paraphrasing for their peers and I find that that kind of shared experience is great and also, sometimes they come up with ways that I haven't shown them and I go, "Why have you done that for?... and then sometimes they come up with great ways that they've done it and it's like, "Yeah, didn't even think of that… brilliant!"*

Annie: "maths gives me so much anxiety…."

Background

Annie (Interview E) is a female teacher (late-20s to mid-30s) at a P-6 school in suburban Melbourne. She had three years of teaching experience at the time of the interview, including a year of experience as a casual relief teacher (CRT). As a result of her CRT work, she had experience teaching all years except for Foundation. Before teaching, Annie worked in retail and believed that this experience made her more flexible and open to changing workplace conditions.

> *I think that does definitely influence, just* [being] *thrown in the deep end with regards to last year with work and things like that…*

Attitudes

When asked to explain her perceptions about mathematics as an individual, Annie immediately used the word "*negative*". She explained that she struggled with it as a child, did not understand it, and had only ever "*scraped by*".

> *It* [mathematics] *straight away brings negativity to me, only because I struggled with maths when I was younger, never understood it, even in high school, I never understood it. I'd just scrape by with results. So yeah, I don't have a positive outlook on it.*

She explained that she often felt anxious teaching mathematics, especially when she had not had a chance to prepare beforehand. She confessed that she often finds it confusing.

> *…maths gives me so much anxiety cos like, I put so much stress on myself because I'm, I really need to, you know, if I'm not that confident in it, how am I going to teach it so when I plan for each topic that we learn every two weeks or a week, I'm making sure that, yep, I've got it. If I'm questioned by a student, I know how to answer him or her…*

She stated that she tries to make mathematics fun and interesting for her students. Still, she admitted that she struggled to challenge her class, the top ability group in the grade (students are divided into mathematics ability groups: below, at and above). She explained that she also found it difficult to simplify mathematics concepts to meet the needs of students who were considered "*weaker*" in their understanding.

> *I try and make it positive for the kids cos I went through the negative side of it, so I try and make it fun and interesting for the students… I was struggling to challenge them (top Year 3/4 ability group) …, especially me being weak in that area* [of mathematics] ...

> *I find it difficult, like really difficult with weaker students that are… really behind… it's really hard, even like having concrete materials… You know, even with, like, you try and make it interesting and introduce with like, lollies or whatever and they still don't get it; in that aspect, it's really hard.*

She stated that she does not find mathematics interesting and sees reading and spelling as important. Basic calculation skills, enough to get by, were considered necessary.

> *I don't find it interesting myself… for me, reading and spelling, individually, is more important. Does that make sense? As long as you can calculate and add and just the little things to get you by, it's enough.*

Annie acknowledged her lack of confidence in mathematics and explained that misconceptions are likely to occur when a teacher is not confident. She went on to state that this resulted in students falling behind and raised a concern that one reason students may struggle with mathematics is the literacy component.

> *So if a teacher is not that confident, like myself, obviously those misconceptions are going to occur within one lesson… When it comes down to their reading skills and language and understanding what the question is asking, they can't even grasp that so when the teacher sits there and explains it to them, they're like "oh yeah" and then they're able to answer the question but if it's just them and the paper or the computer, they're not understanding what the question is asking. So I feel like the language and the types of terms used in maths… that they can't understand it which is why they don't understand the concept and the ability to answer the question.*

Expectations

Annie stated that her expectation of her students is they understand where they should be (according to the curriculum), and they are working towards that. She explained that she spent extra time with students falling behind because she believes that they have "missed the train" on their learning if they misunderstand an element of a concept.

> *…for me, as long as the students understand where they're meant to be, where their standard of learning is meant to be, especially with maths, it's good. I really do focus more time in the kids that don't understand or are a bit weaker because, if they miss one little thing, they're gone. It's hard to get them back whereas with the students that already know, it's like, great, just keep challenging them, set work that's a level or two higher than where they're at. But I expect that a lot of them should be at their normal standard.*

Annie admitted that she believes mathematics can become too much for some students and that they need concrete materials and literacy knowledge to understand mathematics. Due to her attitude and experiences with mathematics, she maintained an expectation to teach mathematics in a fun and engaging way.

> *For me, the way I want to teach the students is the way I sort of, especially the weaker ones, is the way I struggled learning maths and not understanding it and things like that would always be at the back of my mind teaching the younger ones. So, in my teaching, I'd always try and make it, you know, make sure they understand and make sure that it's fun and make sure that it's not just in the classroom.*

Annie indicated that she placed a lot of pressure on herself because she feels responsible if the students fall behind, arguing that students ultimately either "*get it or don't get it*" because of the teacher. Annie stated this was one key reason why teaching mathematics gave her so much anxiety. To meet this expectation and prevent students from falling behind through misunderstanding, Annie explained that she always put in a lot of planning and preparation and expects herself to be learning alongside her students. Annie also expected that students find fractions harder to understand while concepts like money are more fun for the students and easier to understand.

> *In my teaching, definitely the expectations for myself are higher for me because it's in my hands that the children either get it or don't get it and if I'm not that strong in it or good in it, I'm held accountable for either them falling behind or excelling… that's why maths gives me so much anxiety…*
>
> *I think that some mathematical concepts are a bit easier to understand so… for example, money or, you know, those fun maths tasks… I do find it a lot easier because I think it can be more fun, you know, you have the fake money, there's more games to play with money other than fractions.*

Annie's expectations appeared to be to meet the curriculum's but an expectation of just being "*at*" the curriculum standard presents a problem, especially for students who are already at or above the standards set down by the curriculum. The way Annie described her expectation, "*I expect that a lot of them* [my students] *should be at their normal standard*", steered away from individual expectations for each student and suggested a group or cohort expectation.

Influences on Expectations

Annie stated that her "*lack of knowledge*" influenced her expectations for both her students and herself. She explained that this lack of knowledge led her to believe that other teachers could teach the subject better and that her students would find it easier to understand another teacher. Annie explained that this probably influenced her expectations. She elaborated that it made her more dedicated to planning lessons, ensuring that students understand and, when they lack understanding, rearrange and be flexible to move students into different ability groups and classes.

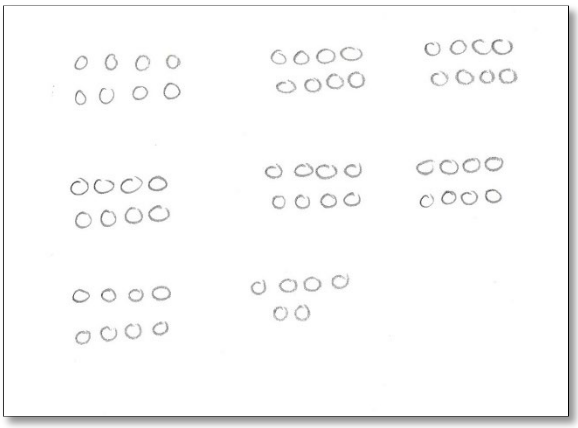
Artefact 1

In Annie's response for Artefact 1, she began to solve the problem but seemed to get lost a few times and ultimately, did not solve the problem during the interview. When first given the task, Annie appeared very nervous to solve a mathematics problem, repeatedly exclaiming, "*Oh my gosh,*" and explaining that when she sees a problem like that in Artefact 1, as a teacher, she feels anxious and second-guesses herself.

She explained that she would expect her weaker students to solve the problem visually by drawing it, but her stronger students would answer the question without needing to show their working out. She indicated that she would often have to ask them to show her the working out to prove their understanding. Annie then silently drew several small circles in groups as illustrated in Figure 4.10. She drew 62 small circles in seven groups of eight and an additional group containing six small circles. She initially explained that she would provide 58 concrete materials before realising that the question asked for 56 marbles. She then explained that she would expect her students to break this number into three-eighths and then find how many marbles were left in the bag.

Figure 4.10

Annie's Response to Artefact 1



With further prompting, she endeavoured to explain how she would teach the problem. Annie explained that she would show the students what three-eighths looked like and then she would let the students work from there. She explained that she would bring them all back and discuss what they are struggling with if they struggled to solve the problem. In the interview, Annie had not explained her representation in Figure 4.10, so she was prompted to describe it. Annie attempted to explain what she had drawn but became confused. She clarified that she would expect her students to share the marbles into groups, either physically or by drawing them. Her reasoning initially appeared to be a conceptual explanation of the problem, organising eight groups with eight in each and six in the final group. Though this seems like a likely explanation, it is impossible to know whether this explanation is correct as Annie could not explain what she had drawn and why. The division of 62 circles amongst eight groups, with each group not having an equal number of circles, conflicted with a foundational rule of fractions: all parts of a fraction must be equally sized, even in the case of collections. When Annie was asked what model or strategy she might use to teach the problem, she explained that her school used a program that contained resources that she would use to introduce her students to problems like the one included in Artefact 1. In this way, she could scaffold their understanding.

When asked about differentiating between a fraction on a number line and a fraction of a whole, Annie explained she teaches her students the value of fractions because students often place fractions on a number line according to the size of the number in the fraction with fractions like 1/2 and 1/3 placed closer to zero and fractions like 1/8 and 2/5 closer to the one because they contain "*larger*" numbers and students fail to recognise the fraction's value.

Artefact 2

In the final artefact, Annie's responses indicated that her expectations were generally above the curriculum's standards, but her responses provided minimal detail, as summarised in Figure 4.11. After working on the graph for a few minutes, Annie explained that foundation and Year 1 primarily focus on simple fractions without too much depth, including whole, half and quarters. Year 2 moves up a little, and Annie expected thirds and worded fraction problems to be learnt, a Year 4 curriculum outcome. Then in Years 3, 4, and 5, Annie positioned adding and subtracting fractions and converting them to decimals would be learnt, expected at Year 5 of the curriculum.

Figure 4.11

Annie's Expectations Compared with the Vic F-10 Curriculum Expectations

Annie's Expectations

Start of Foundation	Simple fractions: whole, half, quarters	Whole Half Thirds, Quarters Number Line Worded problems	Add/ Subtract fractions Decimals to Fractions Intro.	Multiply/ Divide fractions Percentages	**End of Primary**
	Below Curriculum		**At Curriculum**	**Above Curriculum**	

Vic F-10 Curriculum's Expectations

Start of Foundation	Sharing	Whole Half	Quarters Eighths Collections	Model/ represent unit fractions: 1/2, 1/3, 1/4, 1/5 and their multiples	Equivalent fractions Count by 1/2, 1/3, 1/4 and mixed numbers Number line Decimals to Fractions Intro. Tenths and Hundredths Worded Questions	Add/subtract fractions w common denominator Place value beyond hundredths Compare, order and represent decimals	Fractions w related denominators on a number line Add/subtract fractions w related denominator Multiply/ divide decimals Percentages	**End of Primary**

Multiplication and division of fractions is not expected until Grade 7.

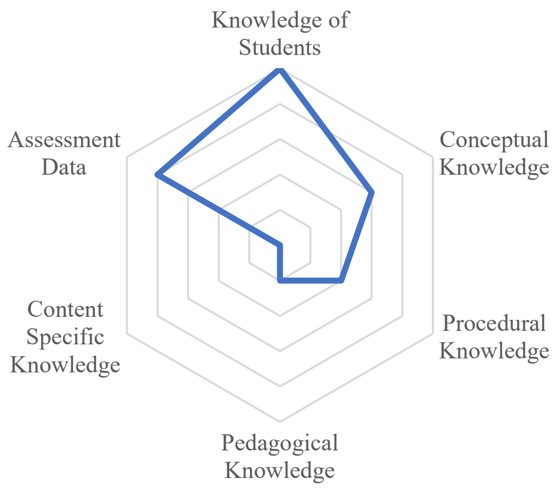
She initially left the Year 5 and 6 areas blank before being prompted to indicate where concepts like multiplication and division of fractions and percentages might fit in. Annie immediately placed these at the end of Year 4 through to Years 5 and 6. Finally, Annie was asked to indicate where a number line would be introduced and placed this at Years 2 and 3.

Knowledge Types

When Annie placed types of knowledge in order of their importance summarised in Figure 4.12, she prioritised knowing her students, followed by Assessment Data and Conceptual Knowledge. She placed less importance on Procedural, Pedagogical and Content-Specific Knowledge. Annie's priority of knowing her students was reflected in her interview responses, particularly when referring to students struggling and providing greater support for the students falling behind. Annie's interview responses did not reflect her placement of Assessment Data as the second most important knowledge for teaching mathematics. She rarely mentioned assessment in her responses other than comments such as "*being on top of their learning*" and referring to a program called "*Essential Assessment… there are free questions and, like, quizzes on there….*" With Conceptual Knowledge, Annie stated that this knowledge is quite important and appeared to approach Artefact 1 conceptually but ultimately did not provide a solution using a conceptual strategy. Annie's placement of Content-Specific Knowledge as least important was consistent with her responses throughout the interview as she frequently stated she lacked knowledge in mathematics.

Figure 4.12

Annie's "Fingerprint" of Knowledge Priorities



Cathy: "they could do that… that could be earlier…."

Background

Cathy (Interview F) is a female teacher (mid-30s) at a primary school in the outer suburbs of Melbourne. Cathy had been teaching for eight years at the time of the interview, including a year as a CRT. She had experience teaching all Years except Year 6. Cathy did not indicate any other career experience aside from teaching. She stated that she was studying a postgraduate degree in psychotherapy, which was a reason she volunteered to be involved in the study.

Attitudes

When asked about her perceptions about mathematics, Cathy's initially responded, "*that maths is in everyday life.*" She then explained that she struggled to "*get* [her] *head around*" mathematics as a child but believes that mathematics is best learnt through a lot of different ways though there is a lot of content in mathematics that teachers "*need to get through.*" Cathy explained that concepts that she considers difficult, like fractions and decimals, are different when teaching them because perceptions are put to the side. Even though she may dislike this concept or another, she still must teach it. Cathy explained that fractions are a particularly hard concept because there are many models of fractions that students need to understand, and students "*either get it or they won't get it.*"

> *Even though I might go, "okay, we've got to teach, like, you know, fractions and decimals and harder kind of subjects, that I consider harder," when I'm actually teaching it, it's a bit different. Because I guess there's a point where you need to know what you're doing but then there's a point where you can still teach and facilitate learning as well. Sometimes your own perceptions you've got to kind of put aside. So even though I might not like doing a particular concept, I've still got to teach it.*
>
> *So teaching fractions can be quite difficult and I guess from a child's perspective, it can be quite a difficult concept to get your head around and, depending on the child and depending on your method, they'll either get it or they won't get it. And there's lots of different ways to teach it, like there's the area model, the collection model, there's lots of different models…*

Cathy explained that very often, students "*have to do it.*" To understand mathematics, they need to manipulate objects and items physically to understand the concept conceptually. When prompted to respond to whether fractions would be considered a concept that both students and teachers struggle with, Cathy explained that she did not understand fractions fully until she went to university and learnt about them. She explained that when she went through school, "*it was all just numbers,*" and the visual models to improve or aid understanding were just not there.

> *I didn't get fractions, and I know this is so silly, I didn't get it until I learnt about it in university… it wasn't until I got to uni that I conceptualised it much better than whatever I learnt in school. Because I think when I learnt it when I was in school, it was all just numbers.*

Cathy stated she believes mathematics is "*hard, and tricky, and challenging.*"

Expectations

Cathy mentioned one expectation for her students is to either get it or not when teaching mathematics concepts. A significant expectation she had for students is that, despite its challenges and sometimes not getting it, they should not give up when trying to solve mathematics problems and always try different solving strategies. Another expectation that Cathy indicated is the importance of students developing a conceptual understanding of the concepts taught. Cathy expected many of her students to be ahead of what the curriculum stated and to be capable of understanding concepts that are not introduced until later in the curriculum. As a result of these expectations for her students, Cathy explained that she also expected her teaching to demonstrate multiple ways to solve problems and model responding to challenges without quitting or giving up. She indicated that she should put aside her perceptions of mathematics when she teaches so that students are not discouraged from enjoying mathematics just because she struggled with it in the past. A final comment from Cathy was that her expectations required constant reflection to ensure her teaching did not become stale and routine but rather promoted new ideas and thinking.

Influences on Expectations

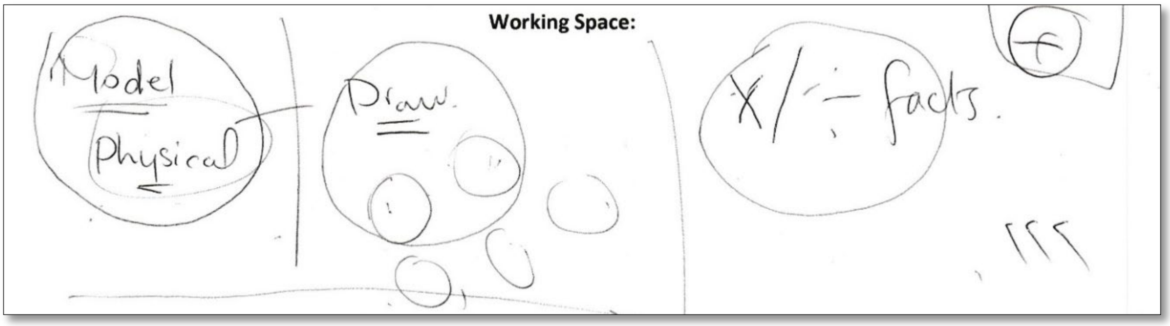
After indicating expectations she had for students, Cathy explained some factors that influence the cultivation of these expectations. She attributed her struggle with mathematics growing up as a critical influence. She elaborated that her experiences teaching over the years also influenced her expectations of what students can achieve. Cathy suggested that the curriculum also had an impact on her expectations.

Artefact 1

When Cathy was given Artefact 1 and asked to explain what she would expect from her students, she was quick to explain multiple ways in which students may approach the problem. As indicated in Figure 4.13, Cathy first suggested that students solve the problem using physical marbles and share them into different groups to find out how much they gave away. She then explained that many students would also be able to draw the problem rather than physically manipulate the objects, reasoning that students would likely divide 56 into eight groups and then take away three groups. Cathy commented that some students may even have a firm grasp of multiplication and division facts and use that to divide 56 by eight.

Figure 4.13

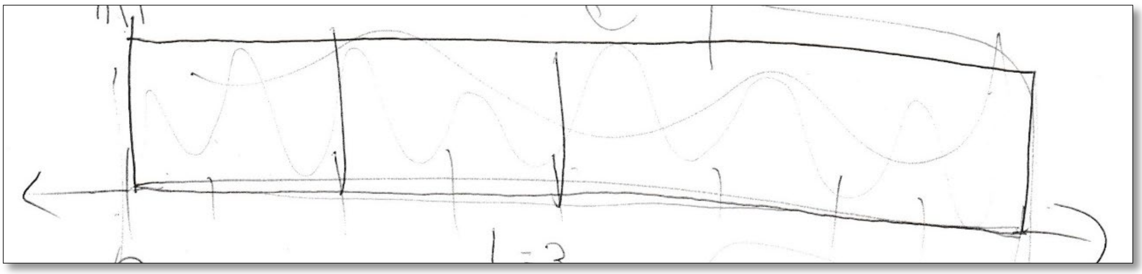
Cathy's Response to Artefact 1



She explained that students could even use a number line to solve the problem if they wanted to, as illustrated in Figure 4.14.

Figure 4.14

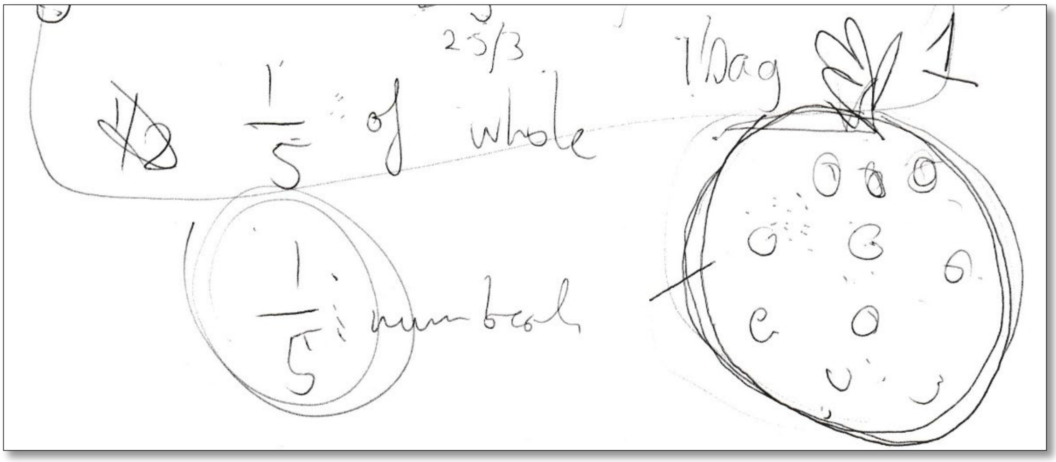
Cathy's Response to Artefact 1 (continued…)



When asked how she would teach this problem, Cathy explained that she would not teach the problem but the strategies to solve the problem. The focus of the discussion shifted to how a teacher can differentiate a fifth of a whole and a fifth on a number line. Cathy stated that this is fresh in her mind as she taught students this principle a week earlier and explained that she often overlayed a number line with an area model, using rulers to show the value of a fraction on a number line.

Cathy explained that it is helpful to draw a bag ("*bag it up*") and explain to students that the contents of this bag need to be divvied up, as indicated in Figure 4.15. Cathy declared this is a difficult concept for students to understand.

Figure 4.15
Cathy's Representation of "Bagging Up" the Fraction Question



Cathy's explanations for Artefact 1 revealed a conceptual understanding of the problem and, though limited, indicated some horizon knowledge in linking different concepts expected at different points in the curriculum.

Artefact 2

Cathy's response to Artefact 2, summarised in Figure 4.16, revealed that her expectations were generally above the curriculum. While responding, Cathy often adjusted her expectations and stated throughout the exercise that students would be capable of learning a particular concept earlier. She changed the placement of her expectations accordingly. This action indicated the authenticity of these expectations. Cathy expected that students in Foundation would be able to understand sharing and dividing collections. According to Cathy's expectations, the area model is introduced in Year 1 along with an understanding of halves, thirds, and quarters. Counting by these fractions should be expected by Year 2, including placing half on a number line with the help of a ruler. In Year 3, the number line is used more, and in Year 4, percentages and decimals are linked to fractions with basic addition. Later, in Year 5, adding and subtracting simple fractions and later again multiplying and dividing was expected, and finally, in Year 6, mixed fractions are introduced and added, subtracted, divided and multiplied. The expectation of mixed numbers at the end of Primary was the only concept where Cathy's expectation was below that of the curriculum. Cathy expected a Year or a few Years higher than the curriculum's in every other area. Throughout the activity, Cathy crossed-out arrows she had drawn to various concepts and reassigned them, stating that she can, upon second thought, expect students to understand those particular concepts earlier. When asked whether this activity could be done with other concepts, Cathy responded that this exercise was an effective activity to support reflection on expectations and compare how teachers might think about particular concepts.

Figure 4.16

Cathy's Expectations Compared with the Vic F-10 Curriculum Expectations

Cathy's Expectations

Start of Foundation	Sharing Collections	Whole Half Number Line using rulers Area Model	Counting unit fractions: 1/2, 1/3, 1/4	Number Line	Decimals to Fractions Intro. Percentages Add fractions	Add/ subtract fractions – simple Multiply/ divide fractions	Mixed Number Fractions	**End of Primary**
	Below Curriculum			**At Curriculum**		**Above Curriculum**		

Vic F-10 Curriculum's Expectations

Start of Foundation	Sharing	Whole Half	Quarters Eighths Collections	Model/ represent unit fractions: 1/2, 1/3, 1/4, 1/5 and their multiples	Equivalent fractions Count by 1/2, 1/3, 1/4 and mixed numbers Number line Decimals to Fractions Intro. Tenths and Hundredths Worded Questions	Add/subtract fractions w common denominator Place value beyond hundredths Compare, order and represent decimals	Fractions w related denominators on a number line Add/subtract fractions w related denominator Multiply/ divide decimals Percentages	**End of Primary**

Multiplication and division of fractions is not expected until Grade 7. Response is very detailed.

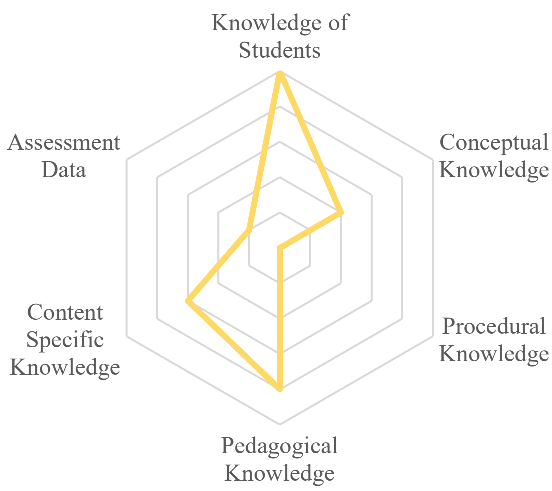
Knowledge Types

When placing types of knowledge in order of importance as summarised in Figure 4.17, Cathy placed the most importance on knowing students, Pedagogical and Content-Specific Knowledge. She placed less emphasis on Conceptual Knowledge, Assessment Data and Procedural Knowledge. These emphases agreed with Cathy's interview responses. In Artefact 2, when she was asked to assign her expectations along a continuum from the start through to the end of Primary, Cathy frequently adjusts her expectations as her students "*could do that earlier.*" Cathy's interview responses indicated a heavy emphasis on knowing how to teach (Pedagogical Knowledge) and what to teach (Content-Specific Knowledge), frequently referring to general teaching strategies and linking mathematical concepts.

> *There's a point where you need to know what you're doing but then there's a point where you can still teach and facilitate learning as well…*

Figure 4.17

Cathy's "Fingerprint" of Knowledge Priorities



Terry: "I'm very confident with maths… that's my area."

Background

Terry (Interview C) is a male teacher (late-30s to early-40s) at a primary school in rural Victoria, where he was also a Year 2 team leader at the time of the interview. He had nine years of teaching experience: five in an independent, single-sex girls' school in Melbourne and four years in public schools. He has worked across all Years between Years 2 and 6. Apart from his teaching experience, Terry worked as a charity worker for almost a decade. He said this, and his experiences working in public and private schools have resulted in him holding a unique perspective of students, their needs, and the influence family circumstances can have.

Attitudes

When initially asked to describe his perceptions of mathematics, Terry responded:

> *I'm very confident with maths… that's my area. That's why I'm more than happy to participate in this stuff…*

He stated that teachers are either numeracy or literacy inclined; they either love mathematics or hate it. In his team of five Year 2 teachers, he explained that all the teachers in his team, himself excluded, are inclined towards literacy. They typically did not want anything to do with maths planning or anything to do with mathematics. On the other hand, he is the only one in his team inclined towards numeracy and mathematics.

> *A lot of teachers are either numeracy based or literacy based. My team of five, I'm math, I'm numeracy, math-science; the other four are literacy, 100%. [They] don't want to touch maths planning, don't want to touch maths… I think it's one of those things where it's a love or a hate.*

He explained that he was always good at maths. He picked it up quickly and enjoyed it because he was successful in it. As a result, Terry expressed confidence in it and enjoyed teaching mathematics. He explained that he understands mathematics and he finds it easier to teach it as a result. According to Terry, mathematics is fun because it is black and white, right or wrong, and it was easy to see how to get students to progress and overcome misconceptions. Literacy, on the other hand, was more ambiguous.

> *At school, I was always good at maths. Math was always my area and I was always very good at it. I picked it up quickly; I learnt quickly. I did it at uni level and I enjoyed it and I think I enjoyed it because I had success with it too. Teaching is kind of the same. I find it easier to teach maths because I understand it and I can understand where I can support the others so… my perception is it's a good subject; it's a fun subject. I can do more with it, I can think more with it, and I can get more out of the kids with it. More so than I could for literacy.*

> *To me,* [mathematics] *uses black and white, especially at the primary level. It's your answer or not your answer and I like black and white. I can see what the answer is…*

He stated that mathematics is easy and fun when it relates to real life but suggested only some mathematics concepts related to real life. He went on to state that some concepts like money and time are really "*tricky*", "*frustrating*", and "*challenging*" to teach.

> *Some areas of maths you can't relate to real life or it's hard to relate them.*

> *I think money and time is more difficult to teach in the younger levels than fractions are.* [The kids] *don't cotton on. The kids just don't get it… it doesn't sink in for some reason and I don't know why… I find those two areas a lot tougher to teach at the lower end.*

Expectations

Terry stated his expectations were based on growth and effort: the students have "*given it a go*" and "*shown learning and improvement.*" His expectation for his teaching was to also grow in some way. He clarified that this was specifically for his "at" and "above" students, and he would expect a full year's growth according to the curriculum in a school year.

> *I'll expect most of my kids, my 'at' and 'above' kids to show good improvement. That they'd get…on a pre-test where they got not much right, I'd expect them to get most right in the post-test… I expect my 'at' and my 'above' level students to grow that 12 months' worth. That's what I would expect.*

For his "below" students, expectations were not as high as he expected them to grow six months (or a half year's growth) in a school year because:

> *… you've got to be realistic in terms of what they can do and you've got to judge them individually so I wouldn't expect my 'below' students to effectively jump that six months or 12 months growth in a subject area… because that's not what they are going to do. They're below for a reason.*

Terry's expectations were primarily based on the curriculum. He stated he was often "*ticking"* students to indicate that they reached the standard prescribed by the curriculum, stating, "*there's going to be a couple that don't quite get there and there's going to be some that slide through and above.*" His expectations for his "above" students were that they reach the "at" standard in the curriculum and "*ticking some boxes*" in standards above that too. He went on to state that this expectation of growth is why he found teaching money and time difficult because "*growth there is smaller than… fractions… where the growth is significant.*" Terry explained that he communicated his expectations to his students through learning intention, success criteria and setting goals for individual student's achievements throughout the year. His teaching expectation was to provide students with the goals, resources, materials, and knowledge necessary to achieve those goals.

When asked whether putting his expectations on a continuum was helpful in any way and whether he would use it for any other concepts, Terry explained that he would not do this for any mathematical concept. Instead, he would refer to the Victorian Curriculum and expect his students to achieve whatever the curriculum stated. He described his process of teaching a concept as firstly referring to the curriculum, then pretesting, placing students in groups according to ability ("below", "at", or "above") and teaching "at" standard before post-testing to see what students had learnt based on the curriculum standards. As a result of Terry's curriculum-based expectations, his expectations for his Year 2 class were specific (e.g., students can write, name, and draw the fraction; students working "above" can understand the size/value of the fraction).

Influences on Expectations

Initially, Terry misunderstood the question asking what factors influenced expectations, but his responses revealed several factors that appeared to affect his expectations. Curriculum and pre-test data based on the curriculum standards appeared to impact Terry's expectations heavily.

> *I'd look at the Vic Curric and whatever Vic Curric says and as well, you've got your pre-test… so if I'm teaching Year 4, my Vic Curric, I'd be looking at some Year 3, 4, 5 and then you're going to have kids below it, I know that, and you're going to potentially have kids… above it but get you base level data. If you've got kids who nail the whole thing, I'd be looking at whatever the Vic Curric says for Year 6 or 5 or whatever. If they completely bottom out, I'm probably going to go back to back here: my Year 2, 3 stuff and then build the basics up.*

> *I always have the Vic Curric in front of me and do it that way at all maths concepts, irrespective of what the area is, I do it for all of it.*

Ability grouping also appeared to influence his expectations when he mentioned his expectations for "below", "at" and "above" students earlier in the interview. As the interview progressed Terry discussed his experiences outside of teaching. He explained the impact of parental expectations in the expectations he set for his students, particularly in an "*affluent*" school environment. The expectation of how much support a student received at home affected his students' growth and achievement expectations.

> *I come from a school who's affluent and… you had parents who were very well educated and you've now got a new environment where that's not the case and parents don't have the same abilities as other parents I've taught with so you have to change your thinking also and… you asked the question earlier about the expectations, well, I've got different expectations of support coming from home of what I need to do than what I did three years ago when I was at the other school. You know, I would expect parents to give me grief if a kid came home with lower results than their Years whereas I wouldn't expect that now.*

Artefact 1

When asked how he would expect his students to approach the question in Artefact 1, Terry began by explaining what a fraction is and the parts of a fraction (e.g., numerator and denominator). As illustrated in Figure 4.18, he explained that he would remind students that to find three-eighths of a collection, they needed to understand that there must be eight equal groups, so students would need to divide 56 into eight equal-sized groups.

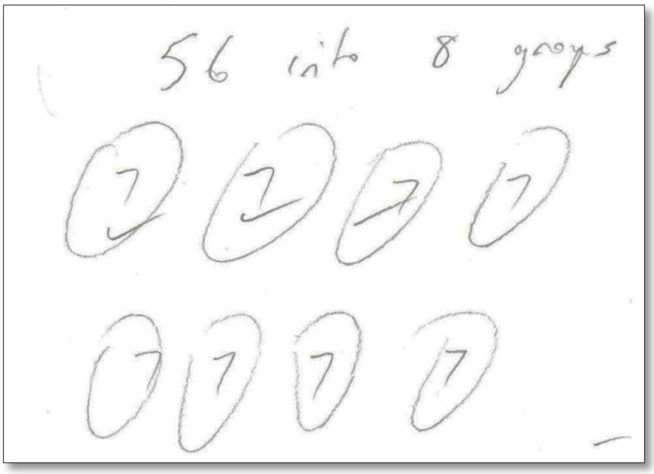
Figure 4.18

Terry's Representation of a Simple Fraction when Teaching Fractions

He explained that students could do this problem in several ways. Still, he showed in Figure 4.19 that students might draw eight circles and then divide 56 by eight to get seven in each group. He explained that students might share 56 into eight groups by ticking each group seven times, resulting in seven in each group.

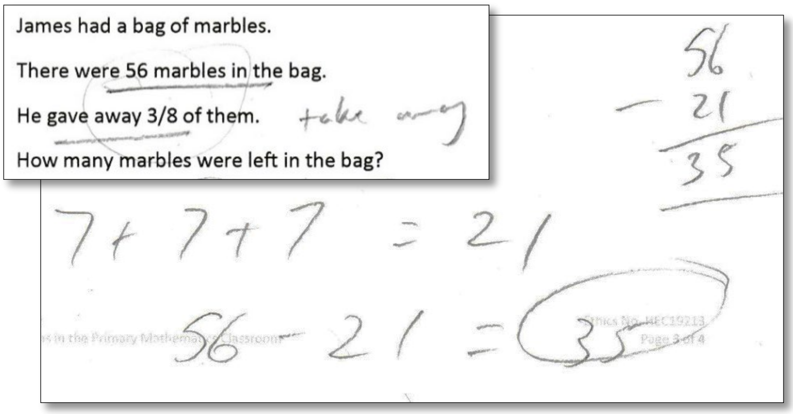
Figure 4.19

Terry's Response to Artefact 1



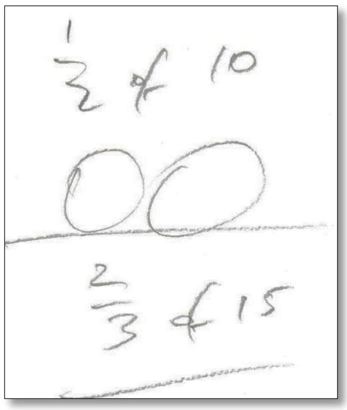
When students reached this step of the problem, they might place a large tick next to the three groups taken away or cross out the other five groups. As illustrated in Figure 4.20, students would then realise that three groups of seven are 21, either by multiplication or addition and subtract 21 from 56, resulting in 35.

Figure 4.20
Terry's Response to Artefact 1 (continued…)



This explanation revealed a procedural approach to the problem. Although several procedures could be done in the process, Terry seemed to use the most straightforward additive strategies and explained that some students might find the solution quicker because they already understood more complicated procedures to solve the problem. Terry explained that a vital part of this problem was making sure that students understood the language of the problem (e.g., "*56 marbles in the bag*", "*gave away 3/8*", "*were left in the bag?*").

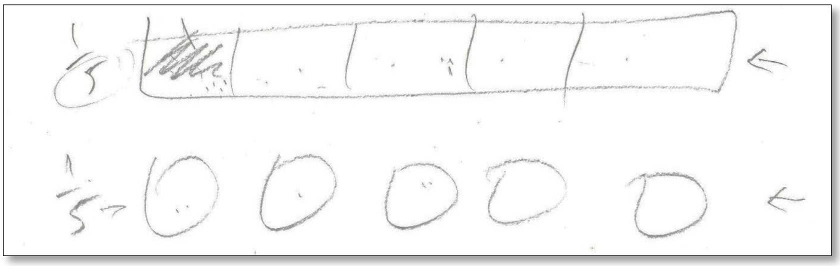
Figure 4.21
Terry's Scaffolding Questions



Terry explained further that he would not expect his students to solve this immediately but would first introduce simpler related questions. Terry noted simpler problems, such as 1/2 of 10 and 2/3 of 15 in Figure 4.21, demonstrating scaffolding students' understanding.

Figure 4.22

Terry's Representation of Differences and Similarities between Fractions of a Whole and of a Collection



Terry's explanation revealed a specialised content knowledge, uniquely representing fractions for teaching purposes. Throughout the problem, he related addition to multiplication and fractions to division. When asked how he would differentiate for students the difference between a fraction of a whole and a fraction of a collection, he drew the diagram in Figure 4.22. He represented 1/5 of a whole on a bar graph with a fifth shaded and then as five circles, explaining that 1/5 would be one in a collection of five, unpacking the concept for students to develop an understanding of fractions.

Artefact 2

In Artefact 2, Terry's responses in Figure 4.23 were consistent with the curriculum and compatible with his frequent references to the curriculum in planning. His expectations for the early years of Primary (i.e., Foundation and Year 1) were basic and somewhat vague (e.g., *1/2, what is a fraction*). Despite this, Terry's expectations remained above the expectation of the curriculum, which focused on sharing and understanding half of a whole.

Figure 4.23

Terry's Expectations Compared with the Vic F-10 Curriculum Expectations

	Terry's Expectations				
Start of Foundation	What is a fraction Half	1/2, 1/4, 1/8 Unit fractions Part of whole Collections (Relate to sharing and division)	Number Line – comparing size of fractions 1/3, 1/5 – in collections Adding/ Subtracting (same denominator) Decimals to Fractions Different numerator and denominators – comparing size Tenths and Hundredths	Percentages Multiply/Divide + - x ÷ with different denominators	**End of Primary**
	Below Curriculum (red)		**At Curriculum** (yellow)	**Above Curriculum** (green)	

Vic F-10 Curriculum's Expectations								
Start of Foundation	Sharing	Whole Half	Quarters Eighths Collections	Model/ represent unit fractions: 1/2, 1/3, 1/4, 1/5 and their multiples	Equivalent fractions Count by 1/2, 1/3, 1/4 and mixed numbers Number line Decimals to Fractions Intro. Tenths and Hundredths Worded Questions	Add/subtract fractions w common denominator Place value beyond hundredths Compare, order and represent decimals	Fractions w related denominators on a number line Add/subtract fractions w related denominator Multiply/ divide decimals Percentages	**End of Primary**
Multiplying and dividing fractions is not expected until Grade 7. Terry did not mention equivalence, place value beyond hundredths, worded questions and much of the curriculum expectations of decimals.								

Knowledge Types

When organising knowledge types in order of importance for teaching mathematics, summarised in Figure 4.24, Terry prioritised Assessment Data, Knowledge of Students and Conceptual Knowledge and placed less emphasis on Procedural, Content-Specific and Pedagogical Knowledge. Terry placed more importance on Conceptual and Procedural Knowledge than Content-Specific Knowledge. Terry's interview responses reiterated the importance he placed on Assessment Data. He often referred to assessment in the form of pre- and post-tests and grouping students according to "below", "at" and "above" ability groupings. The emphasis of knowing his students was indicated in Terry's responses when he summarised the students in his class and recounted their competence in mathematics when describing his classroom. The lack of differentiation evidenced in his responses did not support this emphasis.

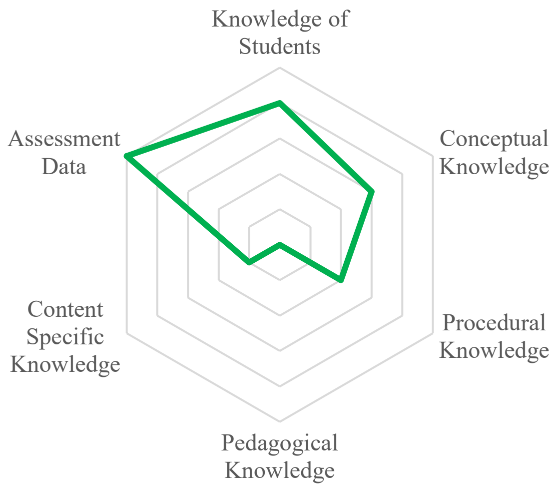
> *My expectation is that, at the end of the unit, I've got growth. They've showed learning, they've improved. The pre-test and post-test* [results] *are different. Whether they get two or three right or whether they get ten right, it's still showing improvement. I'll expect most of my kids, my 'at' and 'above' students to show good improvement.*
>
> *I've got twenty Year 2 students. I've got one student who's nearly diagnosed with an intellectual disability. I've got several students who are probably with all the maths in general, we've got probably a couple of students who are operating at a*

mid-prep level. I've had a handful of kids at the Year 1 level. I've got one kid who's in the gifted and talented scale, so she's operating Year 3, Year 4 level maths and picks things up very quickly and I've got about four or five kids who are operating above level.

Terry's tendency towards Conceptual Knowledge was reiterated in the representations used in responding to Artefact 1. Terry approached the problem in several ways, most of which revealed a conceptual understanding of the problem, supporting his preference of conceptual knowledge over procedural.

Figure 4.24

Terry's "Fingerprint" of Knowledge Priorities



Penny: "I'm definitely not a Pinterest teacher…."

Background

Penny (Interview B) is a female teacher (late-30s to early-40s), working in an Assistant Principal role at the time of the interview in a special (F-12) school in suburban Melbourne. The school caters to Intellectual Disability (ID) students with an IQ between 50-70. She had not been in a teaching role in the past year, but she had 11 years of teaching experience, mainly in mainstream primary schools in Melbourne. Her teaching experience ranged across most Years, including Years 2, 3, 5 and 6. Before becoming a teacher, Penny studied a Bachelor's degree in Commerce and commented that teaching real-world application and relevance in mathematics is the key to effective mathematics teaching.

Attitudes

When asked to describe her attitude to mathematics, Penny immediately responded:

Maths is something that I've always really loved. I've always been a maths person.

She explained that it is hard not to enjoy mathematics when mathematics can be seen everywhere in everyday life. Penny asserted that she tried to pass this practical understanding of mathematics to her students and her own two children so that they too can enjoy mathematics. She argued that a sound knowledge of mathematics and a comprehensive understanding of it were pivotal to teaching mathematics confidently with a positive mindset. Penny said that it was important for students to understand that mathematics is not difficult and assigned it one out of ten for difficulty. In contrast, Penny indicated that writing and spelling were the most challenging subjects to teach. Penny explained that many teachers have negative feelings towards mathematics, often due to a lack of knowledge in that area.

I talk to… teachers a lot around well, even if maths is something that you hate… if you're not enjoying it or you don't like it, you've got to be an actor. You've got to put on that, "this is great, I love this."

I've worked a lot with teachers who I've had to work on their knowledge. If they don't understand the concept, how can you teach the concept? …You need to deal with teacher anxiety so that they're not bringing that to their classroom and if they've got the knowledge, they're not going to feel anxious.

… there are so many teachers in there that have negative feelings towards teaching maths…

Despite this, Penny stated this could not be generalised as there is no "typical" teacher because every teacher is different. She explained that some teachers are "Pinterest" perfect teachers with picturesque classrooms and fancy templates, while others prefer to decorate their classrooms with students' work. Penny identified as the latter. She commented that no matter the kind of teacher, a good teacher is a good teacher.

I'm definitely not a Pinterest teacher. My classrooms were never perfectly displayed or anything like that. I tried to make it as real to my students as it could be so it would be all student work up there, not the pretty stuff printed off. I don't

> *know… what does a typical primary teacher look like? I think that a good teacher is a good teacher and they look like many different things… there is no box of that's what a teacher looks like and that's what we all should be.*

Expectations

A positive mindset was one of the first expectations Penny mentioned she had for her students.

> *I've been really conscious of making maths a positive thing for them… in the classroom, I was always really particular around maths doesn't just happen in our classroom. It's not just a one abstract thing that we talk about when it's a math session. It is everywhere… so yeah, trying hard to instil that positive mindset.*

As a result, Penny's expectations for her own and other teachers' teaching were that, regardless of how they felt about a mathematics concept, they be an actor and feign enthusiasm because "*if you're not enthusiastic, then your kids are going to pick up on those things.*"

Penny placed a strong expectation on students to have mental computation skills and be able to apply their understanding to the real world. She expected them to solve the problem and explain the concept(s) behind the problem and was satisfied when students could provide one of the multiple strategies and approaches to solve a problem.

> *I want my kids to be able to have a bank of skills that they can use. Mental maths is a really big thing for me. I have tried to steer… away from using algorithm, formula, that sort of mechanical stuff because, unless they understand the concept, unless they can explain the concept to you, that doesn't mean they can do them. If you're in a shop and you're working out the percentage of something, are you going to whip out your piece of paper and write an algorithm to write it down or are you going to try and solve it mentally? So just that sort of efficient bag of tricks for them.*

Penny expected her students to solve real-world problems and that she would build relevance into her teaching and provide numerous opportunities for students to work "hands-on" and physically manipulate mathematics. Her students would solve problems using various strategies, while she would expose students to multiple problem-solving strategies in her teaching practice. Penny expected to effectively communicate expectations via success criteria, learning intentions, modelling and feedback. Penny's goal for her teaching was to be "*effective*".

> *Expectations for your teaching are, well, I want my teaching to be effective.*

Penny expressed several expectations for her students. She expected students to have mental computation and problem-solving skills and for them to demonstrate their understanding of a concept by explaining it. She stated that she does not expect any of the students at her school, despite some parents' expectations, to go to university after school as they will complete their Victorian Certificate of Education (VCE) because they have an ID.

> *There are some parents who, for them, we are their respite. Their kid comes to school, that means they've got a few hours of the day. For other parents, it's, well, you're not doing enough for my kid, you know, they have expectations of they'll go to university. Well, no one at our school can go to university because they're not going to go do VCE and they're with us because they have an ID.*

Penny's expectations were mixed between an outcome-focus, explaining, "*I suppose expectations for the kids are, well, you want them to get that understanding…*" and a process-focus, explaining that she wanted students to enjoy mathematics and use specific strategies.

Influences on Expectations

Penny described many factors that influenced her expectations, which she predominantly related to her special school teaching environment. A significant factor that Penny identified was the school community in which the teacher is situated. The priorities of school leadership, fellow teachers and the external pressures of standardised tests like NAPLAN influenced expectations resulting in too high or too low expectations for student achievement.

> *Working in different schools, there are different priorities. Having lead a Year 5 team and NAPLAN was coming up and you felt that pressure of, well, you know, this is going to reflect on the whole school and that's a different expectation to the current context I'm in where… we put the pressure on ourselves… We're in a special school and I think a lot of the time special schools are, well, it doesn't matter. Progress for our kids is much more difficult to measure.*

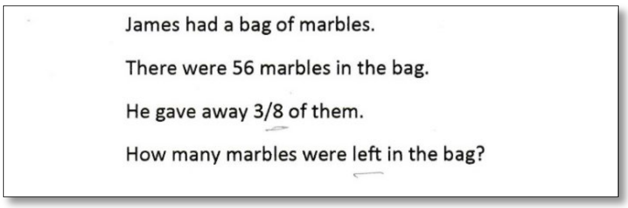
It's really about your context and the priorities of the school, the priorities of the principal, what sort of leadership you've got, the community…

Penny explained that the lack of expectation from those stakeholders resulted in teachers scrambling to find the standard by which they could compare students. Penny noted that other teachers influenced expectations and teaching practice due to collaborative planning where strategies, resources, learning and research were shared. Parental expectations, according to Penny, played a crucial role in influencing expectations. Some parents may not expect anything other than their child to be looked after throughout the day while others may expect their child does so well that they will be able to progress to university. Penny stated that the pressure to be "*on top*" of where students are educationally, and what they are doing, also influenced teachers' expectations.

Artefact 1

Penny's response to the worded question problem was primarily verbal, and she did not illustrate her solution beyond underlining keywords, as indicated in Figure 4.25. She responded to the question "How would you teach it?" with a description of expectations of how students would approach the problem but without explicitly solving the problem or providing a specific strategy. She indicated a procedural strategy suggesting she would get students "*to work out… what's one-eighth of 56*" and then "*multiply that by three*" and then "*use your subtraction skills*". Her answer was vague, and Penny did not provide a solution to the problem. The only things noted down on Artefact 1 was a line beneath "3/8" and "left" in the question. Penny missed the correct response indicating only the first few steps of the problem and did not verbalise the final step to subtract the fraction taken away.

Figure 4.25
Penny's Response to Artefact 1



Artefact 2

In Artefact 2, Penny annotated her expectations of achievement across a line graph as summarised in Figure 4.26. She was vague in placing her expectations and did not indicate year levels on the graph. However, based on the placement and explanation, it appeared that Penny's expectations were congruent with the curriculum. There were minor exceptions in equivalence, which was placed early in the graph although not expected until Year 4 in the curriculum, and ratio, which was placed at the end of primary but is expected the following year in secondary teaching. One aspect unique to Penny's response is the headings "*understanding*", "*fluency*", and "*problem-solving/reasoning*" placed alongside the graph, potentially indicating an expectation of scaffolding. These expectations indicated understanding to be taught first, then fluency and finally, putting both together to "*reason*", a marrying of conceptual and procedural knowledge. It is noteworthy, however, that these proficiencies are prescribed across the Victorian F-10 Curriculum's Mathematics Strands and may not reveal personal expectations but that of the curriculum (VCAA, 2021). Despite placing her expectations broadly, Penny later emphasised her expectations were heavily student-dependent because her expectations adapt to students who are far ahead of the expectation and to students who are far behind it.

Figure 4.26

Penny's Expectations Compared with the Vic F-10 Curriculum Expectations

Penny's Expectations

Start of Foundation	**What appeared to be Foundation to Grade 3** Part Numbers Money Fractions of a whole/ Fractions of a group Equal	**Grade 4** Decimals	**Grade 5** Mechanical application (Adding & subtracting, etc. with fractions)	**Grade 6** Percentages Ratios	**End of Primary**
	Understanding	**Fluency**		**Problem Solving/ Reasoning**	
	Below Curriculum	**At Curriculum**		**Above Curriculum**	

Vic F-10 Curriculum's Expectations

Start of Foundation	Sharing	Whole Half	Quarters Eighths Collections	Model/ represent unit fractions: 1/2, 1/3, 1/4, 1/5 and their multiples	Equivalent fractions Count by 1/2, 1/3, 1/4 and mixed numbers Number line Decimals to Fractions Intro. Tenths and Hundredths	Add/subtract fractions with common denominator Place value beyond hundredths Compare, order and represent decimals	Fractions with related denominators on a number line Add/subtract fractions with related denominator Multiply/ divide decimals Percentages	**End of Primary**

					Worded Questions		

Ratio is not expected until Grade 7. Penny's response is quite vague with many specific concepts missing.

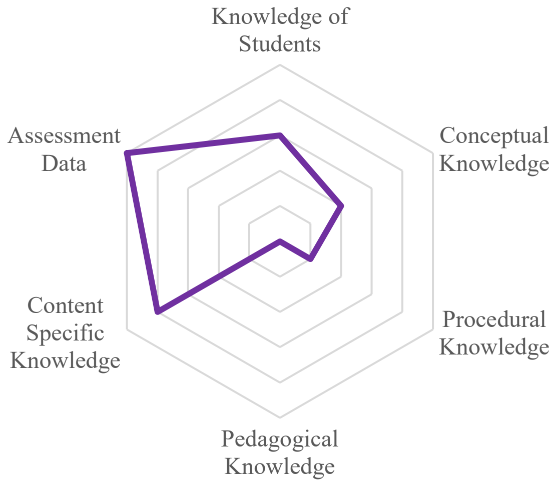
Knowledge Types

When prioritising knowledge types for teaching mathematics, Penny listed an order of Assessment Data, Content-Specific Knowledge and Knowledge of Students with less emphasis on Conceptual, Procedural and Pedagogical Knowledge, indicated in Figure 4.27. This aligned with Penny's interview responses. The exception was Penny's prioritisation of Assessment Data as most important. Penny discussed the importance of teachers understanding concepts themselves first to teach them. She also referred to the importance of teaching understanding of the concept before any procedural information was taught.

> *If they* [teachers] *don't understand the concept, how can you teach the concept? That's probably a lot of it. You need to deal with teacher anxiety so that they're not bringing that to their classroom and if they've got the knowledge, they're not going to feel anxious.*

> *Mental maths is a really big thing for me. I have tried to steer our teachers away from using algorithm, formula, that sort of mechanical stuff because, unless they* [students] *understand the concept, unless they can explain the concept to you, that doesn't mean they can do them.*

Figure 4.27
Penny's "Fingerprint" of Knowledge Priorities



Penny's emphasis on Assessment Data was less evident in her interview. She briefly mentioned assessment during her interview, referring to NAPLAN and stated that measuring students' progress in her school context was "*much more difficult to measure*".

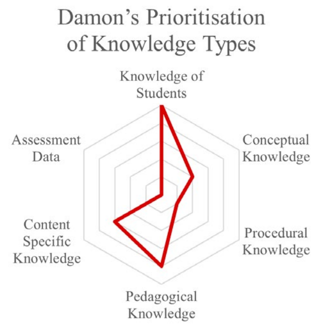
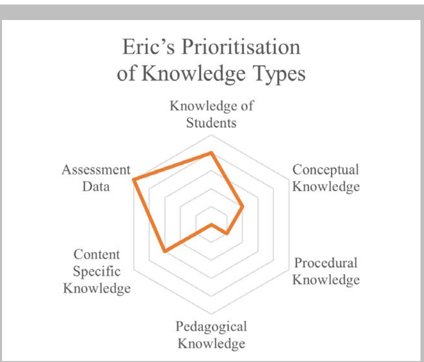
> *We've had to create our own, sort of, documentation around how we measure our kids and the… because they do grow, they do learn. How do we measure that? How do we show they've progressed? Department supports don't support us; we have to create our own stuff…*

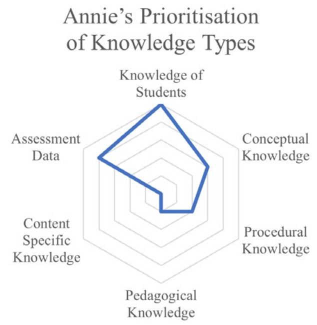
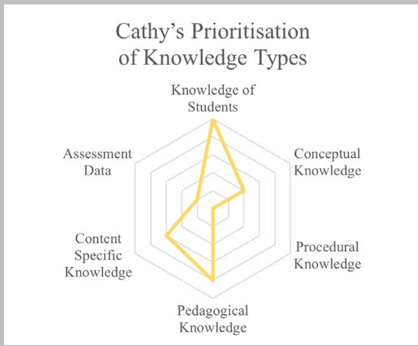
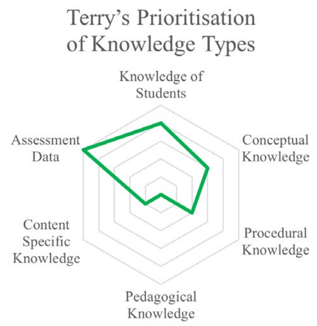
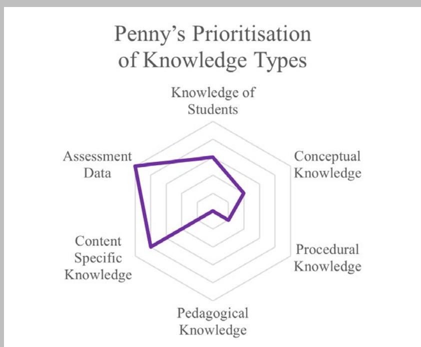
Summary

The following table, Table 4.2, is included to summarise the interview snapshots discussed in this chapter. The next chapter—Chapter 5 Discussion—discusses the ramifications of the research outcomes addressing the knowledge of teachers in this study and the prioritisation they place on various forms of knowledge; the representations of fractions by interview participants and how this compares with current literature; the expectations of teachers in this study; and the influence their knowledge appeared to have on the perceived expectations.

Table 4.2

Summary of Interview Participant Snapshots

Interview Participant	Participant Details	Participant's Knowledge "Fingerprint"
Damon	• 2 years teaching experience. • Independent Denominational P-12 school in rural area. • Negative perception of mathematics growing up. • Acknowledges that mathematics is still difficult to teach at times. • Presented fractions primarily as part of a whole. • Expectation for the process of learning rather than the outcome.	
Eric	• 3 years teaching experience. • Independent all-boys' school in metropolitan Melbourne. • Positive perception of mathematics and feels confident. • Believes that some mathematics is just memory based and that genetics plays a role in achievement.	

	• Expects specific outcomes from students such as “mental computation, the four processes, and application of knowledge to tasks.”	
Annie	• 3 years teaching experience. • P-6 Denominational Independent school in suburban Melbourne. • Negative perception of mathematics and expresses mathematics anxiety. • Believes that the basics are “enough to get by.” • Expectation students meet the curriculum requirements of their year level.	
Cathy	• 8 years teaching experience. • P-6 Government school in outskirts of Melbourne. • Struggled to understand mathematics as a child; understood it more as an adult. • Believes mathematics to be hard, tricky and challenging but necessary. • Expectation for students to use multiple strategies when working mathematically.	
Terry	• 9 years teaching experience. • P-6 Government school in rural area. • Positive perception of mathematics; “Maths… is my area.” • Finds it “frustrating” when “the kids don’t get it.” • Expectation for students to meet the “at” standards of the curriculum.	
Penny	• 11 years teaching experience. • P-12 Special school in suburban Melbourne. • Positive perception of mathematics; “I’m a maths person.” • Believes many teachers lack knowledge in mathematics but believes it to be easy. • Expects specific outcomes of students including “mental	

	computation and application of understanding to tasks"; also expects a positive mindset from students.	

5. Discussion

You can't teach what you don't know, and you can't expect from students what you don't know should be expected.

The statement above formed the foundation of this study. The study focused on how this proposition played out in teachers' understanding of content and centred around two teacher characteristics that influence student achievement: knowledge and expectations. Teacher knowledge was understood and defined as the teacher's understandings specifically related to content. As a literature review was completed, however, and a methodology was constructed, it became apparent that the definition was insufficient in capturing the complexity of teacher knowledge that it was intended to encompass. Although content knowledge was the initial focus of this study, teacher knowledge encompasses many aspects of knowledge, including pedagogical knowledge, knowledge of students, curriculum knowledge, and various forms of content knowledge such as procedural and conceptual knowledge (D. Ball et al., 2008; Hill et al., 2008; Shulman, 1986). Teacher knowledge also encompasses knowing what gaps there are in knowledge, particularly a teacher's own knowledge. In other words, "knowing what I don't know."

Initially, expectations were defined as the beliefs the teacher holds for their students' capabilities and achievement (Peterson et al., 2016; Timmermans et al., 2015). Like teacher knowledge, this definition lacked the appropriate complexity of everything that teachers' expectations comprise. Teacher expectations are not limited to the beliefs held about students' capabilities and achievements. They include an intricate web of expectations that consist of beliefs for themselves and their capabilities as teachers and their beliefs about the environment they teach in, the parents/guardians of students they teach and the societal expectations they believe to be in place (Rubie-Davies et al., 2018). In this sense, a teacher may perceive certain expectations placed on themselves from various stakeholders and respond by holding expectations based on the school context. Thus, teachers' expectations for their students have a dynamic relationship with their expectations for themselves, which reflects the school community's expectations.

The directing statement about teacher knowledge at the heart of this study is particularly relevant to the primary teaching environment where teachers are not always experts on what they are teaching, especially when it comes to mathematics and science. In many primary classrooms in Australia, teachers are generalists trained to teach across the curriculum and are unlikely to have specialist knowledge in one or more disciplines

(Brown & McNamara, 2011; Collins, 2016; TEMAG, 2014). Even when primary teachers pursue a specialist discipline, it is unlikely to be mathematics or science. Consequently, and according to the literature, mathematics is a discipline that many primary teachers struggle to teach and, in some cases, causes a great deal of anxiety for the teachers and their students (TEMAG, 2014). This is particularly the case when it comes to fractions, a concept that teachers and students alike struggle to grasp fully (Getenet & Callingham, 2021; Way & Bobis, 2011). This issue raises many questions: How can teachers who do not have a strong understanding of mathematics, specifically fractions, teach it effectively? If they do not have the precise pedagogical understandings of the content, how can they identify what understandings students need? How can they set high, realistic expectations of students for a concept in which they have limited knowledge? This study aimed to address these concerns.

This chapter is divided into four sections. The chapter discusses findings from two sources, namely the questionnaire results and the interviews. As such, each section first addresses and discusses the broader questionnaire results. Subsequently, the findings from the six interviews participants are discussed in detail. The four sections of this chapter are as follows:

1. Representations of fractions by teachers in this study
2. Teachers' knowledge and justifications for preferencing types and qualities of knowledge
3. Teachers' expectations and associations with teachers' knowledge
4. Perceived identity teachers held for themselves and potential impact on pedagogy

Representations of Fractions

This section discusses the responses of the surveyed respondents which also includes responses from the six interviewed participants. Respondents were surveyed on their attitudes towards mathematics and fractions, specifically regarding the perceived difficulty of teaching fractions and what they considered the most difficult concepts for students to learn and teachers to teach. The interviewed participants provided further detail and explanation of their responses. They developed Artefact 1 during the interview (Appendix D), responding to a fractions question with how they would expect students to solve it, that demonstrated to some extent their understanding of mathematics and fractions. These interview responses are discussed in light of Behr et al.'s (1983) and Kieren's (1976) five subconstructs of fractions.

Perceptions of Fractions Among Questionnaire Respondents

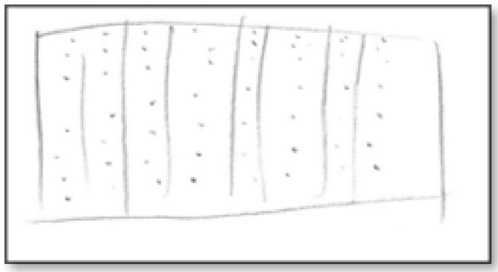
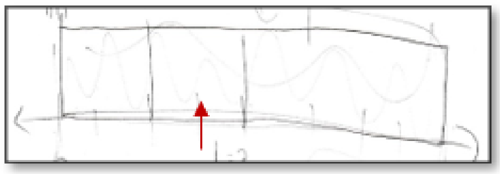
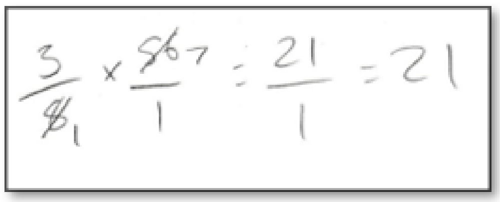
Numerous researchers point to fractions as a notoriously difficult concept to both learn and teach (Behr et al., 1983; Getenet & Callingham, 2021; Lamon, 2007, 2012; Siemon et al., 2015; Way & Bobis, 2011). Perceptions of mathematics and fractions differed among questionnaire respondents, but most responses reflected what the literature reported in this regard. A third of respondents indicated they found mathematics somewhat challenging, with some experiencing anxiety when working with and teaching mathematics. The majority indicated fractions was one of the most challenging concepts to learn in primary mathematics. Kieren (1976) argued that this is largely due to the complexity of fractions, interpreted in at least five different subconstructs, each of which must be understood to comprehensively understanding fractions.

Fraction Subconstruct Representations Among Interview Participants

Though the questionnaire respondents provided a glimpse into their fraction understandings, the interviews provided detailed accounts of teacher understandings concerning fractions. The interviewed participants exhibited a broad range of fractions understandings. These fractions representations aligned with the subconstructs of fractions developed by Kieren (1976) and Behr et al. (1983) and summarised by Way and Bobis (2011). According to Way and Bobis (2011), five subconstructs can be used to understand fractions: part-whole comparison, quotient, measure, operator, and ratio. These subconstructs are explained in Table 5.1 using examples from this study.

Table 5.1

Description of the five fraction subconstructs, adapted from Way and Bobis (2011)

Fraction Sub-construct	**Meaning (as applied to the fraction $\frac{3}{8}$)**	**Examples from participants in this study ($\frac{3}{8}$ of 56)**
Part-whole comparison	$\frac{3}{8}$ is interpreted as three parts out of eight equal parts. Equivalent fractions are found by identifying a constant multiplicative relationship between the units being compared. There is only one rational number underlying each set of equivalent amounts.	
Quotient or Division	3 divided 8. If there are three items to be shared among 8 people, they each get $\frac{3}{8}$. (Note: This understanding of fractions enables the student to realise that sharing 56 into 8 is the same as 56 eighths or 7 marbles per person).	While some representations in this study showed some signs of this subconstruct, it was not clearly represented in this study but could be presented as: 56 marbles divided into 8 groups is the same as 56 eighths.
Measure	$\frac{3}{8}$ refers to a number that can be located three $\frac{1}{8}$ units distance from zero on a number line.	
Operator	$\frac{3}{8}$ 'of' something. Fractions as operators act to enlarge or shrink a number.	
Ratio	A multiplicative relationship is used to compare the size of two sets or measurements e.g., 3 girls compared to 8 boys.	Not represented in this study but could be presented as: The number of girls in the class is $\frac{3}{8}$ the number of boys. If there are 21 girls, how many children are there in the class?

Part-whole Subconstruct.

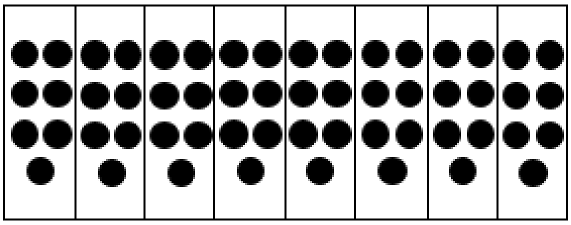
Most of the participants in this study exhibited the part-whole subconstruct of fractions. This finding supports Getenet and Callingham's (2021) finding that the part-whole construct was the most frequently observed among teacher's and students' discussions. During the interview, all participants illustrated this subconstruct when describing how they expected their students to approach fraction problems. This subconstruct was described by Way and Bobis (2011) as the most well-understood subconstruct when working with fractions, and it applies to each of the other subconstructs. This subconstruct represents fractions as equal parts of a greater whole and, according to Behr et al. (1983), is the first fraction subconstruct students learn. Despite the fraction question in Artefact 1 referencing a fraction of a collection, most participants represented the collection as a whole shape divided into eight equal parts and shared the collection into those parts. Participants frequently referred to "sharing" the fraction into each part and "dividing" the collection. Although this terminology is similar to that used when referring to the quotient subconstruct, this language primarily reflected a part-whole understanding.

Quotient/Divisor Subconstruct

The quotient or divisor subconstruct can be compared to the part-whole subconstruct of fractions which, according to Kieren (1976), is closely related but differs slightly according to context. Although the part-whole subconstruct refers to fractions as a part of the whole, the quotient subconstruct recognises the partitioning aspect of fractions. In other words, the part-whole model represents a fraction as a piece of a cake, but the quotient subconstruct represents a fraction as a cake cut into pieces. Though most participants used a part-whole representation of fractions, none represented the quotient subconstruct other than referencing "dividing" and "sharing", which also apply to the other fraction subconstructs. As illustrated in Figure 5.1, participants in this study typically shared a collection of objects into sets (56 objects into eight sets—part-whole, on the left) rather than objects into parts (56 objects in eight groups are equivalent to 56 ÷ 8 = 56/8 = 7 per group—divisor, on the right):

Figure 5.1

Comparison of Part-whole and Quotient/Divisor Subconstructs of Fractions



$$56 \div 8 = \frac{56}{8} = 7$$

Measure Subconstruct

The measure subconstruct of fractions, which represents fractions as an amount of something, was referred to throughout the study. One participant, Cathy, referred to rulers as an effective way to teach fractions. Cathy, Damon, and Terry also referred to placing fractions on a number line, referencing the measure subconstruct. Kieren (1976) described this subconstruct as a "natural" subconstruct for fractions where the fraction is assigned to a region and addition of the fraction, and decimal notation of fractions is more clearly seen and linked (p. 121). Way and Bobis (2011) further described the measure subconstruct as often misunderstood because many students see fractions dependent on the size of the whole rather than as a number in and of itself. Getenet and Callingham (2021) observed similar misunderstandings. Therefore, Way and Bobis (2011) recommended using numbers lines extensively with students to help them “see how whole numbers, fractions and decimals relate” (p. 30). This subconstruct is particularly relevant to the problem posed in Artefact 1 (Appendix D), where the whole is made up of 56 units, and three-eighths of this collection was equivalent to 21 units.

Operator Subconstruct

The operator subconstruct is a largely procedural subconstruct of fractions dealing primarily with multiplication and division (Getenet & Callingham, 2021), which shrinks or enlarges a number. This subconstruct was represented by participants using multiplication and division facts to solve fraction problems; however, representations of this were scarce, clearly illustrated only by Eric. The other participants that mentioned this subconstruct referred to “multiplication and division facts” without representing how they could be used when working with fractions. Penny referred to multiplying an eighth to find the answer to the problem in Artefact 1 but did not provide any visual representation of this nor did she provide a final solution to the problem.

Ratio Subconstruct

Finally, the ratio construct was not referred to or represented during this study; however, this may have been due to the fraction questions presented in this study, which did not lend themselves to representing fractions as a ratio. The closest a participant came to conveying a ratio construct of fractions was comparing the groups in a collection. They stated that there were 21 marbles given away to 35 marbles left, but this resulted from working out the problem using the part-whole construct rather than explicitly identifying a ratio subconstruct at work.

Fraction Subconstructs as Precise Pedagogical Understandings

Generally, in this study, fractions were primarily understood and represented using a part-whole subconstruct, while other constructs were used less frequently and occasionally misunderstood. This preference for the part-whole subconstruct supports findings from other studies suggesting that current teaching practices typically “focus on the part-whole interpretation, often to the detriment of a more inclusive understanding of fractions” (Getenet & Callingham, 2021; Way & Bobis, 2011, p. 13). This was apparent with one participant, Annie, who used the part-whole subconstruct to represent the problem in Artefact 1 but then struggled to find a solution to the problem. Each subconstruct is equally important as they provide a holistic understanding of fractions (Behr et al., 1983; Getenet & Callingham, 2021; Way & Bobis, 2011). Despite this, the part-whole subconstruct is typically well understood by teachers and students as it relates to how whole number is learnt and understood. The subconstructs of measure and operator also relate more closely to an understanding of whole number. Unsurprisingly, participants also used these subconstructs to represent fractions, albeit less frequently than the part-whole subconstruct. The final two subconstructs, quotient and ratio, were rarely represented accurately by participants in this study, if at all. A likely explanation for this is because these two subconstructs differ the most from understandings of whole number (Lamon, 2012; Way & Bobis, 2011). This outcome supported Lamon's (2007, 2012) and Way and Bobis' (2011) arguments, which suggested various misconceptions occur due to not understanding fractions thoroughly.

Possible Reasons for Lack of Subconstruct Representation in this Study

The lack of representation on most of the fractions subconstructs by participants in this study presents a concern as these subconstructs form a series of precise pedagogical understandings of fractions. If they are misunderstood or fail to be represented or expected by teachers, students can struggle to understand fractions holistically and are more likely to hold misconceptions in this area (Getenet & Callingham, 2021; Lamon, 2007, 2012; Way & Bobis, 2011). There are four potential reasons for this apparent lack of representation. The first explanation for the apparent lack of representation of the various subconstructs of fractions, particularly that of quotient and ratio, could be due to the nature of the interview questions. These questions could only point teachers towards representing the problem in various ways but did not compel participants to represent the problem using all five subconstructs. Requesting that participants represent each subconstruct in their response would have interfered with the validity of their responses. Secondly, the mathematical questions used to analyse participants' fraction knowledge did not readily lend themselves to quotient and ratio subconstructs, as did the other subconstructs. A third explanation is that participants solved the problem provided in the interview rather than explaining how they would have taught it or expected their students to solve it. Most participants first solved the problem and then explained that they expected their students to solve it in much the same way. A final explanation for the lack of variety in fraction representation is that the participants may not have been familiar with or confident in representing fractions using other representations. This explanation is consistent with the conclusions made by Lamon (2007, 2012) and Way and Bobis (2011), suggesting teachers are not comfortable using subconstructs other than part-whole. They suggested this was due to feeling overwhelmed by the other subconstructs and primarily experiencing only a part-whole subconstruct throughout their education.

Teacher Knowledge and their Justifications

Initially, much of the knowledge reflected by teachers in this study was discussed as primarily Content Knowledge in the form of "knowing" fractions. This was the specific lens through which this study examined participants' knowledge and expectations. Beyond this, however, the teachers in this study made multiple references to other types of knowledge beyond content knowledge, reflecting broader pedagogical knowledge. These references pointed to the complexity of teacher knowledge proposed by D. Ball et al. (2008) and Shulman (1986) and were considered in the design of the questionnaire and interview used in this study. Effectively teaching mathematics goes beyond simply knowing specific concepts and subconstructs in a particular discipline. It extends to knowing: students and how they learn; how students have performed in the past; how best to teach a specific concept in a particular discipline; fundamental pedagogical understandings behind concepts; and how to solve problems effectively and efficiently (AITSL, 2019; D. Ball et al., 2008). Beyond these, however, teacher knowledge extends to the individual beliefs, experiences and attitudes teachers hold towards the disciplines and concepts they teach (Bobis et al., 2012). Of 34 respondents, 27 categorised their prioritisation of knowledge in this study. As the questionnaires were carried out and analysed first, followed by the interviews, the 21 questionnaire responses are discussed first, excluding the six participants' responses. The interviewed participants' responses are then discussed, collectively considering their questionnaire and interview responses. A further theme emerged from the results, namely how teachers respond to knowing what they do not know and is also discussed.

Prioritisation of Knowledge Types by Surveyed Teachers

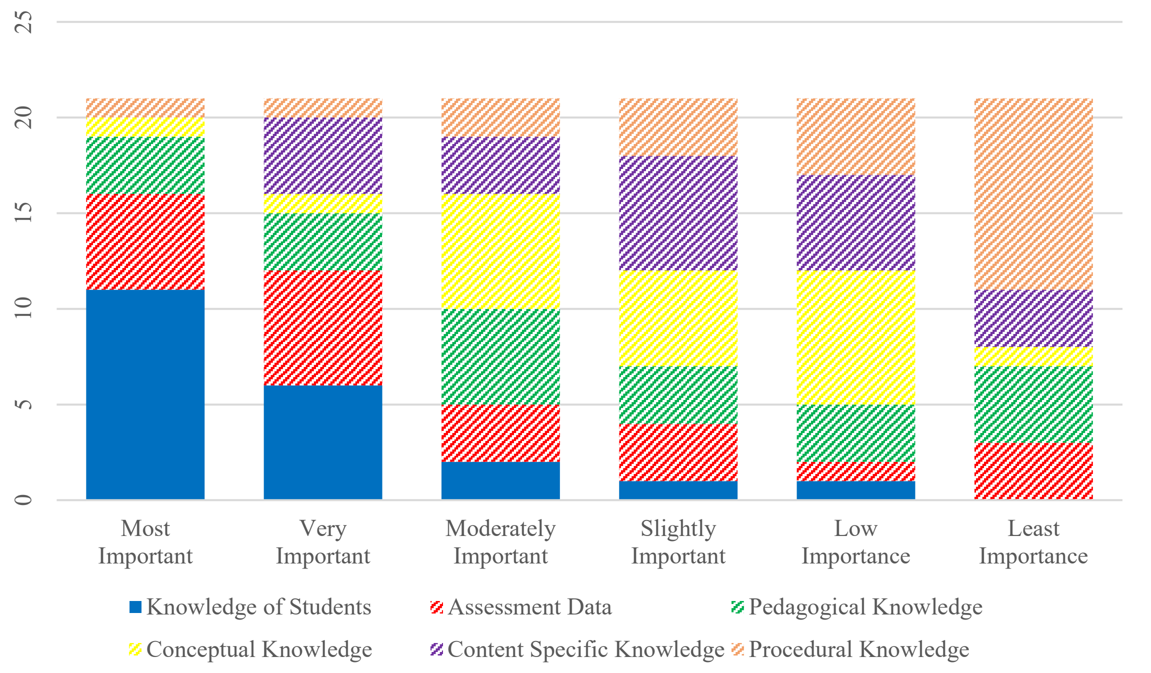
This study found that each respondent had distinct content and pedagogical knowledge. Each teacher had diverse experiences with mathematics, formed unique beliefs and attitudes towards mathematics, and indicated and depended on various forms of knowledge more than others due to individual experiences, beliefs and attitudes. Nevertheless, a broad range of knowledge was displayed by teachers throughout this study, together with justifications for why each respondent preferred certain forms of knowledge over others. Drawing from Figure 4.2 in the previous results chapter, Figure 5.2-5.4 illustrate the various emphases on the specific types of knowledge necessary for teaching. These allocations of knowledge types generally corresponded with the stated experiences and attitudes of the interviewed participants towards mathematics and teaching mathematics.

Knowledge of Students

Generally, all surveyed respondents in this study prioritised knowing their students, with many teachers rating it as "most important" as indicated by the blue in Figure 5.2. The Australian Professional Standards for Teachers support this emphasis, acknowledging the importance of teachers knowing their students and how they learn (AITSL, 2018). Additionally, this finding supports Ball et al.'s (2008) claim that "many demands of teaching require knowledge at the intersection of content and students" and that effective mathematics teaching "requires an interaction between specific mathematical understanding and familiarity with students and their mathematical thinking" (p. 401). It is this interaction of knowledge that gives teachers "skills, insights, and wisdom beyond that of other mathematically educated adults" (Hill et al., 2008, p. 395).

Figure 5.2

Surveyed Teacher Respondents' Prioritisation of Knowing their Students



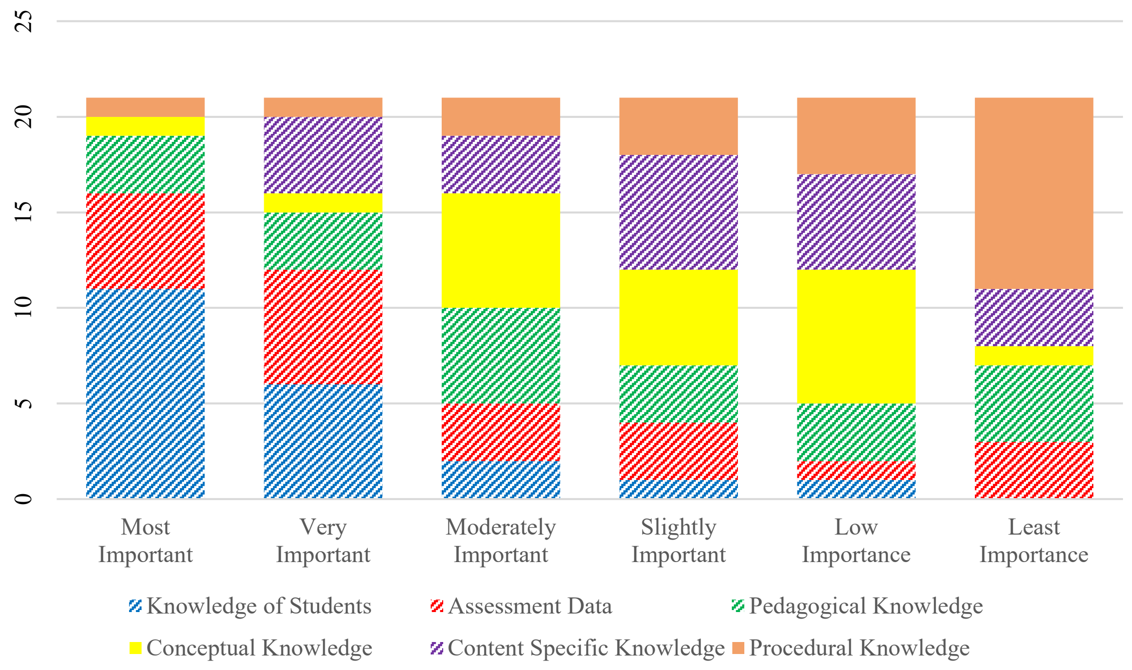
Note: this does not include the findings of interviewed participants.

Conceptual and Procedural Knowledge

With few exceptions, all teachers considered conceptual knowledge slightly important for teaching mathematics, as indicated by the yellow in Figure 5.3. Procedural knowledge was typically considered of the least importance, as indicated by the orange in Figure 5.3. This placement of conceptual and procedural knowledge as low in importance, and the varied placement of content-specific knowledge among most respondents challenge the argument that teachers need to know the content to teach it, a founding notion at the heart of this study. Similarly, conceptual knowledge is typically ranked higher than procedural knowledge in this study, indicated by the greater distribution of yellow than orange on the left side of Figure 5.3. This indicates that teachers generally believe that students' understanding of the underlying concepts in mathematics is more important than teaching the specific rules and procedures associated with mathematics. This finding supports Star and Stylianides' (2013) argument that teachers typically consider conceptual knowledge more important than procedural knowledge. However, this finding supports a founding notion of this study, namely that conceptual knowledge is a fundamental part of students' mathematical understanding and should be taught with as great a focus as, if not more than, procedural knowledge.

Figure 5.3

Surveyed Teacher Respondents' Prioritisation of Conceptual and Procedural Knowledge



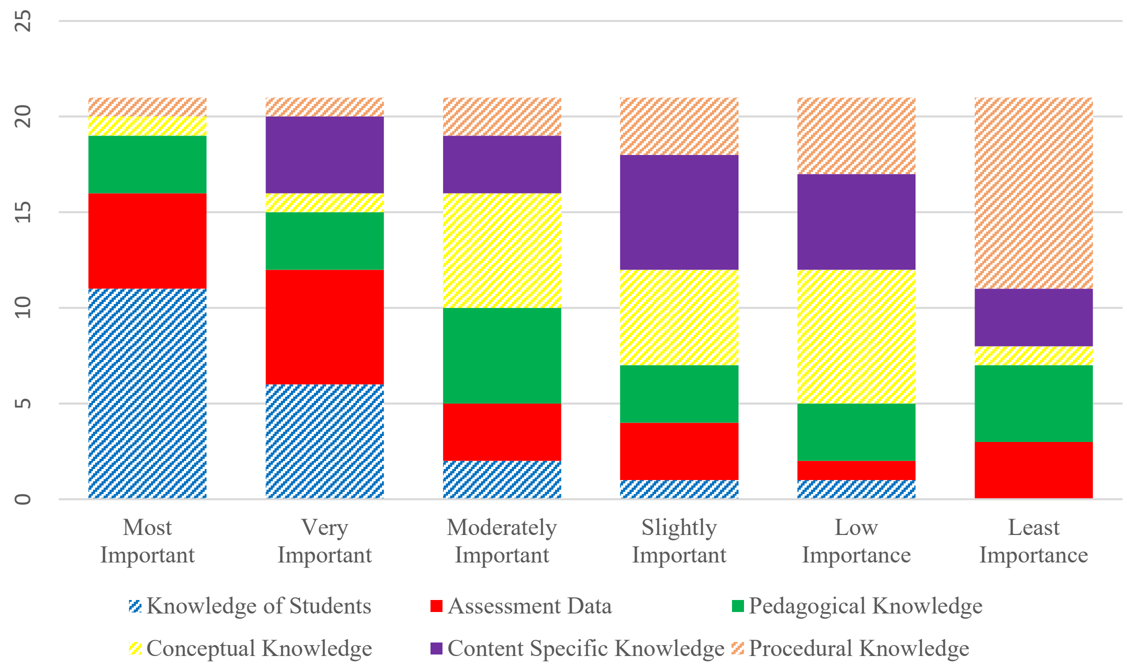
Note: this does not include the findings of interviewed participants.

Assessment Data, Pedagogical Knowledge, and Content-Specific Knowledge

In contrast, the other forms of knowledge presented to the respondents of this study were varied in prioritisation, summarised in Figure 5.4. There were few consistent trends. Assessment Data was one of the most important forms of knowledge needed for teaching and planning for teaching according to 14 respondents rating Assessment Data as Most, Very or Moderately Important. The remaining seven respondents stated that this was one of the least important, rating Assessment Data as Slightly, Low or Least Important. The Australian Professional Standards for Teachers explicitly list this type of knowledge, like Knowledge of Students, which supports prioritising this form of knowledge as a priority (AITSL, 2018). It also flags significant variance among the respondents regarding the importance of assessment data which typically assesses specific outcomes and relates closely to the expectation types discussed in the next section.

Figure 5.4

Surveyed Teacher Respondents' Prioritisation of Assessment Data, Pedagogical Knowledge and Content-specific Knowledge



Note: this does not include the findings of interviewed participants.

The responses emphasising knowing how to teach (i.e., pedagogical knowledge) and what to teach (i.e., content-specific knowledge) were varied. On the one hand, 14 respondents prioritised pedagogical knowledge over content-specific knowledge. On the other, seven respondents prioritised content-specific knowledge over pedagogical knowledge. In most of these responses, however, both forms of knowledge were listed side by side, indicating no significant variance in respondents' preference for one form of knowledge. Ball et al. (2008) broadly categorised all types of teacher knowledge under

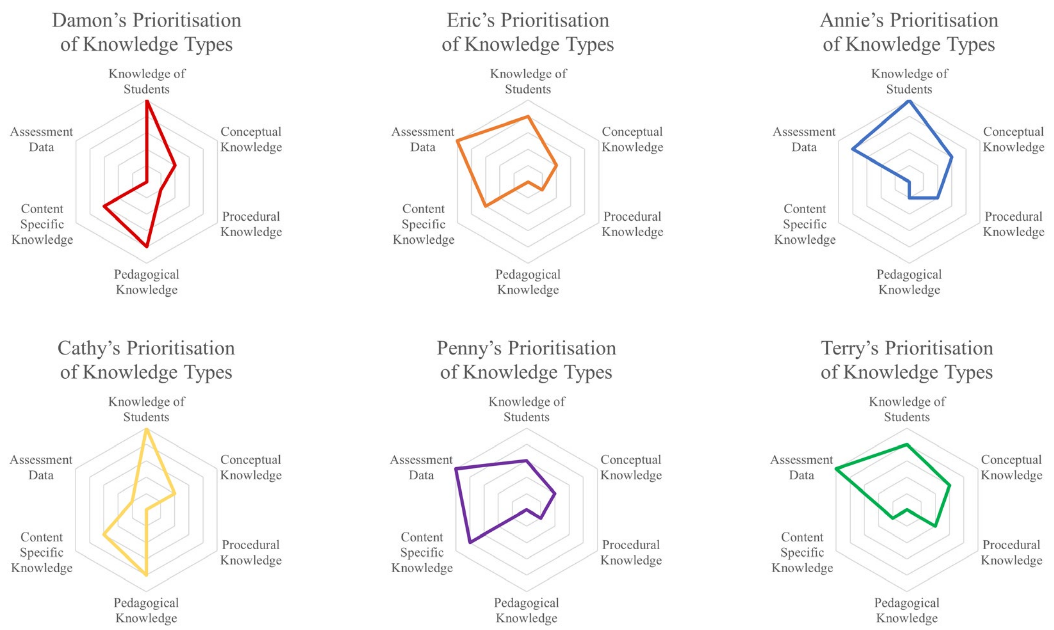
Shulman's (1986) content knowledge and pedagogical knowledge, and it is the combination of both as PCK that produces effective teaching. Thus, it is to be expected that these forms of knowledge would be prioritised similarly.

Comparing Interview Findings with Questionnaire Results

The responses provided in the questionnaire from the interviewed participants were like those of the surveyed respondents. However, unlike the surveyed respondents, the interviewed participants' prioritisation of knowledge types was compared with their interview responses, illustrated in Figure 5.5, summarising results from the previous chapter. Like the surveyed respondents, the interviewed participants prioritised knowing their students as most or very important. In every interview, this prioritisation was apparent. Each participant frequently referred to the diversity of students in their classrooms and how they catered for this. The only discrepancy in this regard was the difference in how participants placed their expectations. Some participants stated expectations that were imprecise and targeted a cohort of students across multiple year levels. In contrast, other teachers indicated precise expectations for each year level or suggested that certain students in their classroom were working at a specific level while others were working at another.

Figure 5.5

Interviewed Participants' "Fingerprints" of Knowledge Prioritisation



Note: The two participants on the left have distinctly different forms to the four participants on the right.

Likewise, Conceptual Knowledge and Procedural Knowledge followed a similar trend. Every participant prioritised Conceptual Knowledge over Procedural Knowledge, and both knowledge types were prioritised as slightly, low or least important. Most participants referred to both types of content knowledge in their interview responses, outlining a balance of both types as necessary for understanding and performing mathematics, a finding supported by Star and Styliandes (2013). Eric provided one exception to this. He stated that his students no longer needed specific conceptual instruction in Year 6, but rather, his job was primarily to instruct his students in using procedures effectively and efficiently. This prioritisation of procedural knowledge before conceptual knowledge did not support his questionnaire response. However, this emphasis does not contradict Eric's responses as this was a specific claim in the context of the Year 6 students to whom he was referring.

As indicated in Figure 5.5, there are distinct differences in the "fingerprints" of Cathy and Damon compared with the other four participants. Cathy and Damon, the two "fingerprints" on the left, prioritised Pedagogical Knowledge, unlike the other four participants who stated that Pedagogical Knowledge was low or least important in teaching mathematics. Likewise, the two "fingerprints" on the right, Annie and Terry, prioritised Content-Specific Knowledge as low or least important. In contrast, the other four participants prioritised it as very or moderately important. Like the questionnaire respondents, these responses indicated variance in the prioritisation of these two knowledge types. Cathy and Damon emphasised Pedagogical Knowledge equally in their interview and questionnaire responses, frequently referring to understanding pedagogy over understanding mathematical content. Additionally, both Eric and Penny emphasised Content-Specific Knowledge in their questionnaire responses and this prioritisation was reflected in their interviews. Both participants frequently described their positive and confident attitudes towards mathematics and teaching mathematics. Similarly, Annie's anxiety and lack of mathematical content knowledge presented in her interview reflected her low prioritisation of Content-Specific Knowledge in the questionnaire.

Finally, the prioritisation of Assessment Data as a knowledge type necessary for teaching was varied. The four participants on the right prioritised Assessment Data as most or very important, whereas the remaining two participants on the left, Cathy and Damon, rated it as low or least important in favour of Pedagogical Knowledge instead. Most of the interviewed participants supported their prioritisations through various beliefs or attitudes stated in the interview. Both Eric and Terry prioritised Assessment Data in their questionnaire responses and made specific references in their interview regarding the use of assessment and how they assess. In contrast, Annie stated in the questionnaire that Assessment Data was very important for teaching mathematics but made little mention of it in her interview. Similarly, Penny prioritised Assessment Data, but her responses in the interview did not support her prioritisation. This does not indicate that Annie and Penny did not prioritise Assessment Data but may instead suggest that the semi-structured nature of the interview did not lend itself to address assessment in Annie's and Penny's cases specifically.

Pedagogical Responses to Knowing "what I don't know"

A finding that emerged concerning teacher knowledge in this study that did not appear in the literature review was that participants' understanding of what they knew was equally as crucial to their understanding as what they did not know. In one response to a question regarding the impact of experience on teaching mathematics, a teacher wrote, "it [experiences with mathematics] directly impacted my lack of understanding mathematics! Teaching it has helped me understand concepts so much more." This teacher recognised mathematics concepts she lacked understanding in and addressed these knowledge gaps in her practice. As a result, this teacher's knowledge could be placed in the consciously incompetent stage (Hansen, 2013) where the individual knows what they do not know (i.e., are conscious of their incompetence). This teacher is then in the position to respond to this conscious incompetence by addressing the knowledge gap and turning their conscious incompetence into conscious competence (Hansen, 2013, p. 35).

Participants in this study appeared to have a sufficient mapping of mathematics, particularly fractions, to identify the areas wherein they lacked understanding. This realisation poses an ultimatum: to teach the areas of poor understanding by seeking out greater understanding or prioritise teaching areas of knowledge competence and neglect knowledge gaps? Some participants pedagogically responded to knowledge gaps by seeking to demystify the process for their students so that their students did not experience what the teacher had experienced when learning mathematics. Annie stated that her response to her own knowledge gaps was to prepare mathematics lessons in advance to discuss these with her colleagues and instructional leaders before teaching them. This finding supports Askew's (2008) proposal of mathematical sensibility. Teachers cannot be expected to know everything about mathematics. Still, they should have a sufficient sense or mapping of mathematics and feel equipped and confident enough to seek out new understandings and develop their knowledge as and when they need to. This finding could be explored in future research.

Teachers' Expectations and the Influence of Teachers' Knowledge

The unique identity of each teacher would not be complete without considering the expectations a teacher holds for their students and themselves. Though variation in teacher expectations has primarily been attributed to students' characteristics in the past, this study aimed to identify how teachers' characteristics, specifically their knowledge, influenced and shaped their expectations. Initially, this study aimed to examine how the quality of teachers' content knowledge influenced the quality of their expectations for both them and their students. Though this study did not find that teachers' content knowledge directly influenced the quality of their expectations, it discovered some association between the quality and type of teachers' knowledge and the types of expectations they held for their students. The types of expectations held by participants in this study will be discussed in this section.

A Typology of Expectations

This study found that many participants' attitudes and beliefs towards mathematics and the type and quality of their knowledge influenced the type of expectations they held for students. Consequently, a typology of expectations is proposed for teachers' expectations in this study, categorising them into general or specific expectations for outcome or process. These expectation types are compared to Brown and McNamara's (2011) perceptions of mathematics learning. The phenomenological view of mathematics learning emphasises "the student exploring mathematics, making connections, seeing structure and pattern", and the teacher facilitates learning "from the learner's current perspective rather than didactic teaching" (p. 23). In this view, the attitude to teaching mathematics enables students to build their own mathematical thinking. In contrast, the official view of mathematics learning emphasises the "performance of prescribed mathematical procedures [and] is quantifiable through diagnostic testing" (p. 23). This perception creates an attitude that ensures students attain the required skills of mathematics. Participants' expectations in this study resonated with these perceptions.

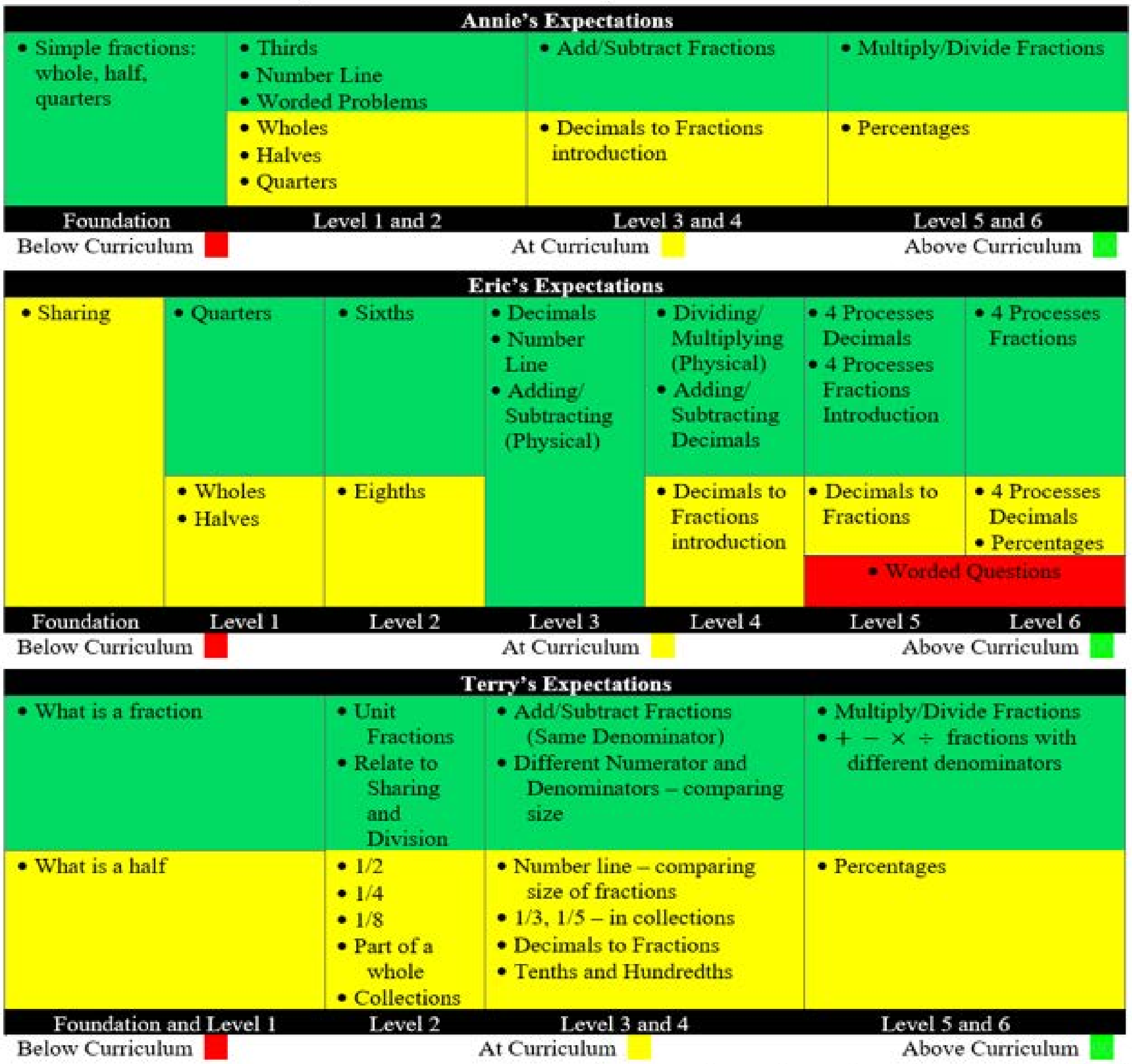
Outcome Expectations – Annie, Eric and Terry

The first expectations found among some participants could be described as outcome or achievement expectations where the expectation is that students achieve a particular standard, grade or tick a box. One participant, Annie, frequently stated that she struggled with mathematics anxiety due to various experiences and beliefs about mathematics and placed her expectations above the curriculum. Yet, her expectations were imprecise, concept-based expectations that targeted an outcome for a general cohort rather than the individual (e.g., students in Year 3/4 should be able to add and subtract fractions and see links between decimals and fractions). Annie also stated that her role as a mathematics teacher was to get students to where they needed to be and prevent students from falling behind. Annie described expectations of general outcomes for her students as summarised in Figure 5.6. Unlike Annie, both Eric and Terry stated that they were very confident teaching mathematics. They described it as their area of expertise compared to other teachers who had more expertise in literacy teaching. As illustrated in Figure 5.6, Eric and Terry expected precise content outcomes specifically for each year level.

These expectations fit Brown and McNamara's (2011) "official" perspective of mathematics learning where students attain specific skills to perform mathematics, and these skills are measured using various forms of assessment data. This perspective of mathematics clarifies Annie, Eric and Terry's prioritisation of Assessment Data as most or very important, illustrated previously in Figure 5.5.

Figure 5.6

Annie's, Eric's, and Terry's Outcome Oriented Expectations



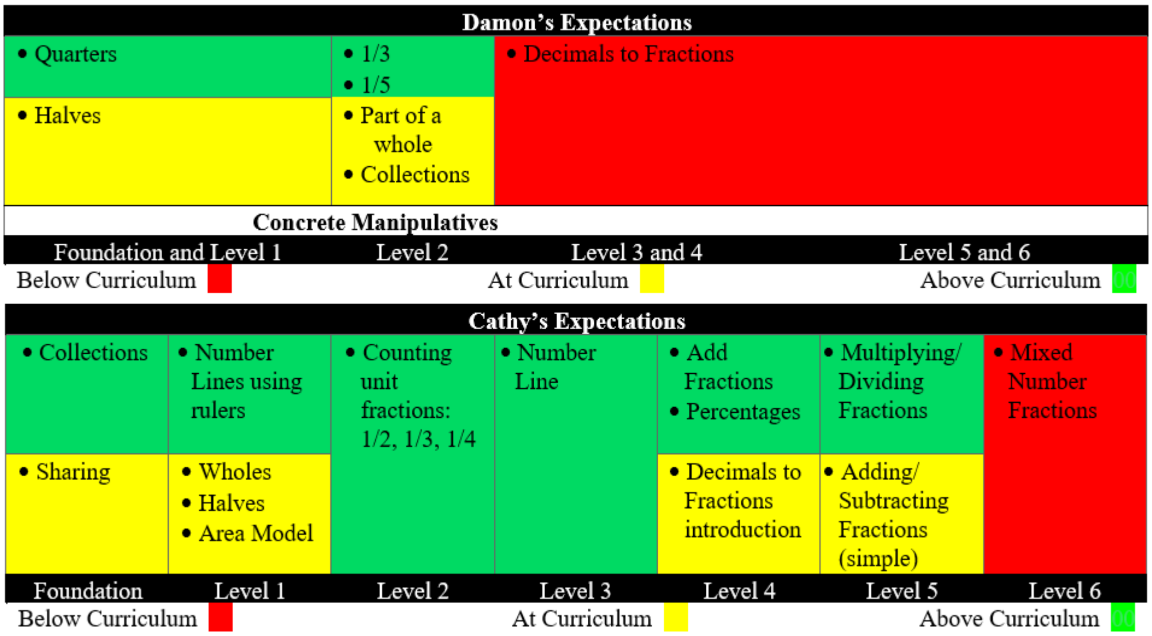
Note: Annie's outcome expectations were imprecise, targeting cohorts (Grade 1/2, 3/4, and 5/6) while Eric's and Terry's were precise, targeting specific year levels.

Process Expectations – Damon and Cathy

The outcome expectation type expected by Annie, Eric and Terry contrasted with another participant, Damon, who, like Annie, also struggled with mathematics and experienced mathematics negatively in school. Unlike Annie, however, Damon experienced mathematics more positively later in life. Damon placed imprecise expectations above that of the curriculum, as depicted in Figure 5.7, but was reluctant to state any expected outcomes for his students. Instead, his expectations were for students to "give it a go… listen and participate… and don't give up." Damon expected students to build strategies for working with mathematics and endeavoured to reduce anxiety and build confidence in his students. While indicating more specific, curriculum-based outcome expectations, Cathy also stated expectations like Damon in Figure 5.7. Cathy indicated that she struggled to understand mathematics through school and did not fully understand many concepts until she studied teaching. Cathy, like Damon, maintained strong expectations of students to build strategies and confidence when working mathematically, explaining that “a lot of kids can look at something and go, ‘That’s too hard. I’m not going to do it.’” She argued that “maths can be hard, and tricky, and challenging,” but her expectation for her students was “not to give up when you have those challenges” and to “try different ways of solving.”

Figure 5.7

Damon’s and Cathy’s Process Oriented Expectations



Note: Damon’s few outcome expectations were imprecise, while Cathy’s were precise and detailed, but both stated a series of process expectations for their students, such as giving it a go, building strategies and reducing anxiety.

These expectations targeted the process of learning mathematics rather than the outcome of learned mathematics concepts. This expectation type could be described as a process expectation, in which the teacher holds an expectation for *how* the student learns rather than *what* content they learned. Brown and McNamara’s (2011) phenomenological view of mathematics learning fits this type of expectation in that the teacher expects the student to explore and engage with mathematics and “the quality of student’s learning experience was privileged over objectives” (p. 23). This perspective of learning mathematics clarifies Cathy and Damon’s prioritisation of Pedagogical Knowledge over most other types of knowledge seen earlier in Figure 5.5.

Mixed Expectations - Penny

One participant, Penny, indicated a balanced mix of outcome and process expectations, summarised in Figure 5.8. Penny provided a series of precise mathematical outcome expectations for her students and exhibited a series of process expectations around how students perceive and respond to mathematics, not just as a subject in school but as a part of everyday life.

Figure 5.8

Penny's Outcome and Process Oriented Expectations

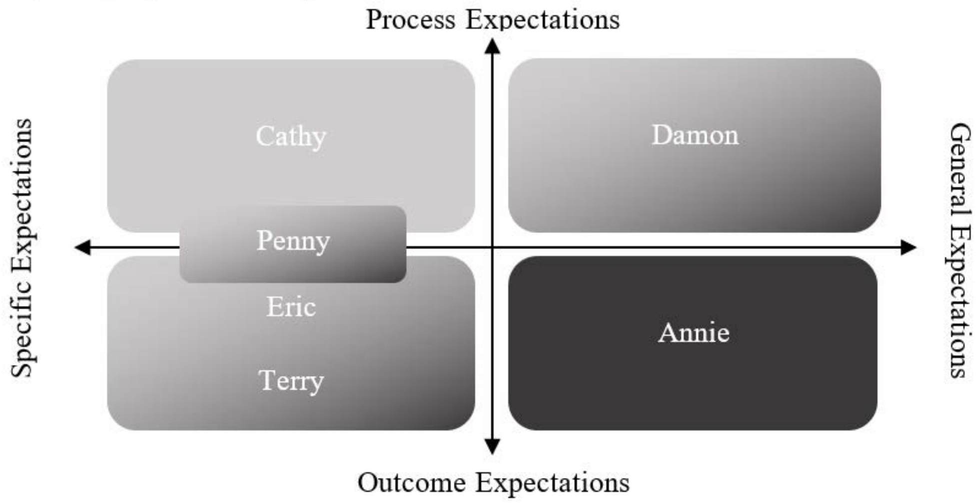
<table>
<tr><th colspan="7">Penny's Expectations</th></tr>
<tr><td colspan="4">• Equal</td><td rowspan="2">• Decimals</td><td rowspan="2">• Mechanical application - (Adding & subtracting, etc. with fractions)</td><td>• Ratios</td></tr>
<tr><td colspan="4">• Part Numbers
• Money
• Fractions of a whole
• Fractions of a group</td><td>• Percentages</td></tr>
<tr><td colspan="2">Understanding</td><td colspan="2">Fluency</td><td colspan="3">Problem Solving/ Reasoning</td></tr>
<tr><td>Foundation</td><td>Level 1</td><td>Level 2</td><td>Level 3</td><td>Level 4</td><td>Level 5</td><td>Level 6</td></tr>
</table>

Below Curriculum At Curriculum Above Curriculum

This study proposes a typology of expectation types found among the participants and summarised in Figure 5.9 but does not categorise any type as inherently good or bad. An expectation from teachers for students to achieve a specific outcome is reasonable as students are required to meet various criteria as they progress through the curriculum. Often curriculum needs to adopt an official perspective of mathematics learning to develop the scope and sequences by which educators teach. Likewise, teachers' hopes for students to enjoy learning and engage in learning are also reasonable. Consequently, Brown and McNamara (2011) referred to Askew et al.'s (1997) "connectionism" as a reconciliation between the official and phenomenological perspectives. As Askew et al. (1997) stated regarding varying belief orientations towards mathematics, "no single teacher is likely to hold a set of beliefs that precisely matches those set out within each [numeracy teaching] orientation" (p. 37). Likewise, all participants held mixed expectations for their students but in different capacities, leaning toward either process or outcome expectations.

Figure 5.9

A Typology of Teacher Expectations



The Scope of Expectations

It is important to note that the teachers in this study rarely mentioned their expectations for their students without also referring to the expectations they held for other stakeholders. These included expectations for themselves, those of the school community and colleagues, parents of students, and the expectations of the curriculum and standardised testing. One participant, Penny, stated that a significant influence on her expectations for her students was "the expectations that the school has… working in different schools, there are different priorities." She suggested these varying expectations create pressure to expect particular outcomes from students. She provided an example of leading a Year 5 team as they prepared their students for NAPLAN testing. She compared these external pressures to the intrinsic pressures of a special school community where parents "have expectations [that] they [their children] will go to university" and that "you [the teacher] are not doing enough for my kid." Eric also suggested that the environment teachers teach in vastly impacted the expectations he held for his students. He commented that when "parents expect it [high expectations], the kids expect it, and the school expects it." Yet another participant, Damon, noted that his own experiences and the expectations that were placed on him as a child by both his parents and teachers influenced his expectations for his students and clarified that "experiences influence expectations, not just what someone tells me."

These observations indicate that the discussion of teacher-held expectations for students cannot be isolated to the teacher-student relationship. Extensive review of the teacher expectations literature conducted by Weinstein (2002), Rubie-Davies (2014) and S. Wang et al. (2018) repeatedly drew attention to this issue, stating that teacher expectations need to be considered beyond the teacher alone, examining the school and the community too. Likewise, the responses of participants in this study highlight the need for expectations to be researched in light of the various stakeholders involved.

Perception of the Teacher's Role

In addition to discussing their knowledge and expectations, each interviewed participant stated individual beliefs in perceiving their role as a mathematics teacher. One participant, Annie, said her role as the mathematics teacher was to get students to where they needed to be and prevent students from falling behind. This contrasted significantly from Damon who indicated his role as a mathematics teacher was to demystify mathematics for his students and remove any anxiety students may have. Eric stated that his role in upper Primary was no longer about teaching the understanding of concepts but teaching students about the processes used to solve mathematical problems efficiently. This perception of role differed from Penny's perceived role of passing on practical understandings of mathematics in everyday life so that students can ultimately enjoy mathematics. Finally, Terry's perception of the role of the primary mathematics teacher was to provide the goals, resources, materials, and knowledge required to meet curriculum-informed goals. This perception both agreed and contrasted with Cathy's perception of teachers putting their perceptions of mathematics and the concepts they are teaching aside and teaching and facilitating learning despite not knowing everything about the topic. Each of these unique perceptions of the primary mathematics teacher's role contributes to the teacher's identity, which is constantly informed by and influences other aspects of identity such as beliefs, knowledge, expectations, and experiences.

Individual Experiences, Beliefs, and Attitudes Impact Teaching Approach

Teachers' justifications for how they taught mathematics and why they expected what they did were divided. Three of the interviewed participants leaned towards teaching mathematics how they were taught. In contrast, the other three leaned towards a new or alternative approach to teaching mathematics counter to how they were taught. Often teachers expressed the reasoning behind teaching the way they were taught was due to positively experiencing mathematics or finding it easy to understand the way they were taught. One questionnaire respondent stated, "I had a positive experience because I was good at it. I was never scared of maths", and another wrote, "I learnt mathematics best through procedures. Therefore, I tend to introduce rules and steps to children." Contrary to this, teachers who experienced mathematics negatively or found it challenging to understand stated that they sought alternative teaching methods. They did this so that their students did not share the same negative mathematics experience they had. One respondent explained this in their questionnaire response writing, "you make it [the teaching of mathematics] better, so they [the students] like it more than you did." Askew et al. (1997) found a similar response from teachers observing, "their own negative experiences as learners influence them in trying to make mathematics enjoyable and accessible for all children" (p. 94). A third but less common response inferred by one interviewed participant was that they taught the same way they had learnt, not due to a positive experience, but because they knew and were comfortable with that method or saw that as part of the process. Askew et al. (1997) found that "[some] teachers still saw mathematics as a fragmented set of techniques and knowledge to be memorised. Thus the cycle of negative attitudes was likely to be reproduced" (p. 95). D. Ball (1990c) referred to this cycle as an “apprenticeship of observation” wherein teachers taught mathematics in the same way they were taught as students, often reflecting a transmission approach (p. 10). Despite teachers’ aspirations to teach differently, “many of them lack alternative images of mathematics teaching” (D. Ball, 1990c, p. 11). Each of these responses to individual experiences with mathematics can be beneficial provided teachers are mathematically sensible (Askew, 2008), reflecting on their own experiences of mathematics and seeking out the best ways to teach their students. The danger, however, in each of these responses is suggested by Brown and McNamara (2011), stating that “uncertainties resulting from restrictive knowledge of mathematics and its pedagogical forms can result in a conception of teaching that is more transmission orientated, since such teachers are less willing to deviate from a well-prepared script” (p. 16). This may lead teachers to develop pedagogies that are contrary to their beliefs and the teaching practice they would prefer.

In some cases, teachers adjust their teaching if their beliefs about their students differ from the curriculum’s expectations. Some participants adjusted their expectations for their students based on their knowledge of students despite differing curriculum expectations. In some cases, teachers believed their role was to transmit a specific series of understandings and keep students moving along a continuum of curriculum standards. This central belief is associated with their expectations, attitudes, and beliefs towards teaching. Likewise, some teachers believed teaching should help students discover new understandings and strategies, build confidence, and reduce anxiety. This belief is similarly associated with teaching expectations, attitudes and beliefs. These observations reflect the self-perceived identity of the teacher and their perceptions of the role of the teacher, not just in mathematics but broadly. These variations in belief appeared to be associated with the teacher’s prioritisation of a specific type or quality of knowledge and the maintenance of a particular type of expectation for students.

Brown and McNamara (2011) argued that perceptions of identity and the role of the primary mathematics teacher are influential. They proposed a hermeneutic for examining teachers’ beliefs, based on models of teacher belief proposed by Askew et al. (1997). On the one hand, the official perspective reflects a transmission approach to teaching believing that knowledge is to be transmitted from teacher to student. On the other hand, the phenomenological perspective mirrors a discovery approach believing knowledge is to be discovered by students through teacher facilitation. A third perspective, the connectionist approach to mathematics teaching and learning, sits between these two perspectives.

Askew et al.'s (1997) perceptions of mathematics learning can be likened to the types of expectations teachers hold for their students. According to these orientations, transmission-oriented teachers believe mathematics is a series of procedures and routines to be transmitted to students and value content knowledge and mathematical fluency. Consequently, expectations from this teaching approach would be for students to perform a specific outcome. In other words, this belief would produce outcome expectations. Conversely, teachers who believe students learn through discovery and merely need facilitation do not prioritise content knowledge but, instead, prioritise pedagogical knowledge, knowing how to facilitate and provide for students' learning. Consequently, expectations for students would lean toward the journey of discovering knowledge and understanding rather than reproducing a specific procedure or outcome. Thus, this belief generates process expectations. Finally, the connectionist-oriented teacher balances the priority of both outcome and process and thus would have mixed expectations for students. Although each of these belief orientations influences expectations, Askew et al. (1997) found that highly effective teachers held to connectionist beliefs while less effective teachers held to either transmission or discovery beliefs. Muijs and Reynolds (2002) supported this finding that connectionist-oriented beliefs enhanced effective teaching. To determine whether certain types of expectations are more beneficial for effective teaching, further research should be done examining Askew et al.'s (1997) belief orientations and the type of expectations teachers hold for their students.

Even though the belief orientations model proposed by Askew et al. (1997) and the typology of expectations presented in this study do not align perfectly, they can be used to discuss how teachers' beliefs are associated with their expectations. Likewise, teacher knowledge and the prioritisation teachers place on certain types of knowledge correspond with Askew et al.'s (1997) belief orientations. Consequently, associations can be made between teachers' beliefs, expectations and knowledge.

The next chapter—Chapter 6 Conclusion—summarises the key outcomes of this study, providing a brief response for each of the research questions guiding the study; notes the implications of the study's findings on education research and teaching practice; concludes with the constraints of this study's design and recommendations for future research.

6. Conclusion

This research explored primary teachers' knowledge of teaching fractions as a lens to investigate the associated expectations teachers have for their students within the mathematics teaching context. This study aimed to advance understanding of how teacher knowledge influences teacher expectations in the teaching and learning of mathematics and specifically fractions. While an association was found between teacher knowledge and teacher expectations, there was not enough data to state that teacher knowledge influences teacher expectations. The conclusions that emerged from this study are made based on a small sample of 34 respondents, 6 of which were verified with follow up interviews. The findings supported and contributed to the current literature. This chapter summarises the key outcomes of this study. It addresses how each aim of this study produced findings and indicates the successive contributions to the field. This chapter also addresses the implications of these findings in both theoretical and practical contexts. Finally, this chapter concludes by addressing this study's limitations and considerations for future research directions.

Key Outcomes of the Study

The key outcomes of this study make three overarching contributions to the research and education communities in response to the three research questions posed at the start of this study:

1. *How are fractions understood and represented by primary teachers?*
2. *What type of knowledge is used by primary teachers when teaching fractions and what justification do they have for this?*
3. *How, if at all, are expectations of what teachers want their students to achieve influenced by teachers' knowledge?*

This study contributes to the current teacher knowledge and teacher expectations research community, specifically around mathematics knowledge and fractions. The study's findings also inform current teaching practice, pre-service teacher education, and professional development for current teachers and educators. Finally, this study's findings shed light on the relationship between teacher knowledge and teacher expectations, an area of the literature that is relatively underdeveloped.

The Quality of Primary Teachers' Fraction-Specific Content Knowledge:

This study supports the findings of other studies regarding teachers' fraction specific content knowledge. Getenet and Callingham (2021) suggested that most teacher respondents believed fractions to be among the most difficult concepts to learn and teach in primary mathematics. Participants in this study likewise stated fractions to be among the most difficult. Additionally, findings supported previous research regarding fraction subconstructs (Behr et al., 1983; Way & Bobis, 2011). Participants in this study typically taught and were more comfortable teaching the part-whole subconstruct of fractions with little to no focus on the other subconstructs. As these subconstructs represent a precise pedagogical understanding of fractions, teaching a part-whole dominated perspective of fractions could influence teacher expectations in mathematics-related learning. The lack of depth revealed in fraction knowledge by participants substantiated fractions as a suitable lens to investigate teachers' knowledge and the association with expectations. These findings also point to the need for more research on teachers' understanding of fractions.

The Type of Knowledge Primary Teachers Prioritised

A teacher's knowledge of how to teach effectively can contradict popular belief or research understandings due to the teacher's relationship with and knowledge of the student. An example of this was observed when Eric suggested that his students had a good conceptual understanding of content, and their point of need was procedural fluency. This focus contradicted teaching students conceptually as recommended by research literature in this area. This finding suggests that though teachers may be guided by best practice as defined by the research community, they are also bound by their relationship with students. As such, teachers make teaching decisions based on knowing their class and their individual students.

Participants indicated they did not need to know content deeply to teach it. Cathy captured this argument succinctly, stating, "there's a point where you need to know what you're doing but then there's a point where you can still teach and facilitate learning as well…" This finding contradicts policies that require teachers to exhibit a high level of content knowledge. The compulsory LANTITE indicates that teachers should be in the top 30% of the adult population in mathematics, yet teacher participants typically perceived content knowledge as not of the highest importance. Participants perceived knowing their students, general pedagogical knowledge and assessment data as most important to teaching practice. Additionally, prioritisation of knowledge was not isolated to the teacher's beliefs. The school context and the knowledge community also valued particular forms or expressions of knowledge. This knowledge prioritisation can subsequently influence teachers' perceptions and prioritisations of knowledge, when in Eric and Penny's case, the school community was commented upon as an influence on the knowledge employed in the classroom. This finding suggests teachers' knowledge preferences may not match the knowledge community's belief or perspective.

This study's hypothesis of "knowing in order to teach" was challenged when participant teachers indicated awareness of knowing content and also knowing what they did not know. This study found that the teachers who were able to identify their knowledge gaps would address these gaps through professional development and discussions with colleagues as in Annie's case. Conversely, whether some teachers prioritise teaching the areas they are confident in while ignoring areas where they are less confident is a topic for further research. These responses to knowledge gaps inadvertently influence the improvement of teaching practice. Recognition of knowledge gaps also appears to influence the expectations teachers' set and hold for their students.

The Influence of Primary Teachers' Knowledge on Expectations

This study did not find that quality of teacher knowledge had a direct influence on the quality of teacher expectations. It did point to an association between teacher knowledge and teacher quality. The type and the quality of a teacher's knowledge is associated with the type of expectations teachers set for their students. In this study, teachers' expectations fell into a spectrum of outcome and process expectations. Askew et al.'s (1997) belief orientations were similar to the expectations of participants in this study. Askew et al. deemed connectionist orientations more effective, however, this study did not look at the impact of teacher expectations on students and their achievement. Therefore, there is no statement made as to whether any expectation type is more or less effective. Future research could address this.

In addition to the influence of knowledge, it was found that various other elements influence teacher expectations. One of these factors was teachers' perception of their role. In essence, their identity as a teacher and their teaching philosophy and beliefs about mathematics shaped their expectations for their students and their own teaching. Some teachers perceived their role as keeping students at level and helping students below level to reach their peers' level while others perceived meeting curriculum standards and teaching what was required as the teacher's role. Another perceived role was more holistic, believing in the need to pass on practical skills and instil a love of learning. Each of these perceptions of the teacher's role, informed by experience with and beliefs about mathematics, ultimately influence the type of expectations teachers hold for their students.

Additionally, the scope of expectations is not limited to the student-teacher relationship but is applicable to all school community stakeholders. By giving a voice to the teachers in this study, teacher expectations have been found to be influenced by a plethora of factors beyond students' characteristics. The teacher's knowledge community and their personal characteristics, knowledge, attitudes and beliefs hold substantial influence over their expectations. This points to complexity and individuality in addressing these areas of research. These findings also suggest complexity in the framing and quantifying of teacher knowledge due to individual learning experiences and backgrounds that situate personal beliefs, attitudes, and contexts. It is notable that this complexity is not detrimental in and of itself, but rather, it is how this complexity is addressed that influences practice and expectations. This study effectively indicates that every teacher has a story, and it is teachers' subsequent response to their experiences that determines their approach to teaching mathematics and their prioritisation of certain knowledge types.

Implications

The findings from this study have implications for three areas. Firstly, there are important implications for teachers' ongoing professional development, particularly in reflecting on their expectations and the potential influence of these expectations. Secondly, there are implications for how school and knowledge communities operate. Teachers at their best should not be isolated in their teaching practice as higher expectations and greater knowledge sharing comes from teachers working collaboratively. School and knowledge communities, when working together, are impactful when setting and maintaining expectations and pivotal in providing teachers with the holistic knowledge required to teach all primary school curriculum areas. Finally, there are implications for the research community in approaching teacher knowledge and expectation studies in the future. Future research would benefit from interpretive study designs due to the complexity and individuality of both teacher knowledge and teacher expectations. This section will discuss these implications in turn.

Professional Development

Professional development implications are significant in this study as teacher knowledge was found to be associated with teacher expectations. Many of the participants in this study confessed that reflecting on their expectations and knowledge caused them to reconsider their teaching effectiveness, exposed them to ideas they had not considered previously, and produced a fresh enthusiasm for setting higher expectations for their students. As a result, professional development should target the development of teacher knowledge. This is not, however, sufficient. Professional development should also target the development of teachers' expectations for their students and promote high quality and consistent reflection on the influence of individual experiences, beliefs and attitudes on the effectiveness of personal teaching practice.

School and Knowledge Communities

It is important that teachers work as part of a knowledge community rather than operating alone. Participants in this study frequently referred to the benefit of a school community where they could approach their colleagues and seek advice or approach leadership for professional development opportunities. A collaborative approach to teacher knowledge and expectations is vital to every member of the school community's success. This is reflected in Askew's (2008) recommendation for knowledge sensibility. No teacher can know everything there is about teaching everything, so the richest knowledge and highest expectations result from a collaborative school community where teachers work together to share knowledge, set expectations and consistently enforce those expectations throughout the school.

Research Implications

An implication for future research is found in the complexity of teacher knowledge and expectations discussed in this study. Each participant discussed their individual knowledge and expectations. They told their story and their knowledge and expectations flowed from these stories. As a result, more studies into teacher expectations should be conducted that explore this topic through interpretive means that give a voice to teachers in their respective contexts. Interpretive paradigms readily capture individuals' perspectives rather than the majority's generalised opinion or experience. This will contribute to current literature in this area.

Limitations and Considerations for Future Study

This final section addresses three constraints of this study along with two additional areas that require further research. The perceived knowledge of participants in contrast with their actual knowledge are discussed, and recommendations made for future research. Recommendations are also made for the questionnaire and interview design, particularly the language used in each and validity concerns. Awareness of knowledge gaps was identified as an area that requires additional research, particularly regarding how teachers respond to these gaps and the influence of these gaps, if any, on teaching practice and expectation setting. This research found an association between teachers' characteristics and their expectations for their students. Further research that investigates the extent of this association could identify the ways these aspects further influence teaching practice.

Perceived Knowledge vs Actual Knowledge

Participants responded to questions from the questionnaire and interview with how they teach or how they believed they should teach. This enabled teachers to reflect on their teaching practice yet did not ensure participants' accurate representation of their knowledge or understanding. The participants presented an account of the knowledge they believed they had in the interview and under the conditions of an interview setting. This is a perceived knowledge based on the context of the interview. Participants' actual knowledge may differ. Additionally, participants ranked the forms of knowledge according to their perceived importance which did not accurately represent their own knowledge. Rather, this task assumed participants could define the types of teachers' knowledge that they prioritised which may not always be true. As such, the results represent participants' understanding of the terminology used to refer to the forms of knowledge in the questionnaire and interview components of this study rather than the forms of knowledge as they are defined in the literature. The questionnaire's lack of validation may have contributed to this. Future studies in this area should consider these limitations when designing studies on teacher knowledge.

Subconstruct Targeted Questions

A constraint was found in the representations of various subconstructs of fractions as potentially biased. The question used in Artefact 1 asking participants to divide a collection into fractional parts and share it did not clearly lend itself to some subconstructs such as quotient and ratio. As a result, when considering further research in teachers' understanding of fraction subconstructs, a question or variety of questions would need to be carefully designed and validated to cater for multiple subconstructs and reduce bias.

Questionnaire Validation

A further limitation of this study was the design of the semi-structured questionnaire. While the semi-structured questionnaire was designed for this study and efforts were made to validate this research tool, validity concerns remained surrounding whether respondents provided 'true' responses and whether or not they understood the questions being asked. This limitation is mitigated to some extent by the anonymous nature of the questionnaire which, according to Cohen et al. (2018) "encourages greater honesty" and the verification of six participants' responses in a follow up, face-to-face interview but should be taken into consideration in future research design (p. 278).

Knowledge of Not Knowing and Pedagogical Responses

Additional research conducted on teachers knowing what they do not know and their pedagogical responses to this knowledge would contribute to this area. This study aimed to address what teachers did or did not know and how that influenced their expectations. It was observed, however, that understanding knowledge gaps is a crucial element of teacher knowledge. The way teachers respond to these knowledge gaps appeared to vary. Some teachers may respond by seeking out professional learning and development while others may seek support and resources from colleagues and others yet may avoid addressing these knowledge gaps altogether. These differences, while glimpsed in this study, would benefit from further study.

Teacher Identity and Expectations of Students

This area has been studied to some extent exploring how the teacher's own socio-cultural context, environment and various other factors go on to influence the expectations teachers hold for their students (Rubie-Davies, 2014; S. Wang et al., 2018). A significant gap remains in how a teacher's self-perceived identity impacts their expectations of students. This relationship could be examined in future studies.

Conclusion

In summary, this chapter addressed the resulting outcomes from the three research questions posed at the start of this study. It also discussed the insights gained and how they contribute to the literature. The chapter concluded with the implications of these findings along with the constraints of this research design and outlined considerations for future research.

This research gave voice to the individual knowledge and expectations of teachers. As such, it highlighted the interplay between these distinct aspects of teacher identity. This association can impact the way teachers are educated, how they practice and reflect on their practice and how teacher knowledge and expectations are researched in the future.

Appendices

Appendix A: Questionnaire

Start of Block: Demographic Data

Q1. Please indicate your gender:

○ Male

○ Female

○ Other

Q2. What Primary Sector do you currently work in:

☐ Public

☐ Catholic

☐ Independent

☐ Co-ed

☐ Single Sex

☐ Special Education

Q3. Please indicate the postcode of your current school:

____

Q4. How long have you been teaching in a primary classroom?
(Sliding scale: 1 to 50 years)

Q5a. What grade(s) **have you taught**:
(Please tick all that apply; Foundation to Level 6)

Q5b. What grade(s) do **you currently teach**:
(Please tick all that apply; Foundation to Level 6)

Q6. Are you a first or second career teacher:(A second career teacher is someone who has worked in/studied another profession prior to becoming a teacher)?

○ Teaching is my first career

○ Teaching is my second career

If "Teaching is my second career" is selected

Q6b. Please specify previous study or profession prior to becoming a teacher:

____

End of Block: Demographic Data

Start of Block: Knowledge & Expectations

Q7. What subjects do you find most challenging to teach as a primary teacher?

____

Q8. Has anyone influenced the way you think about mathematics? (i.e., parents, friends, teachers?)

____

Q9. How do you think your own experiences of learning mathematics impact how you teach it?

____

Q10. In your experience, how would you rate the difficulty of teaching mathematics: (Sliding scale: 0-10; 0 being Extremely Easy, 10 being Extremely Difficult)

Q11. Is there a particular mathematical strand(s) within the Australian Curriculum that, in your opinion, students find difficult to learn?

- ☐ Number & Place Value
- ☐ Fraction & Decimals
- ☐ Money & Financial Mathematics
- ☐ Patterns & Algebra
- ☐ Units of Measurement
- ☐ Shape
- ☐ Location & Transformation
- ☐ Geometric Reasoning
- ☐ Chance
- ☐ Data Representation and Interpretation
- ☐ Other (please indicate) ____

Q12. Is there a particular mathematical strand(s) within the Australian Curriculum that you find particularly challenging to teach? (Please tick all that apply)

- ☐ Number & Place Value
- ☐ Fraction & Decimals
- ☐ Money & Financial Mathematics
- ☐ Patterns & Algebra
- ☐ Units of Measurement
- ☐ Shape
- ☐ Location & Transformation
- ☐ Geometric Reasoning
- ☐ Chance
- ☐ Data Representation and Interpretation
- ☐ Other (please indicate) ____

Q13. What factor(s) help you to plan for and teach mathematics most effectively? Please number the following in order of importance with 1 being most important and 6 being least important:

______ Procedural Knowledge
______ Conceptual Knowledge
______ Knowledge of Students
______ Pedagogical Knowledge
______ Content Specific Pedagogical Knowledge
______ Assessment Data

Q14. How do you, as a primary teacher, differentiate students' learning needs when teaching mathematics?

____

Q15. How far do you see your current students achieving in mathematics?

____

Q16. How have you grown in your teaching of mathematics since you started as a teacher?

____

End of Block: Knowledge & Expectations

Start of Block: Concluding Questions

Q17. Did you attend the Primary Mathematical Association of Victoria (MAV) Conference in June 2019?

○ Yes

○ No

Q18. Would you be interested in participating further in this study by attending a 30min interview?

○ Yes

○ No

If "Yes" is selected

Q18b. Please provide a contact email:

____

End of Block: Concluding Questions
End of Survey

Appendix B: Interview Schedule

Section A: Introduction

Brief explanation of study as per Participant Information Statement.

Q1. Tell me a little bit about yourself and your current teaching role?

Section B: Knowledge

Q2. What are your perceptions of mathematics as an individual?

Prompt(s):

- Are your perceptions of mathematics as an individual different from your perceptions of teaching mathematics?
- Your history with mathematics?

Q3. How would you rate the difficulty of teaching fractions?

Prompt(s):

- Do you teach fractions differently from how you would teach other concepts? Why? /Why not?
- How do you think students learn fractions/fraction concepts?

Q4. I'm asking these questions because research shows that fractions is often a concept area that is widely misunderstood by teachers and students. How do you feel about this?

Prompt(s)

- Why do you think students often struggle with this concept?

Q5. How would you expect your students to approach the following question? "James had a bag of marbles. There were 56 in the bag. He gave away 3/8 of them. How many marbles were left?

(Question steers away from part-whole construct to operational construct)

Prompt(s):

- How would you teach fraction problems like this one?
- What models/approaches do you take to teaching fractions?
- How do you help your students differentiate between representing a fifth of a whole and a fifth of a number line?
- Do you have a specific class or group in mind in your example?

Section C: Expectations

Q6. In mathematics, what do you expect from your students and how do you set those expectations? How do you as a teacher set expectations for your students?

Prompt(s):

- Expectations for students vs expectations for teaching
- What do you think influences your expectations?
- What has the greatest influence?
- How has your own experience of teaching mathematics influence your expectations?

Q7. On the following graph, could you create a timeline indicating what fraction concepts can be taught between Foundation to Level 6 and when and how you would introduce each concept?

Prompt(s):

- How would you approach this differently for another mathematical concept?
- Can you explain your graphic?
- Some researchers suggest that fractions can be taught as early as prep; would you agree with this? Why/Why not?

Section D: Concluding

Q8. Do you see yourself as a "typical" primary teacher?
If "no": Why not? How would you say you differ from a typical primary teacher?

If "yes": Why? What makes you a typical primary teacher?

Q9. Has this interview changed your thinking about teaching mathematics or setting expectations generally in any way? Is there anything you would like to add?

Appendix C: Interview Transcripts

Interview A: Eric

Interviewee: Eric
Interviewer: JD
Date of Interview: 31/08/2019
Location of Interview: Café, South Melbourne
Acronyms: TA=Teacher A; JD=Jarah Dennison

Observation prior:
TA appears quite enthusiastic and excited to participate in the interview and also seems casual and relaxed.

JD:
Ok so I've explained this study there [on the participant information statement] and then again thank you for participating. It's actually really hard to get teachers to do an interview or even to do a survey to start with so just thank you for participating… it's fantastic.

TA:
(chuckling) No no… No worries. I'm happy to be involved.

JD:
Could you tell me a little bit about yourself and your current teaching role? I know its an independent school I think you mentioned?

TA:
Yeah so I'm at an independent school. We're an ELC to Year 12. I teach currently at Year 6 level. I teach in the middle school so we don't work in terms, I mean, of course it's still primary and year 6 but we really structure from ELC through to pre-prep and then we go from prep to Year 4, which is our junior school, 5-8 is our middle school and then we have a, it's on the same grounds, but year 9 have their own campus and then we do a three year senior school. So I'm based in the middle school at year 6. I currently have my boys for just English and Mathematics which is 15 periods a week, 50 minute periods, I have the boys for maths for 7 of those and then they have different teachers for different subjects. I used to have them for more but now I'm the daily organiser at the school and the head of cricket and I'm involved in the energy breakthrough program so there's lots of other activities I do which take me out of the classroom.

[brief interruption from waiter with coffees]

JD:
So you mentioned 'the boys'. Is it a single sex school or…?

TA:
So the school is co-ed the whole way through with boys and girls in the same classroom until year 4 and then they split into a girls middle school and a boys middle school and then they're generally in single sex classrooms all the way through to year 12. There's a couple of subjects that they may do together or, depending on numbers, the electives in the older years so I've just got boys and we're capped at 20 so no more than 20 in a class...at year 6 level. It gets smaller and smaller as you go into the higher year levels and gets a little bit bigger at the lower year levels.

[single sex and smaller classrooms is obviously a context that most teachers don't have the luxury of teaching in.]

JD:
Fantastic. That's awesome. Thanks for that. So jumping into the gist of the interview, what are your perceptions of mathematics as an individual?

TA:
[teacher seems quite confident to respond]

I've had a reasonably successful background in mathematics. I was… in primary school, I always got good grades. Went to high school in year 7, got really good results, skipped year 8 maths and went straight to year 9 maths [in] year 8 which in retrospect was probably not a great idea so I missed a few things that made it hard along the way. I always did advanced mathematics, ended up doing further mathematics but that was more due to my attitude as a 16-18year old [laughs] rather than my ability and then, I've always felt confident with numbers. I was an electrician before I was a teacher so worked with numbers a lot so I've always felt comfortable with maths and been able to quickly recall numbers and mental computation with numbers has always been good so, yeah, always had a positive relationship with mathematics really. It's not been something that has caused any anxiety or anything like that.

[At this point, the teacher seems to be really confident talking about mathematics and his experiences with mathematics. Doesn't appear to suffer from maths anxiety or anything like that.]

JD:
Being a, what we call a second career teacher, so you were an electrician before, how would you say that influenced your perceptions of mathematics?

TA:
Um, I suppose what it did do was… I think sometimes as teachers we're always trying to build relevance in our classroom. Especially with my boys…

[another brief interruption from the waiter]

…that's the most important thing. I think if they can see that… if they think they're just doing something to tick a box for [TA] or because you do it at school, they're just less likely to be engaged. I mean, our kids are good. They're pretty high achievers so they'll just do it for you anyway but if you can build relevance in terms of how you would use it outside of the classroom, they really buy in. So I suppose what it did for me was, and I might have been the same, it's hard to reflect back, it's been 10 years ago now, but I think they're getting out of the classroom going "wow, so these things that my Maths teacher was harping on about and I thought they were just, you know, on my back for the sake of being on my back, I'm actually using them so much."
[at this point, the teacher emphatically states the following]
Especially mental computation, the ability to be able to do things in your head, it's so important and I think we need to try and teach more explicitly strategies around that because we do teach a lot of things in terms that are algorithm based but how often in real life do we actually sit down with a pen and a pencil and work something out. So I found

relevance and then it's probably helped my teaching because I really try to build relevance as much as possible for the boys.

[Relevance and mental computation seem to be themes that this teacher is passionate about].

JD:
Fair enough, fair enough. You've definitely described that perception of mathematics as an individual but also, as well as that, as a teacher and how they kind of, there's a slight difference. It's good. How would you rate the difficulty of teaching fractions as a concept?

TA:
[Brief pause; the teacher seems a little caught off guard by the question]

Uh… good question. I mean, it's interesting being at year 6 level. A lot of my boys already have a really good understanding of fractions and what understanding of breaking down fractions so if I gave them something, say I gave them physical blocks, they could separate seven eights for me, that's fine. So then pretty much at my level, I'm more teaching addition, subtraction, obviously the four processes of fractions. For me, it probably just goes down to, and it's like anything in mathematics, if the boys have strong number sense, they'll be good at anything so trying to teach lowest common denominator means that they've just got to have a great understanding of number facts so that's probably the hardest thing and that's what I, I find that in any subject that I teach, fractions included, if they have great number sense then they are successful because they can break down numbers. Fractions becomes so difficult if you start dealing with larger numbers... if the boys have the ability to break down from… right, what's the lowest common factor here and then they're away. Find lowest common multiples, all those different things, then it's a lot easier. Some of it, for me, is just memory based as well so in terms of flipping your fraction for your division… like kids with strong memories, they just do that and then I find it's just repetition with my boys who require more assistance and just more one, like anything you know, more one on one support and perhaps more practice at home. Things like that I never make compulsory but I do communicate with parents and I say, "Right, I've set this thing, there's a program called Maths Based, and then its up to them whether they want to do it or not."

[when answering, TA doesn't convey a great difficulty in teaching fractions however, I was slightly concerned with how much emphasis the teacher was placing on a number sense and "memory" work and the inference that kids with strong memories just get maths]

JD:
Would you say that fractions are taught in a different way to other maths concepts or in the same way?

TA:
Uh… no I'd say they were generally taught in the same way. I mean, we structure our units in a way that we always pretest to measure growth and then we'll go through and teach what I would consider, perhaps, the easier concepts then through to the more difficult concepts and pretty much the way it works… [at this point, the teacher briefly pauses and then conveys a bit of uncertainty] I don't know if, actually, if I just reflect now in my head, I don't know if it is the best way but we always teach more algorithm based,

more short answer and then lead through to more worded questions to finish with so hopefully by then the boys will have an understanding of the four processes and they can transfer that knowledge to real world tasks. Yeah, all going well, they do that but we don't get a 100% result on every post test so there are obviously always things that you're always looking to improve, you know, being reflective. So… um… yeah.

[at this point, I began to see a bit of a pattern in TA's responses with a lot of emphasis on "memory work", algorithms first, real world tasks later. My initial thoughts are that TA may be more reliant on procedural fluency and understanding rather than conceptual understanding]

JD:
How do you think students actually learn fractions? How do you think they understand them?

TA:
Um… [brief pause] its a good question to ask and as I said before, because I teach at 6 and I've only taught at 6, I probably don't do a lot of the actual breaking down and understanding like, "okay, this is our three quarters" as such. Um… we… I have around the room different posters and on the board magnets to show like one whole and then how a half looks in a whole and how three quarters and so on.

JD:
Yeah, yeah, very typical…basically like the part-whole model?

TA:
Yeah yeah. In terms of that, I suppose there's less, uh, actual concrete resources used, a lot of our boys have that understanding and then its, and then its more teaching the processes. Uh, just thinking, yeah, yeah… no it's a good question. Like, how would they learn but a lot of the time they have that knowledge but I suppose, we don't do any, uh, kinesthetics stuff, in terms of like, multiplying a fraction, what that actually looks like as such.

[the teacher seems less confident and more hesitant in answering and responds in a way that makes it seem like the teaching of fractions in and of itself is outside his role as a grade 6 teacher and that students should have this fundamental understanding of fractions prior to coming into his class]

JD:
Fair enough… the reason I'm asking these questions is because research shows, more recent research, has been showing that fractions are an area where a lot of students struggle…

[the teacher appears to be slightly distracted and is looking around the table]

… did you want some water?

TA:
No… I was going to get some sugar but I can go without it…

JD:

Ah… so yeah, basically research is showing that fractions is often an area that students struggle to learn and that teachers often struggle to teach. Particularly, even the questionnaire that I sent out showed something very similar to that, a similar trend. How do you feel about that particular research saying that's one of the more difficult concepts? Do you see that?

TA:
Well I haven't noticed it to be honest; I mean, we keep a lot of data around pretesting and post testing and ACER and NAPLAN and stuff and we wouldn't see any, I don't see any abnormalities in, uh, fractions compared to any other topic. Uh, we find our data shows us that our boys struggle more with those worded questions in terms of being able to apply their knowledge into more real-life tasks which we're constantly working at to try and get better at. If anything, I find that geometry is the subject that uh, is harder to teach from the conceptual point of view because I feel like, compared to any other topic in mathematics, it is more memory based. There's more just the fact that this is the shape and you've got to remember what the shape is rather than say that number sense behind it so that's my, I just did a pre-test with my boys and we teach a year above so our boys would be doing, all the homework I set is Year 7 and some of its Year 8 work but we had a pre-test, it was a hard pre-test, result of a 150% but I would expect that, and this is maybe a high expectation, but I would expect that our class to average a minimum 85-90% at the end of it. That's just my job then to make sure…

[teacher briefly pauses and cringes slightly]

…well, not make sure… to teach them the content that they don't know.

JD:
Yeah...Absolutely, absolutely. Okay, now something to take a look at. So this is a simple question, probably aimed at more a grade 4/5 level leaning towards grade 4. How would you expect your students to approach this question?

[Question 5 Artefact 1 passed to the teacher]

TA:
[Teacher took a brief second to take a look and answers almost straight away]

There's a couple of ways...um… I… I mean, there's one way you could do it and my boys would probably naturally do it is they would go 56 divided by 8 equals 7, 7 times 3 equals 21. That's the way they would probably do it. Um… because I'm trying to teach them with the processes "of" means "times" so maybe I would expect them to do…

[TA writes the equation down while speaking]

…3/8 times 56 over 1, um and then, hopefully they would cancel out and go eight goes into 8 once, 8 goes into 56 seven times. 21 over 1 equals 21 marbles

[TA stops writing down his working out]

…and then they would take that away from 56 to get… 35 marbles. That would be the two ways that I would expect them to do it and the same with once they found out 21 then they would take that away. Some boys might also just go straight away well, and this is probably my higher boys, well if he's giving ⅜ of them away then ⅝ remain. I still have, once they worked out that 8 went into 56 7 times then they'd just go straight away 35 that way or they would do ⅝ times 56 over 1 is the algorithm. Obviously that would be the two ways they would approach it.

[at this point, TA's response, which is very procedural, doesn't really reveal how he would teach his students the question. As a result, I pose the following prompting question to further understand his teaching knowledge and approach]

JD:
How would you teach them to approach that particular question?

TA:
Exactly like that… just exactly like that.

[TA repeatedly points at the equation he has written down and refers to it as he answers]

I would teach them… [brief pause to look over answer]
they would naturally break… so if the whole is 8 then I would explain that we have 7 wholes, um, and because I'm trying to teach them with the algorithm at the moment and cancelling out, called the bow tie method, then I might put it on the board like this just to show them because then we would be getting them into more difficult questions and it would just show them the structure of… like, this is the way to do it, something easier, then hopefully they can "fire" their knowledge.

JD:
Fantastic! So I guess modelling it up on the board and those sorts of things? What's your typical approach to teaching any fraction concept? [Pause] Is it that same modelling?

TA:
Yeah… it would be modelling. So pre-test first and then yeah, but it would be modelling on the board and then an almost "I do, we do, you do" kind of release so I would model on the board, we'd work together as a class, and then release control of the board, get them to do a couple, then check back in me and then I would have something ready for them to then progress forward with.

[at this point, TA seems to get increasingly excited to share how his classroom operates]

So, I'm a big one with, my boys love being the teacher so a lot of the time I just have Textas up the front and once I've shown them how to do it really explicitly, I'd put three up there and I'd think, right who's the teacher, then I just throw the Textas around cos they like that, then I go and sit in one of the seats and pretend I'm the teacher and talk them through it and then get them to hang on, break down, why are you doing it like that, hang on, you can't just cancel that one out and not tell me why and get them to repeat the language back so they're obviously summarising but I'd say paraphrasing for their peers and I find that that kind of shared experience is great and also, sometimes they come with ways that I haven't shown them and I go, "why have you done that for?" Sometimes, I'll say, "Look, you can do it that way but it is more efficient to do it this way and I always say, "whatever way you are more comfortable with but I am trying to make you more efficient." so that's kind of a bit of a… yeah that's a contentious one and then sometimes they come up with great ways that they've done it and it's like, "Yeah, didn't even think of that… brilliant!" I always make a joke, "Oh, you'll put me out of the job" yada yada yada, all those different things, you know, so hopefully it's an enjoyable experience and then away for them to go and apply their knowledge and then check back in with the class, summarise, do some on the board again, and then, hopefully, their knowledge has been consolidated but of course, we're not just going to do one lesson on fractions and go, "Oh you know everything about fractions" Units normally last anywhere between 4 to 6 weeks.

[TA's enthusiasm in his response conveys quite a passion for teaching and he seems to genuinely desire creating an enjoyable learning environment for his students]

JD:
Exactly… in that regard, this question is often found to be tricky for students because, instead of finding your typical eighth of a whole, your whole is a number in and of itself so I guess, thinking on that example, how would you differentiate or help students to differentiate between finding a fifth of a whole and a fifth on a number line for example?

TA:
So… a fifth of a whole… okay… um....

[TA seems quick to respond but quickly comes to a pause, seeking clarification]

Sorry, could you explain the question to me again?

JD:
Yeah, sure. Often students might approach a question by thinking a fraction is a part of a whole so…

TA:
Part of one whole?

JD:
Yeah, exactly. Part of one whole… how do you…?

TA:
So they're just going to look at a number line and think ⅜ or something like that. Is that what you're saying?

JD:
Yeah yeah exactly. Whereas with a number, there's more than one, there's 56 marbles, 56 whole marbles for example, and yet that is a single whole.

TA:
Yeah, so you could use physical… if you had 56 marbles, that would be a wonderful thing [laughs], we don't always, but we could probably find 56 little coffee stirrers or something from the staff room. I would probably then break them up and show them that, right, this is a whole. Like 8 is a whole and break it up that way and then you would take 3 of each 8…

[at this point, TA seems a little bit confused and takes a few seconds to gather his thoughts]

sorry 3… what am I saying… hang on I'm confusing myself…

JD:
That's all good. Take your time.

TA:
[15 second pause]

Yeah, no, sorry, break them into 7s and then, right, here are our eighths then I would take 21 and show them that there's five eighths left over which is 35. That's what I'm saying… sorry.

JD:
No you're all right, all good. And obviously that's your grade 6 group of boys that you've got in mind as you're thinking through?

TA:
Yeah yeah yeah… that's how I'd show them. To be honest, I haven't had to do that, so I'm kind of thinking on the spot but I would. I would probably, I think when you're getting the fractions and if they can't… cos what they're trying to do, talking about mental computation, but they're trying to picture that, obviously, in their mind and if you've got a visual learner or someone that's really a kinaesthetic hands-on learner, I think just giving them those physical resources and then, you know, doing a few with that, and then releasing control. Hopefully that works and if not, try something else and so on and so forth.

JD:
Yeah fantastic. So just moving from that knowledge side of things to expectations, in mathematics, what do you expect from your students and how do you set those expectations?

TA:
I worry less about the post-test result, I mean, my boys always know they have a pre-test and post-test result, I always speak to them before every pre-test, "try your best, this is," and I always say to them, "I don't care if you get zero percent. All that shows me is what I need to teach you." So I always joke, "that's my job, and that's what I get paid for." I said, "If you all got a 100 [%], I'd be out of a job." so I always joke about things to try and lighten it up and I said, "Just try your best, like, you're not supposed to know, I haven't taught you any of this so whatever you know is a bonus." So then go from there and then I just have expectations that I expect them to work hard… um… in class time, they know that there's… it's time to focus and I'm, I would say that I'm pretty strict in terms of, "If you don't focus, then we stay in or we stay in as a collective." I expect them to have all their homework done. Its Monday to Monday homework… um… we set quite a lot of homework compared to most schools so there will always be three online quizzes and then a math sheet as well so the quizzes will apply to the unit that we're covering and then the maths sheet is more general so just so the boys are getting exposed to a whole range of concepts rather than, you know, just fractions if we're doing fractions. And then, it's just about improvement so, and I don't really set a number but, I haven't had yet somebody not improve so, and I always say to them that I'm more interested, I'd said I would rather a student go from 20% pre-test to 60% post-test to somebody that goes from 85% to 88% for example, or I might say 70 to 75 because once you get higher grades, it's harder to improve but that's shown me your growth. If you go from 20 to 60, I said, you've doubled your knowledge in four weeks or six weeks and that's incredible and I really focus on that with the parents… about the growth. Because whether some parents

like to believe it or not, there is just… genetics plays a role. You know, some people are just… stronger memories or they're more number based so they're just going to, uh… I mean, not on all occasions but on a lot of occasions, just, yeah, pre-dispositioned to achieve higher… because of just their academic background and knowledge. So if we focus more on the effort that's being put in which we can really measure through pre-test to post-test, then we get less caught up on like "Oh but I know that such and such's son got 90% and my son only got 65%." "Your son got 15% for the pre-test and turned that into 65%... that's a 50% increase… that's incredible. Let's celebrate that. Let's not worry about what he can't do, let's worry about what he can do. And I think if you can get parents on board with that, that builds a growth mindset, that builds confidence, and all the sudden, people go… I find that my boys go, "hang on, I can do mathematics… like, [TA] is backing me, mum and dad are backing me." and it goes to their pre-test results aren't as low, post-test results are higher and it's amazing what can happen. Yeah… worry less about the end result and how much effort has been put in.

[TA seems quite genuine in his belief that growth, whether small or big, is what's important rather than the assigned score a student might receive. Again, my initial reaction to his response was concern with the belief that some students are just naturally more able than others to achieve but also reassuring that TA encourages a growth mindset with both parents and students]

JD:
Fantastic. That covered that question really well. How do your expectations change, so you have an expectation for your students and, obviously, as you said, that's growth; you expect them to grow in some way. What's your expectation for your own teaching?

TA:
[TA is quick to respond then briefly pauses before jumping into the bulk of his answer]

Well I expect to grow too, yeah. [brief pause] I'm pretty… well our whole school is, but we do keep a lot of data and I'm always reflective in terms of ah… have I taught this as well as I, well, could have? I mean we do a professional learning, kind of, review which, that's my job today actually, to put everything together where we actually go through and assess our teaching. We have our peers come in and observe us regularly and so getting feedback through that. We do uh… we are involved in a program called Educator Impact where we self-assess. We have a colleague assess us and the students assess us so that gives us really good feedback. And it's interesting sometimes in terms of what I think I can improve on and then what the boys give me as far as areas of improvement so classroom management is always low but I think that's their idea of what classroom management is but no, building relevance or all those different things so I'm always reflective in that way. We're very lucky. Our professional learning program is unbelievable so always being involved in different things like that, new ways to get better, ways of trying to incorporate ICT, but I'll look at results and I'll… we will get, we break it down into different questions so perhaps there's been a breakdown in, say, the application questions haven't… were the area that's the lowest, we're like, right okay, so next year, how can we get better and then, even in the next subject, how can we get better? We meet as a department every two weeks and then we'll actually reflect through that, look at data and share resources. "Oh, my application results were actually really good for fractions. I did this." "Oh brilliant! Can you send me the resource?" "Yeah." And it's just that whole sharing, collaborative process. So yeah, constantly reflective and I think teachers when they get caught into a… uh… way of looking at results and go "oh they haven't got that, oh they should've got that. Yada yada" If you're really honest with yourself, well why? You know, if there's 1, there's 1 student who skews the data then okay, you can be like "well I've probably done a decent job here." but if you find you've got about 50% of your students not getting one of the concepts of the unit, then you've got to look at yourself and be like, "surely I could have taught that better." And that's not to say that you haven't worked hard, you haven't tried hard, but you've got to be honest enough to just reflect and be like, "right, okay, well clearly, I have to do that better in the future." And then it's about going through a process whether it be at the meetings, PD, whatever it is, how could I do that better next time?

[TA seems really happy with the professional development opportunities at his school and the way feedback is given and seems to strongly believe in critically reflective practice]

JD:
What do you think influences your expectations... for your students and for yourself?

TA:
[again, TA is really quick to respond]

Uh… the environment I work in. I think… um… we… uh… I think being an independent school… you need… we are… how can I put this? We're obviously a school where we care highly about our students and that is our focus but I think when you're asking for the school fees that we ask for, you need to get results to deliver.

[my first thought here is "don't all schools, independent or not, care highly about their students?"]
So we are definitely a school but we're a business and our business is education and so we expect, and there's an environment that we expect to have high results so that really drives it. Um… and our ultimate goal is to have 50% of our students get an ATAR of 90 or above… um… and we're at about 45%, 47% at the moment. So that's high expectations um, so I think that drives it but I also just think that there's a belief too that every student is capable and it's a matter of, I look at as it's a matter of the teacher to get the best out of the students.

[interesting focus on the ATAR score and achieving a number despite the earlier statement that a score doesn't matter as long as there is growth]

There's obviously going to be some limitations but I just think that every student is capable and I think you can go in with that mindset rather than, I think some teachers go in and maybe they get previous year's data and go, "Oh, gee, Tommy's no good at maths so that, that'll be a hard one, that'll be a hard slog this year" then that kid has got no hope, you're already defeated.

[this statement supports what some expectation research has already shown where teachers expectations for students are heavily impacted by previous year's reports and data and conversations with other teachers]

Whereas, I'd be looking at it...um, and I'm no perfect… I'm no, you know, I'm certainly not the Messiah of teachers but I'd be looking at it and be like, "right, what can we get for Tommy this year" but it's almost, I think you see it as a challenge as a teacher to, like, drive you and work with your… you know, work with your young man and be like, "right, we can do this" and try to really build confidence in him at the start and then just keep rolling on… um… I think that really helps.

[interesting statements regarding "negative" data on students… one response is low expectations while the other is a challenge to provide more support and learning opportunities… but are the expectations still low?]

But yeah… probably just the environment. Parents expect it, the kids expect it, and the school expects it, so it all works. I mean my, some of my students get 98% and their tests are out of 50, they get one [wrong] and they'll be filthy on themselves that they didn't get 100 and that's just the environment that we're in. If they got anything lower than 80% and we teach a year above, they'd be disappointed and that's just instilled from the day they walk through the door.

[interesting statements regarding a high expectation environment where students take responsibility for their learning].

JD:
Fair enough. Thanks for that. Okay, another activity. So I'm going to give you this one…

[passes Question 7 Timeline Graph to TA]

So basically on this very simple, just a line, graph, could you create basically a timeline indicating what fraction concepts you would teach between foundation to the end of primary, so end of grade 6, and when and how you might introduce each of those? And do it as much or as little as you'd like.

TA:
Okay… so it just works on a year by year?

JD:
Yeah.

TA:
Okay… I'll work on uh.... [5 sec pause] Now, I've got to admit that this will be more difficult for an inexperienced teacher to do as I have only teached at year 6 level but I'll start there and I'll work back.

[initially, TA looks confused about the number of segments on the graph]

JD:
Think of it almost as like a year in between each bracket…

TA:
Yeah, yeah, oh yeah, sorry… [chuckles and mutters to himself] I'm a maths teacher, aren't I?

[TA goes on to label each section on the graph]

Artefact 2 (6.5mins to complete)
TA then proceeded to start noting the expectations for year 6 and quite confidently listed a number of expectations: "4 processes Decimals, %, 4 processes (fractions) worded questions."

TA then jumped back to foundation noting only "sharing" before jumping back to year 5 and further listing a number of expectations: "4 processes decimals worded questions, decimals to fractions, 4 processes intro (fractions)."

TA then jumped back to year 1 and 2 and listed a few expectations "whole, half, quarters, eighths, sixths, etc."

TA was then very hesitant to complete the expectations in years 3 and 4 and spent some time on these two years noting the following: "number line, adding/subtracting (physical), decimals to fractions intro, dividing/multi. (physical), adding/subtract decimals."

Comments made as TA completes Artefact 2:
TA:
Sorry, I'm really wracking my brain here.

JD:
No… that's all good. Take your time.

TA:
I need a curriculum planner in front of me, don't I?

JD:
Just think of it as a curriculum planning day or something like that.

[interesting that TA wants to refer to the curriculum]

Explanation of Artefact 2:
TA:
Righteo! Want me to talk you through it?

JD:
Yes… absolutely.

TA:
Right… uh, so I would probably starting in Foundation, just in terms of just sharing without kind of the uh… necessarily… well maybe the introduction of mathematical language but just getting the kids learning how to share and break things down in terms of like, the, we've got 12 things and there's 3 of us and then counting them out so they get an idea. Then [pointing to year 1 section] bringing the language of the whole, half and quarters. I think we can break that down. Then [pointing to year 2 section] more complicated things like sixths and eighths and twelfths, those kinds of things. Probably no higher than twelfths but still just sharing and I don't think I would be doing anything algorithm based at the moment. Um… and then we would start year 3 looking at placing things on a number line um… and… uh… adding and subtracting uh… fractions but doing that in a physical manner. Then I think we'd look at introducing [pointing at year 4 section]… uh… decimals to fractions and then dividing and multiplying but with a physical sense uh... and then I'd look at adding and subtracting decimals as well. The kids should have a fair understanding of just keeping the decimal point in line. Then we'd look at doing the four decimal proc… in Year 5, the four processes with decimals, worded questions for both, start… and obviously they'll get harder. Um… that probably starts as

well… [pointing at year 4 section] but I'd say the really difficult worded questions start in year 5. Decimals to fractions, much harder, get them to master that. Um… and the four processes introduction for fractions. Then in year 6, the four processes with decimals, and that's probably just keeping, progressing on what you've already done, understanding the relation between fractions and percentages, four processes for fractions, get that mastered and then worded questions. Does that make sense?

JD:
That's making a lot of sense. Just one question: so we've got… uh decimals to fractions here [pointing to year 4]. Where would you introduce decimals?

TA:
[Pause] Uh… with a number line in here [writes "decimals" above "number line" in Year 3 section]… I think…

JD:
Fantastic.

TA:
Is that how you'd do it?

JD:
Yeah yeah yeah... it's basically just getting an idea of how we approach these kinds of different concepts because building up a fraction or any concept in maths takes a number of smaller steps. So… I guess, just looking at these [pointing at Artefact 2], these ones here are very detailed [pointing at year 5 and 6] and that's where a lot more of your experience is coming in…

[my initial response to TA's Artefact 2 responses was that the higher levels are much more detailed when compared to the earlier levels. I thought this may reveal a little about TA's content knowledge and horizon content knowledge]

TA:
Yes… no doubt about that. [chuckles]

JD:
And so these are the concepts, but how would you introduce each of these?

TA:
[Long Pause; TA seems a bit confused]

Uh… in terms of…?

JD:
Like a teaching approach or…?

TA:
For sharing [pointing at Foundation]… in terms of… uh… I think it'd be really important with fractions in the early years to really actually get them with hands on resources. I would pretty much work… and our school does 'I do, we do, you do' release and it might be especially when we're first… with the sharing of a whole and halves and sixths and eighths, I'd be doing that with physical resources and probably doing it in small group

work. Trying to get around, make sure to work with every different group and then it… from there, once you get it to follow up with different worksheets where they might have to colour in half or colour in a whole or colour in a quarter and then... um… having that comparison with the eights and sixths and twelfths and those different things so then they can see the relation as they progress through. [Pointing at Year 3 section] Number line, I'd definitely have something on the board and then work with it that way… uh… and they could see the relation between decimal and a half is zero point 5 and they should have a fair understanding of their, obviously, their number there and they can hopefully understand that so zero point five is half of one and start introducing those concepts. Um… [pointing at year 4 section] adding and subtracting with physical… well… I would have them using um… actual resources so then once they do progress to using the four processes just in an algorithm-based manner, they can hopefully get some understanding of what they're doing and why numbers are increasing and why they're getting smaller. Um ... yeah, decimals introduction through the number line and then just working through the uh… four processes on the board with 'I do, we do, you do'. Yeah… that's probably how I'd progress through. Does that answer your question?

JD:
That does answer my question. Thanks for that. I really like that you've got down here that there's an, uh, introductory fractions going on down here at foundation and some researchers are actually saying that you can teach children fractions, at least initially in Foundation. Why… uh… do you agree with that statement and, if you do, why or why not?

TA:
Oh, absolutely! I would dare say at our school, they're probably doing it at ELC through just sharing, being able to break things up and I think if you've got those especially physical resources and it's also um… the great thing about teaching is… when you're teaching mathematics, but you can also teach great things about life. So, we know that kids at that stage of their development are very selfish human beings which is fine so teaching something like sharing is great for their personal development and they get the idea of "hey, if I've got six of these things and I've got two other friends, we can actually have two each" and they can share that out and see that and before they even know it, they've just broken up their 6 wholes into thirds, so um… they don't, wouldn't necessarily understand it at that moment but they're actually, that's what they're doing, they're doing fractions and we spoke about building relevance earlier. That… Why do I need… relevance? Why do I need to learn how to do the fractions? You get the kids who are like, "oh I don't want to do this. I just want to kick the footy" or "I just want to be doing something else" but hang on, you do fractions every single day. Have you ever shared something with your brother at home? Oh yes. That is fractions. Why? You can actually sit down and show them and they're like, "Oh, he's got a point this guy, you know, I better listen to him." And yeah, and then obviously they can share and see what they're doing and so the earlier the better with those concepts and um… I think what the teachers do, as somebody who teaches in upper primary, I think what teachers do in lower primary and how they build relevance and the skill set that my students have so I can, you know, I really am teaching almost high school math and then just go bang, bang, bang with them and the way they're able to pick it up, it's brilliant. I think, not that what we… obviously it's difficult because the concepts are becoming more difficult but in terms of being able to shape fractions and put them in a way that somebody at the age of 5 can understand, I think there's a real art to that which is sometimes… uh… undervalued and underrated. So...yeah.

[Some great links here to real world applications of mathematics. Its also good to see the teacher here recognising the work that teachers in lower primary have to do in order for teachers to have sufficient prior knowledge of fractions concepts to enter grade 6]

JD:
That's a good observation. Okay, so just to conclude this interview, thank you so far for everything you've added and for your responses. Too often, when we interview, we might get one-word responses or just a few words so it's good you were able to give some good, lengthy responses.

TA:
I'm sure I've got a lot out of today too.

JD:
Fantastic so I just want to conclude by asking do you see yourself as a 'typical' primary school teacher?
[I use my fingers to place invisible quotation marks around the word 'typical']
I guess I'm putting quotation marks around typical.

TA:
Um… its hard to know what is a typical primary teacher for somebody who is in his third year and he's always taught at one school and being an independent school too. Um… probably not, no in the fact that I've got capped classes at 20, I only teach boys, which means when we talk about worded questions and building relevance, like, we do, we call them grass tasks, but they're blokey tasks. And I'm really well resourced. We use this program, Maths Based, which is the greatest math resource program I've ever seen and anybody I've ever seen, uh, ever spoke to about mathematics has ever seen… um… I don't know what it costs, I don't know whether all schools could implement it. So probably not. The fact that we teach in middle school and also, probably talking to my peers as I was going through university, I love maths and I love teaching it and so that probably, unfortunately, I could be in the minority. So maybe not typical but I hope that through studies like this and people like [mutual contact] and really great university courses and the great thing about the 'teaching mathematics' subject that I did at LaTrobe is that it was real life. We got skills. So often I feel like we do subjects at uni which are great, theory, wonderful but the nuts and bolts of teaching are… are not spent enough time on and this was 10 weeks of nuts and bolts teaching so, if you were a good uni student, you went to all of the tutes, you just could not help but leave as a more confident maths teacher. So… hopefully, I become the norm if that's my attitude on maths. I understand that not everybody's going to have single sex and 20 only in the classroom but hopefully… you can't expect your kids to have a growth mindset if you don't have one.

[I found TA's response to be interesting in the way it unfolds beginning with not typical due to inexperience and an independent school environment but quickly shifts to his love of mathematics and teaching mathematics being the thing that makes him different from the typical teacher, obviously suggesting that the typical teacher dislikes mathematics]

JD:
Yeah, fantastic and I guess just finally, has this interview changed your thinking about teaching mathematics or setting expectations generally?

TA:
[TA responds really enthusiastically]

No, absolutely! It's definitely made me think that when I get back inside, back home, I'm going to take a look at the curriculum planner and see if I'm on the mark.

[interesting that he wants to check the curriculum planner to see if his answers were correct when the focus of Artefact 2 is expectations of the teacher not the curriculum]

Um… yeah, no, definitely. I think one of the best things you can do as a teacher is have professional conversations with people you work with, other teachers, so definitely got a lot out of it. Sometimes as a teacher, you just do what you do and having a discussion like this actually makes you think back and sometimes it's actually, you kind of do things subconsciously and you think to yourself, not why do I do this but it makes you actually, you know, for me today, it's kind of aired everything back and it's probably, oh I wouldn't say exposed, but it's shown that I have taught in one area of, you know, maths education and it makes you think as well, like, we have amazing teachers at uh… we have amazing VCE maths teachers. But it'd be really interesting to see if they did this interview, and they would teach high level mathematics, specialist maths, if you actually said to them, "How would you introduce fractions at Foundation?" they would probably look at you and be like, "oh, I don't know… that's not my job. They know that stuff before they get to me" so… it is interesting and I suppose it makes me think, you know, how important it is, is it for us to know the whole way through or… our area so, um, yeah, no I got a lot out of it so thank you.

[Again, the teacher presents a view of fractions/mathematics where the teacher who teaches high level mathematics may not know how to go back to basics and presents the question: is it important to know how to teach the basics/fundamentals when students are expected to have that prior knowledge when they get to higher grades]

JD:
Fantastic! Good to hear. And more out of personal interest, what motivated you to say yes to participate in the interview?

TA:
Um… when [mutual contact] asks you to do something, you say yes. I'm forever indebted to her so that was one thing. Um… but I just thought I'd get a bit out of it so… I just thought that I'd get something out of it and if there's other people that are passionate about teaching mathematics, I mean, why not? You know, I think, um, our school, we're lucky that we're highly resourced but I think it's about all teachers getting together and, uh… if my answers on a quiz could help somehow, I mean, as I said, I'm certainly not saying I'm the Messiah of Maths teaching but if my participation in a 15 minute survey and a half hour interview would help kids somewhere, or teachers or anything in any way possible, why wouldn't you? Like, isn't that why you get into teaching for? So… yeah, and as I said [mutual contact] and LaTrobe and, you know, because I went to university there, and all those different things and I'm passionate, um… and I… I've gotten a lot out of today as well so…

JD:
Well… fantastic and thank you once again for participating in an interview.

After completing the interview:

TA went on to talk about teaching in general for 5 or so minutes and I (JD) requested to take note of a few things:

- *TA is a 1st in family teacher*
- *TA mentioned the "vicious cycle of reporting" where he believes that one teacher may report a student has progressed to a certain level in order to tick a box, the following year, the next teacher, recognising the student isn't where he/she is reported to be but not willing to take the flack for the student not progressing also marks the student as having a years' progress and so on and so forth. It takes a bold teacher to recognise at some point that the student is far behind where they should be and report that.*

Interview ran for approx. 47mins

Interview B: Penny

Interviewee: Penny
Interviewer: JD
Date of Interview: 04/09/2019
Location of Interview: Café, Bundoora
Acronyms: TB=Teacher B; JD=Jarah Dennison

Observation prior:
TB appears quite relaxed and professional at the start of the interview although a little flustered.

JD:
Okay… so, first off, thank you for being a part of the study.

TB:

You're welcome.

JD:

As you said, it is very, very difficult to actually get participants in the first place so finding teachers who not only do the questionnaire and then do the interview is really rare so just thank you for being involved. I've explained the participant information statement and feel free to ask any questions about that one.

To get started, could you tell me a little about yourself and your current teaching role?

TB:

Sure… I am a primary school trained teacher. I… that was a career change for me. I graduated… I think my first year of teaching was 2006. I've worked in different public primary schools. I'm currently working at a special school which is also a government school. Its foundation to year 12. Our kids have an intellectual disability so there are different… sort of… classifications of special schools. Do you know about those?

JD:

I do briefly but feel free to explain it.

TB:

Well there's three levels. So, there is a special development school, that's for a student with an ID, so an IQ below 50. There are special schools, which is us, that's an IQ between 50 and 70. And then there are Specialist Schools and they're more based in the rural areas and that's for everybody with an IQ below 70 so that covers remote areas. So we are sort of that in between point; Lots of our kids could go to mainstream school if they… if parents chose to send them there. We've got lots of dual enrolments. We've got some kids that have high support needs but… most of our kids communicate and are able to communicate so they're not at that SDS level. So that… I went across there in 2017 as a leading teacher and worked with the 9, 10 year levels. All our kids are based… uh, put in a year level based on their age so its not around their curriculum level uh… and we work with the Victorian Curriculum depending on where they're at so anywhere from level C, D up to around level 3 in most areas. Yeah… is that enough information?

JD:

That is plenty of information. So you're quite new to the school? Two years teaching there?

TB:

Correct… well I don't actually… I'm out of the room so I don't actually teach there… um… so I'm a leading teacher. I lead a team of 9 classes so I'm their instructional leader. Um… yeah, I've never taught in a classroom there. This year, I'm in an acting assistant principal role which is a little bit different. Um… so leading the curriculum of the school.

[the response that TB wasn't currently teaching classes was a bit of a surprise for me but I think the experience and ideas coming from an experienced teacher who has also worked in lead teacher and assistant principal roles could be valuable]

JD:

Okay. Fantastic! Cool! So jumping into the gist of the interview, what are your perceptions of mathematics as an individual?

TB:

Uh… Maths is something that I've always really loved. I've always been a… a math's person. I've got two kids myself and I've been really conscious of making maths a positive thing for them. And making…

JD:

Do excuse me… sorry… I'm just putting a charger in [to the phone used to record the interview].

TB:

That's okay… um… just making them aware of the maths that constantly surrounds them in their daily lives so that it's not a… and when I was, you know, in the classroom, I was always really particular around maths doesn't just happen in our classroom. It's not just a one abstract thing that we talk about when it's a math session. It is everywhere. So, I've just tried to… I suppose I picked up on the maths anxiety thing early on and tried to be really positive around that and build some confidence in my kids. You know, you'd get the audible brain when you'd said alright we're going to do fractions or whatever so I tried to really instil some confidence in my kids in my classroom and once you have kids of your own, just, you know, constantly talking about… well that was maths, you're talking about maths. So that they were aware of what was around them and had a positive mindset about it. They are in grade 4 and grade 1 and they love maths so… yeah, trying hard to instil that positive mindset.

[Good to see a link outside of the classroom with TB's own kids; TB seems to highly value linking maths to the real world]

JD:

Perfect! Are your, I guess, perceptions of mathematics as an individual different from your perceptions as a teacher or as teaching mathematics?

TB:

[Very quick to answer this question]

I suppose that's sort of hard to… to separate really. I think if I felt apprehensive about teaching math or if I felt apprehensive about maths in general, then that would come through in my instruction. So I think that sort of melds together quite a bit because it would be hard to separate that. I talk to my teachers a lot around well… even if maths is something that you hate or whatever you're teaching, if you're not enjoying it or you don't like it, you've got to be an actor. You've got to put on that, "This is great, I love this." If you're not enthusiastic, then your kids are going to pick up on those things… um, so that's probably… well, it all comes into it.

[The way I feel about mathematics influences the way I teach it and the way I feel about teaching it]

JD:

It all comes together… yeah, fair enough. How would you rate the difficulty of teaching fractions as a particular concept?

TB:

[TB placed a strong emphasis on NOT finding it difficult to teach]

I don't find it… I, I don't find it difficult. Um… its, its, its, I think, around your attitude towards it, your approach to how you're introducing it. And just making sure that your… the language you're using is really clear and that you're communicating around, you know, well there's part numbers and there's whole numbers. Fractions I think is… [pause]… a more simplistic concept than people really think. And its just around how you communicate that with kids and again, making it real for them and exposing them to well, these are the real life applications of fractions and really you're using fractions all the time. You just need to be aware of it. Yeah, so I think having that… and that's probably consistent with all maths… having that real world application of… okay well I try and avoid worksheets as much as I possibly can. I just hate worksheets. So any sort of, you know, real life application will help them with anything.

[Again, linking back to real world applications but also interesting to note that TB has associated a strong belief in real world applications as opposed to a strong distaste for worksheets]

JD:

Fantastic, fantastic! So, how do you think students do learn fraction concepts?

TB:

Um… hands on, lots of manipulations… um, I suppose for my kids, at the moment I'm working with kids with an intellectual disability, fractions is an abstract concept for them… um, it's a lot around that actual physical… so when we're doing, you know, fractions in a group, we'll use the pizza or we'll make even groups and things like that. Um… I think a lot of the pen and paper stuff is not relevant. It needs to be that physical interaction with whatever you're using. Of course, you need to have that abstract nature as well but for the kids I'm working with at the moment, we don't really get to that point. Um… and when I was in a mainstream primary school, you know, teaching grade 5, yeah, you had to go there but the kids had that understanding. They had that… you know, um, sort of background and what…its… I think it's the same with multiplication. If you can round off your times-tables, it doesn't mean anything if you can't explain to me what multiplication actually is. So its around giving them that foundational base of understanding before they're going to the pen and paper stuff.

[TB argues for a kinaesthetic, hands on approach that is real world and allows students to problem solve conceptually. My initial reaction to the statement regarding rote time-tables knowledge as opposed to explaining what multiplication is was to think of procedural vs conceptual knowledge. But why doesn't knowing your time-tables mean anything if you can't explain multiplication?]

JD:

Yeah, yeah, absolutely… fantastic, thank you. So basically, I'm just asking these questions specifically down the line of fractions because research shows that fractions are often the concept that students really struggle to understand and teachers sometimes struggle to teach. How do you feel about that?

TB:

Yeah, I would say, anecdotally, that I would agree with those…uh, statements. Um… but to me, fractions, I mean, if you're teaching place value, you're teaching fractions. Fractions is in everything and I think it's probably more around getting our teachers to understand that so I suppose a lot of my role now is my teachers of my kids, bringing them on board with that, changing their mindset around that, developing their understanding. Um… I think… the school I'm at now is quite different in terms of the teachers that we've got are not necessarily teachers who have really honed their skills. Historically, our school hasn't been academically or curriculum focused. That's been the, particularly in the past 5 years, that's become a real focus for the school. So… I've worked a lot with teachers who I've had to work on their knowledge. If they don't understand the concept, how can you teach the concept? Um… so that's probably a lot of it… you need to deal with teacher anxiety so that they're not bringing that to their, to their classroom and if they've got the knowledge, they're not going to feel anxious.

[TB seems very confident in her responses. An initial question that came to mind was, "Does the statement 'fractions is in everything' indicate TB has a strong horizon knowledge, at least of fractions, that can link concepts of fractions to other areas of mathematical knowledge? TB suggests that teachers can't teach what they don't know and argues that you need to deal first with teacher's lack of knowledge which will improve attitudes which then improves the teaching]

JD:

Yeah… fantastic, awesome… uh, yeah, perfect. I think that answers the question [laughs].

TB:

Okay… good [laughs].

JD:

I looked at my prompts and I was like, "Yeah, no, that answers the question" … um, so how would you expect uh… just an activity for you… [passes Worksheet 1]

TB:

Oh are you going to test my math skills?

[TB seems a little nervous to complete the activity and jokes that I'm going to test her skills despite stating earlier that she enjoys mathematics and doesn't find it difficult. This may be simply due to nerves at being given a task and having to think on her feet or it may reveal some maths anxiety]

JD:

Uh… not so much your math skills but just test how you would approach teaching a concept. So how would you expect your students to approach this question?

So "James had a bag of marbles. There were 56 in the bag. He gave away 3/8 of them. How many marbles were left?" How would you teach it?

TB:

[TB is very quick and confident to answer]

So first of all, I'd be wanting them to identify, like, decode the problem really, you know, what sort of maths is it asking you to solve. Like, you know, problem solving is a lot around… you've got the skills in being able to use the four processes of whatever concept you're looking at but can you identify well what's this actually asking me to do? Is this an addition problem? Is it a subtraction problem? That sort of thing… and then I'd be wanting them to use some efficient strategies to solve it and look at different problem solving strategies to solve it, you know, are they going to guess and check, are they going to draw a picture, that sort of thing, and I think I've always tried to instil in my students that there is no right way. Its what's right for you, what's efficient for you might be different to what's efficient for me.

[while TB's initial responses indicated a good, open, problem solving approach to the question, I noticed that she was hesitant to write anything down on the paper or in the section titled "Working Space"]

JD:

Yeah… sorry, while you're doing that, while you're [talking through the problem]… just uh… could you please, perhaps show some different ways that you would get students to… or you would encourage students to solve this in different ways?

TB:

Yep… so I suppose, we're looking… you know, we're dealing with eighths [TB underlines the 8 in 3/8s] so I'd be getting them to use their division facts. Do you want me to write that down?

JD:

Well… it's up to you and how you want to approach it.

TB:

Okay… [TB seems tentative to respond upon hearing how open the task is]

JD:

Feel free to work through that space or, you know, if you just draw one thing, that's fine.

TB:

Well, I suppose I would be just getting them to work out well what's one eighth of 56 and then you're actually looking for three eighths, so you'd multiply that by 3 and there's your answer.

[Initially, it seemed as if TB was going to finish her explanation there which actually falls on the wrong answer. There was a brief pause before I responded and then a brief pause again before TB seemed to noticed the word "left" in the question and responded further].

JD:

Yep

TB:

Yep… [underlines the word "left"] and you'd be looking at, you know, well then you have to use your subtraction skills; he's given away three eighths and what's he got left?

JD:

Yeah… okay, so it's a combined, you know, concept there?

TB:

A multi-step, yeah!

JD:

…where you've got a couple of different things there?

TB:

Yeah, yeah.

JD:

Fantastic… uh, so I guess, what model would you use to actually teach this?

TB:

What model would I use? Well… I think they need to have an understanding of what problem solving is, they need to have some strategies for 'how do I approach this?' I think if you've just looked at the mechanical side of maths, you… they're going to struggle with this question. I think NAPLAN shows us that. Um… there's a lot of literacy in this as well. Literacy comes into maths… I think vocab is a really important part. So they need to have… they need to understand that, you know, well, left in the bag, well, what's that referring to? So I suppose its… you couldn't just read if its, it has to have skilled them up in identifying, well, what's the problem asking me, what are the math skills I need to use here and that it's not just working out, well, I know what one eighth of 56 is, done, done. Because a lot of kids will just get to that first step and stop. It's going back to the question, have I got to the end point here? So I suppose its… there's a lot of knowledge in that, you know, they need to be aware of, you know, first of all, the mechanical skills of working out what's one eighth of 56, multiplying that by 3, working out what's left, all of those steps…so… a lot in it.

[Good link here to the literacy in mathematics. Mathematics is not simply mechanical. There's a lot more to mathematics and a lot of types of knowledge that students (and teachers) need to know in order to be able to be successful in mathematics. TB also seems to be reflecting on her own oversight of "how many were left", identifying that many students would likely do the same]

JD:

Absolutely, there is a lot in it. So basically the reason I've provided this example, and as you said, "there's a lot in this example", but this question in particular steers away from that part whole concept of mathematics and it moves towards that operational construct where you've actually got a number of different operations going on and, in particular, how do you help your students differentiate between, say, representing a fifth of a whole and then, say, representing a fifth of a number line.

TB:

Yep… I think that that's just exposing them to different ways to do things so, with the kids we're working with currently… um, we use multiple exposures a lot so we look at modelling that in different ways. Um, so we would explicitly teach, this is how would you represent if it's a shape, this… and you might get out your string and you do your whole class focus with your pegs and dividing it so we would be really explicit around these are all of the different ways you could represent this fraction and then give them the opportunity to work with that and practice that. I think it's down to that physical manipulation and them being able to try it out and it's not just, you know, drawing a circle, making triangles and colouring one in. Fractions can be many, many different things.

[While TB did answer the question here stressing the importance of different exposures and experiences with mathematics, it's interesting to note that she didn't seem to make the connection that the fraction problem in Artefact 1 was a fraction where the whole is made up of a series of "wholes" so to speak. I wish I would've prompted further.]

JD:

Do you have a particular class in mind as you… as you think about this problem?

TB:

I'm probably thinking of my 9 team cohort. Um… so it's not a class, its 9 classes but that's the team that I, up until this year, was leading and we would plan together weekly for our math sessions and we would, "alright, fractions is our concept. We've got four math sessions this week. The first session will focus on this, then we'll focus on this." So that sort of… that approach is sort of what I'm thinking of in terms of where you'd spend a session looking at, alright, let's look at fractions over a whole heap of different ways. These are the different ways you'd represent it on a number line, could you draw a picture of that, and all of those different…applications.

JD:

Thank you. Okay, so jumping in from the knowledge side of things into the expectations: In mathematics, what do you expect from your students and how do you set those expectations?

TB (14:21):

Um… we talk a lot about efficient strategies so I want my kids to be able to, you know, have a bank of skills that they can use. Mental maths is a really big thing for me. Um, I have tried to steer our teachers away from using, you know, algorithm, formula, that sort of mechanical stuff because, unless they understand the concept, unless they can explain the concept to you, that doesn't mean they can do them. If you're in a shop and you're working out the percentage of something, are you going to whip out your piece of paper and write an algorithm to write it down or are going to try and solve it mentally? Um… so just that sort of efficient… bag of tricks for them. And also um… expectations in terms of well, what maths can you notice around you? We're not just doing it in the classroom; its not just, you know, in these four walls, it's all around us and being able to draw on their knowledge to choose the right strategy or part of maths they need to solve the problem and… because I think… we use maths all the time. Do you tune into you using maths or is it just an automatic response thing so just that expectation in terms of… and I think for my kids with an ID, its… tuning them into that and making them aware of that… um, yeah. Is that what you mean?

[Initially, TB's expectations centre on expecting students to have a variety of math solving skills, like mental maths, and linking problems to the real world application. My initial reaction to TB's response was that despite having these expectations for students, these expectations don't appear to be set by student factors but by the attitude of the teacher toward mathematics and the experiences the teacher has had, however, it wasn't fully clear how these expectations were set.

JD:

Uh… sort of. How do you, as a teacher, set those expectations for your students?

TB:

Um… I suppose it's through what you model. Um… but also using your learning intentions and success criteria really… um, strategically because that sets your expectation for the session and then, as you're moving through a unit, whatever you've done as learning intentions sets the scene for your expectations around that concept. Um… and in the feedback that you give kids, you know, and what you're recognising in their work or how you're trying to mentor them and improve their understanding of concepts. Yeah… that's really it.

[again, TB's response really indicates how to communicate those expectations to students rather than how those expectations are established. How to make sure students know what your expectations are rather than why you have those expectations in the first place]

JD:

Yeah… that's fantastic. Um… do your expectations for you students differ from your expectations for your teaching?

TB:

I suppose that's a tricky question because I'm not teaching now. Um…

JD:

Thinking back…

TB:

Yeah… I'm thinking back… I don't think so. I think, in terms of expectations for teaching, well I, I think you need to be assessing what you're doing all the time and being reflective and, alright, they didn't get that concept, they've got to go back and do that again. What can I do differently, what didn't I communicate clearly? Um… you know, I think its expectations for teaching should always be around how can I do it better? how can I improve their understanding? It's not that its, "oh yep, I've taught that concept to them last week, I don't need to go back and do that." So, I suppose expectations for the kids are, well, you want them to get that understanding but expectations for your teaching are, well, I want my teaching to be effective. What can I do? What can I improve?

[TB's response here indicates that the expectation the teacher holds for their own teaching should be to be more effective while the expectation the teacher holds for their students should be for the student to "get it." My initial reaction to these statements is whether or not the expectation for students to "get it" is enough or whether teachers need to have higher expectations for their students.]

JD:

Yeah exactly… perfect. Um… what do you think influences those expectations… your expectations?

TB:

As a teacher? I think, um, the school you're in; the expectations that the school has. Um… working in different schools, there are different priorities. Um… I think if, you know, having lead a team, a year 5 team and NAPLAN was coming up and you felt that pressure of, well, you know, this is going to reflect on the whole school and that's a different expectation to the current context I'm in where its around, we put the pressure on ourselves. It's not an external pressure. We're a special school um… and I think a lot of the time special schools are, well, it doesn't matter. Progress for our kids is much more difficult to measure um, so we've had to create our own, sort of, documentation around how we measure our kids and the… because they do grow, they do learn. How do we measure that? How do we show that they've progressed? Um… Department, sort of, supports don't, don't support us; we have to create our own stuff so I think it's really about your context and the priorities of your school, the priorities of the principal, what sort of leadership you've got, the community, um, you know, for our community… its vastly different. You know, there's one spectrum, or one end of the spectrum to another. There are some parents who, for us, for them, we are their respite. Their kid comes to school, that means they've got a few hours of the day. For other parents, its, well, you're not doing enough for my kid, you know, they, and they have expectations of they'll go to university. Well, no one at our school can go to university because they're not going to go… do VCE and they're with us because they have an ID. So its that sort of trying to balance those expectations. Um… I think its around the context really… and how much do you buy into that? You know, if you're on board with that or you're just there for your pay check.

[TB seemed to be reflecting on her own experiences of working in multiple schools and types of schools as she answers this question. Its interesting that TB notes that the expectations of the school environment influence teachers' expectations in different ways. In some schools, the expectations of the school environment influence the expectations of the teacher while in others, the expectations of the other teachers influence the expectations of the teacher.

High expectations for students or for NAPLAN results?

Interesting statement on balancing parent expectations for students to go to university and the difference between teachers who have the same priorities as their school/colleagues as opposed to "it's a job" teachers.]

JD:

Yeah… that's good. Thank you. How has, how would you say your own experience of teaching mathematics in the past has influenced your expectations?

TB (19:30):

Um… [brief pause and seemingly uncertain] that's a tricky question… I don't know. Um… I think maybe because I've always liked maths it hasn't really been, I didn't find it as a challenge. I think, probably, the most challenging time was when I was, you know, in those upper primary years and the kids, you know, I had kids that were working year 8 level and you had to make sure that you were on top of what they were doing, um… that probably influenced a little bit. Yeah… I don't, I don't know… that's probably not a very good answer to that question.

[Not a lot here but interesting statement about "being on top of" what students are doing]

JD:

No… that's your answer and that's fine… you know, everybody answers that question differently. So, another activity for you… [passes worksheet 2] and this one is perhaps a little more labour intensive and you can feel free to take your time with it. So just on this graph, could you create a timeline indicating what fraction concepts you could actually teach between Foundation to Level 6 and when and how you would introduce each concept?

TB (20:30):

[TB responds in an exasperated tone]

Oh my god! You want a curriculum planner?!... Okay, um…

JD:

It can be as detailed or as not detailed as you'd like…

TB:

Okay… um… okay… so I suppose the fractions concepts don't really kick in in terms of the curriculum until, you know, around level 2. So up here I'm going to put… [brief 10 second pause] so how much detail do you want in this?

JD:

It's up to you, how you would like to do it… just thinking about maybe the concepts, maybe the approaches, all of those sorts of things.

TB:

[Again, TB seems to be daunted by the openness of the task and sighs exasperatedly; another 10 second pause] … um, so can I just put up here that I want… so real world… [participant wrote "Real world application" and "Manipulation of physical objects" at the top of the worksheet]. And I think that that's across the whole board… um… alright…

[TB jotted down notes for approx. 40 seconds: "Part numbers, Money, Decimal, Percentage, Ratio"] so I suppose these are the…

JD:

Overarching…?

TB:

Strategies, I suppose, used, yeah. Yeah that's right.

[10 second pause again as TB looks over her notes]

So I'm going to put mechanical… [notes "mechanical application: adding & subtracting etc with fractions" as she speaks] so by that I mean, adding and subtracting, that sort of stuff. [5 second pause] And I know I've got money here [points at the second bar of the chart] and decimal here [points at the fourth bar of the chart] but I think that that's [money] just part of the… you're introducing them to part numbers and whole numbers and that sort of thing whereas this [decimals] is your more, um, manipulation of decimals and… and that sort of thing… um… okay [15 second pause]. [In exasperated tone] It's very… a very big topic… to write, to try and put on one piece of paper… um, alright [further 15 second pause; notes "problem solving" with an arrow horizontally pointed towards the higher end of the bar]. So I think problem solving is something… they need to have to have an understanding of what fractions are before they can start problem solving with it but then problem solving sort of builds across all of that so I suppose I'm thinking of the proficiencies in terms of, well, you want me to build their understanding here [points at lower end of bar], become fluent [points at the middle of the bar] and then their problem solving and reasoning is, is kicking in up here [points at higher end of bar] but then understanding… [brief pause] alright, let me just write that down [writes "understanding, fluency, prob solving/reasoning" at the bottom of the page]. And I suppose this is… understanding and fluency is going to build across but in terms of the general concept of fractions, that's sort of… the timeframe around that… if that makes sense. How are you going to remember all of this? [laughs]

JD:

So this is me recording and also you writing notes…

TB (24:51):

[still chuckling] Alright um… okay… how much do you… is that enough, is that…?

JD:

It's up to you how you want to approach this task and I've left it quite open for your interpretation. It's really to have a think about how… um, how and when you introduce everything and how it progresses um… and kind of what expectations you have for students at each level.

TB:

Okay… [15 second pause] I suppose we always start with fractions of a whole thing rather than a, rather than a set… um… so that's going to come in there [notes "fractions of a whole/fractions of a group"]. Alright… I think I'm coming up with blanks now.

JD:

Yeah? No that's fair enough. So… could you flip it around and I'll look at it with you?

TB:

You're looking at my messy writing, sorry.

JD:

No that's okay… my handwriting is much messier… so could you have… uh, just explain it to me briefly, how you've gone through it?

TB:

Yep… okay. So I think start of foundation, we're really focusing on the whole number part of, of maths… um, and it's also around school readiness and, and all that sort of thing so the part number discussion… and this is really dependent on the student and how much knowledge they bring with them. Um… but in terms of a general sort of introduction, fractions doesn't really come in until, you know, around level 1, level 2. So that would be when we start looking at introducing those concepts of, of part numbers and things like that, um, and shooting them into, you know, the fractions that are around them but that sort of really… sort of introductory basic… uh, level. As I said, we'd start with fractions of a whole thing so… um… looking at, you know, sharing an apple or something and actually physically doing that in the classroom, that sort of stuff…um… and you're also going to bring that into your discussions around division and things like that when you're looking at sharing an equal… um… I don't know the words to put them… like, um, an equal share [notes "equal" under "fractions of a whole"]. So that concept of just because you've put a line through something it doesn't… and divide it into two parts doesn't mean that it's a fraction if they're not the same thing. That sort of… you know, understanding… um, and yeah, moving into, you know, introducing the decimal sort of stuff, you know, around year 3, year 4… um… and linking that into money and… um… you know, once they've got that foundational understanding of what fractions are, you know, you're not going to move into this sort of adding and subtracting of fractions until 5, 6… um… and all that sort of stuff, looking at the percentage and ratio… um… yeah… yeah!

[Its interesting that TB didn't really label the different parts of the line with the different grades. Its also interesting how TB noted concepts and explained them as its quite general. It was good to hear an explanation of how these concepts, particularly the early concepts can be introduced and taught including some misconceptions in these areas.]

JD:

Fantastic, fantastic… thank you. Would you approach this differently for a different mathematical concept?

TB:

Um… [brief pause] I think you just need to… [again a brief pause and seemingly perplexed] as in, would I feel more comfortable in doing it with a different mathematical concept or…?

JD:

Would you feel more comfortable? Would you approach just the way that you've kind of put that together… would you approach it differently with a different concept?

TB:

I don't think so… I think, um… fractions is not something that you're going to start with when they start school so, it won't be the first thing that you do… um… so I think not necessarily, I think you're always going to start with the, what are the basic things that they need to understand about fractions so that they can build… because if you s… if they don't have that understanding where they can say to you "this is what a fraction is, this is, this is the concept of a fraction," doesn't matter what the mathematical concept is, they need to have that foundational understanding first. And you're not… like, if you're looking at, you know, area and perimeter, well you're not going to start that down here either [pointing at "start of foundation"] … its… so I don't think… I don't think I'd approach it differently, I think it's just thinking about well, where does the concept fit in terms of when should it be introduced? And again, you know, you've got start of foundation, end of primary… that's really student dependent… um… for my kids that are 16, some of them, they're still just working on what's part number… um… so its, its around what those… the knowledge that those kids bring, their life experience and, and how much that they understand about things before you start so I, I don't think I would approach it differently I suppose.

[TB's approach to this task shows a different perspective that's obviously influenced by working in a diverse learning needs environment. Initially, as TB was answering the question, I didn't like the direction as TB seemed to suggest that certain concepts shouldn't be taught until later in school because students don't have the foundational knowledge needed to understand, however, TB's response that this is obviously student dependent as the grade a student is in doesn't always guarantee a certain level of prior knowledge. In TB's example, often students with an ID don't have the prior knowledge but the opposite is also true; students can be introduced to concepts earlier as they already have some of the prior knowledge needed to understand that concept. I was concerned at this stage that TB believed that you shouldn't introduce concepts to students at an earlier stage.]

JD:

Yep… fantastic. Uh… Obviously you've explained it, explained it really well uh…

TB:

Oh good… it didn't feel like it… [laughs]

JD:

[laughs] so some researchers, this perhaps a little bit controversial because of what you just explained, but some researchers do suggest that fractions can be taught as early as foundation. Would you agree with that and why or why not?

TB:

Um… yeah… I, I would… um… because I don't think it's, [brief pause] I have this discussion a lot with my teachers in terms of… um… you know, those kids aren't going to understand those concepts but I think it's really a, a useful thing to expose kids to the language and to not necessarily expect that they understand it fully. Um… but that… if they're aware of the language and they've heard of it and they're, they're picking things up about it then that's going to build their understanding because some kids at foundation absolutely do fractions with them because that's what they're up to. Um… that's fine… I mean, in terms of, should it be introduced at foundation, well, you absolutely could, in terms of, you know, having a fair share and, and things like that… um… but in terms of us expecting a level of understanding and proficiency with that… is it reasonable to expect that they've got that at foundation? Again, I would go back to it, depends on the kid, and, you know, we want them to have that whole number knowledge. I suppose it's a little bit like, you know, learning a different language… we were debating this at school yesterday, you know, we've got kids with an intellectual disability, would we have language other than English offered as a subject at our school? No, we wouldn't because we're trying to build their skills around communicating in English. Do you over complicate that trying to introduce another language? So, if they don't have…um… you know, sort of the numeracy understanding of, of what numbers are, of what, you know, what place value is, would you introduce fractions with them? I probably wouldn't… I'd be working on that foundational knowledge first but having language of fractions in there is totally agree… yep.

[TB corrects my understanding of what she was saying, suggesting that you can and should expose students to concepts and the language of concepts that may be more challenging in order to build understanding but be aware that some students won't be ready for that yet and others will be.

Interesting statement made about learning languages other than English. My reaction to this statement is "why not teach students with an ID another language?" but at the same time, I haven't worked in that environment and I don't know enough about the literature in that area.

A question in my mind during this discussion is, "Can your expectations be too high that they negatively impact students' learning?"]

JD:

Fantastic… thank you. Okay, so coming now to the end, or conclusion of our interview today, do you see yourself as a typical primary teacher? [Using fingers to highlight invisible quotation marks] Little quotation marks around that word "typical"?

TB:

[TB seems quite surprised by this question] Oh g…. A typical primary teacher? I don't know… not anymore. Um… I think working where I worked now, I was really sceptical of whether my skills as a primary teacher would be transferrable to my setting given that they're teenagers um… and I did… a good teacher is a good teacher, it doesn't matter if you're a primary school, a special school or a… whatever school you're at. So, whether I'm a typical primary teacher… I don't know… I don't know. I'm not… I'm definitely not a Pinterest teacher. My classrooms were never um… perfectly displayed or anything like that. I tried to make it… um… as real to my students as it could be so it would be all student work up there, not the pretty stuff printed off… um… I don't know… what does a typical primary teacher look like? I think that a good teacher is a good teacher and they look like many different things and… I would hope for my kids as they move through school, that they have lots of different types of teachers so that they're exposed to different ways of learning and… um… there is no, sort of, box of that's what a teacher looks like and that's what we all should be…

[TB seems to be conflicted in her response, seeing herself as not typical due to her experiences teaching in a special school and contrasts herself with the "Pinterest" teacher, making her classroom 'real'. At the same time, TB recognises that there is no "typical" teacher as every teacher is different. She seemed a little irritated by the idea of a "typical" teacher]

JD:

Thank you… that's really, really good. Do you think this interview has changed your thinking about math, teaching mathematics or about how you set expectations in any way?

TB:

Um… I don't know if it's changed it… I think it's, it's… I like hearing about what's happening in other places, so you know, hearing about "oh there's research around introducing fractions at, at foundation." I think the more you learn, the better you'll be… um… so maybe it's just changed in terms of opening your eyes to a different, different opinions…um… I didn't have negative feelings towards teaching maths so, yeah, it probably hasn't changed so much in that way…um… yeah… I don't, I don't know if it's changed it but exposed to different ideas… yep.

JD:

Is there anything you'd like to add?

TB:

No… I think you've been pretty thorough with your questions so yeah… [chuckles]

JD:

Fantastic… that's good to hear and, probably, just more out of personal interest, uh… what motivated you to say yes to do an interview?

TB:

Um… maybe being a student myself and understanding the process of, of research and getting participants to… to get on board was, well it's, it's for the greater good, um… it's contributing to research in the area of maths and the teaching of maths is really important um… because there are so many teachers in there that have negative feelings towards teaching maths and if we can, we need to start at the top and if we can get our teachers more on board with the teaching of maths then that's going to help, you know, our kids be a bit more positive, um… I think families have a big impact on that as well and if they're having negative conversations at… "oh, I was crap at maths" at home… well that's going to impact on the kids so I suppose it was I love maths, I've always loved maths, being a student, understanding that it might be difficult to get participants and just wanting to contribute to, you know, perhaps the bigger picture and… yeah, I've always felt like we're just little fish in a big pond and if you can contribute then contribute… so yeah.

[TB's response here really opened up the idea that I was trying to get at with the "typical" teacher question. She chose to participate, not only because she's also pursuing research but because she recognises that a lot of teachers have a negative attitude towards mathematics which needs to be changed so that kids' attitudes towards mathematics are more positive.

TB also acknowledges the significant role that families play in attitudes towards mathematics and expectations of achievement.]

JD:

Fantastic… well, thank you very much for the time you've given me and for the answers you've given me for this research. I do really, really appreciate it.

TB:

You're welcome.

Interview ran for approx. 35mins.

Interview C: Terry

Interviewee: Terry
Interviewer: JD
Date of Interview: 06/09/2019
Location of Interview: Café, Bendigo
Acronyms: TC=Teacher C; JD=Jarah Dennison

Observation before interview:

TC seems pretty calm about interviewing and doesn't appear nervous or excitable. Behaves very professionally.

JD:

Okay… so um, first off, just um… thank you for agreeing to participate.

TC:

No worries…

JD:

It can be really hard to get teachers to actually participate in an interview because, as we both know, teachers are very, very busy people so thank you for taking the time to participate in the interview.

TC:

Yeah… no worries.

JD:

Could you tell me a little bit about yourself and your current teaching role?

TC:

So… I'm currently a grade 2 teacher at [name removed - public] primary school. I'm also the grade 2 leader, team leader. Um… and the integrated curriculum leader of the school. I've been there for 2… this is my second year. Prior to that I taught at [name removed - private school] in Melbourne for 5 years which is an independent, girl's school and, prior to that, I probably had 7 years working for charity and a couple of years before that teaching also at [name removed - public] primary school in Melbourne so…

JD:

A lot of experience…

TC:

A lot of different little things and, yeah, I suppose the span of time so, when I returned to teaching at [name removed – private school], that was more as a graduate more than anything because I had such a big period out of the game and then… yeah, filtered through so um… yeah… I guess that's my teaching.

JD:

I guess just a little prompt here: how would you describe your classroom that you work in?

[brief interruption by waitress with coffee order]

TC:

Uh… how would I describe my classroom?

JD:

Yeah… how would you describe your…

TC:

In terms of the students or organisation…?

JD:

Just in general…

TC:

So I've got 20 grade 2 students, I've got… um, 1 student who's uh… nearly diagnosed with an intellectual disability. I've got um, several students who are probably… with all the maths in general, just maths um… we've got probably a couple of students who are operating at a mid-prep level. Um… I've had a handful of kids at the grade 1 level um… I've got 1 kid who's in the gifted and talented… um, scale… so she's operating grade 3, grade 4 level maths and picks things up very quickly and I've probably got about 4 or 5 kids who are operating above level.

JD:

Cool, cool… that answers that really well… so what would you say your perceptions of mathematics are as an individual?

TC:

I'd say… I'm very confident with maths… um, that's my area. So… that's why I'm more than happy to participate in this stuff, cos I'm, I'm fairly confident with it. I think, I think maths is an area where… I think, a lot of teachers are either numeracy based, or literacy based. My team of 5, I'm math, I'm numeracy, math-science; the other four are literacy, 100%. Uh… don't want to touch maths planning, don't want to touch maths so I think it's the confidence in terms of them being able to teach it and get the most out of the students whereas, I'm confident that I can teach it and if the students aren't getting it, I can try and work out a different way to get them to understand where I don't think that's… that doesn't come easy for a lot of people. And it's not easy but I think I've got the ability to be able to do that so that doesn't worry me at all. Um… and I enjoy it because I understand it so um… yeah, I really enjoy maths teaching… um, whereas I know others don't necessarily and I think it's one of those things where it's a love or a hate. I don't think there's necessarily… how I see it, a middle ground for most teachers. Um… you know, some are capable across the board. I'm certainly more capable at numeracy than literacy… yep… so.

JD:

Fair enough, fair enough… would you say that your perceptions of mathematics as an individual are different to uh, your perceptions of teaching mathematics?

TC (3:51):

[5 second pause] Uh… not for me. I think I… I'm pretty confident in both. Like, at school, I was always strong maths um…

JD:

I'm just going to move that [the recording device] a little bit closer so it's picking you up.

TC:

Yeah… absolutely… yeah, no worries. Um… yeah, at school I was always good at maths. Maths was always my area and I was always very good at it, I picked it up quickly, I learnt quickly, I did it at uni level and I enjoyed it and I think I enjoyed it because I had success with it too. Um… and teaching is kind of the same. I find it easier to teach maths because I understand it. And I understand… where I can support the others so I guess for me… um, yeah… my perception is its, it's a good subject, it's a fun subject, I can do more with it, I can think more with it, and I can get more out of the kids with it. More so than I could for literacy. Now I can teach literacy but I don't think that I can get the best out of the kids whereas numeracy, I know… and to me it uses also black and white, especially at primary level. It's your answer or not your answer and I like black and white. I can see, I can see what the answer is um… and I guess as the year levels go up, its harder to get the kids to that answer and that's a challenge but I also enjoy that cos again I can see ahead to how to get there whereas I can't see how to get there for literacy a number of times. I can't see how I can get their piece of writing to look like this whereas maths, I can see how to get there. I know how to get there so yeah.

JD:

Fantastic, thank you. How would you rate the difficulty of teaching specifically fractions as a concept?

TC:

We just did fractions, grade 2, um yeah… no problems at all. I like it because it's hands on. I can relate it to real life too. So I can… some areas of maths you can't relate to real life or its hard to relate to them. I think fractions is very easy to see visually so with grade 2s, we're just teaching them the basics, we're teaching what a half looks like, a third, a fourth, that sort of thing. Um… you can do that in a visual representation. You then look at collections of things, teaching them what the number means. I think its quite relatable. So for me, teaching fractions isn't a… isn't the hardest area to teach. Um… as a, in our unit, the kids started with knowing what a half was so the majority of the kids knew what a half was, they couldn't write the fraction in numerate form, um… at grade 2 level. Um… they had a little knowledge of it prior to then. By the end of the unit with their post testing, um, they could all write what a fraction is, they could name the fraction, they could draw the representation of a fraction. Um… and my stronger kids, I was working at, you know, understanding the size of a fraction which, at grade 2, that was certainly beyond a lot of them and it like, you know, there's your number line, where's a half, where's a third? And I think a good thing with the fractions, you can also see, you can see the errors too. You can often see, you know, why they did what they did. Um… you know, putting the number line, the half in the middle and they get that and then putting a third closer towards the one rather than zero and the one cos the one… and it makes sense because the 3 is bigger than the 2. So you can see their thinking there and its, its um an area that I enjoy teaching because I think, I think its easier to get more out of them if you teach it well.

JD:

Yeah… fantastic. Would you say that you have to teach fractions differently than how you would teach other maths concepts?

TC (7:10):

[5 second pause]

Not… I think… no not necessarily… I think there's a lot of maths… it depends on what the strand is, depends on what it is, you know, if it's a number-based thing, then its number. You might be using collections and counters and stuff like that to help them at the grade 2 level. Work with fractions, you've got a lot of visual there, you know, you teach the number stuff but you've got to start with the picture, you've got to start with the visual and work your way towards that and… I'm a number person, more so than visual, um… but beginning with fractions, I know it's easier to teach it with a visual and putting those things together so um, but I think with all maths though, you need to work out what that starting point is and, at the younger level, quite often is that visual thing. You know, we're doing big problem solving at the moment and a lot of them are having more success solving their problems using a visual rather than a number so um… and our brightest kids are trying to do it in their head using number and then they're starting to find that it doesn't work that way… um… but fractions I think you kind of have to have that visual at the start. And relate it to real life too, you know, you know what half of an apple is because you've had half of an apple since you were 2 years old and you know that you're going to get half of it which means you chop it down the middle. So they get that sort of stuff which then relate it to the visual… yeah. Some areas of maths, yeah, you've got to throw a bit of both in. It depends on what sort of learners they are too.

JD:

Yeah, absolutely. Thanks for that. Yeah, that answers that really, really well. So basically, I'm just asking these questions because research shows that fractions is often an area where students struggle to understand the concept and teachers sometimes struggle to teach it. Would you agree with that statement?

TC:

[TC pauses briefly before answering]

Okay… ummmm… yeah, I don't it's probably off the mark. If research is telling it then it's probably true but um… my own experience, I suppose, I think… yeah it can certainly be a tricky area to teach. I don't know if it's the trickiest area but I think it certainly can be a tricky area to teach and then, I guess what I like about fractions also is there's so much on the continuum that you can work with. So even at grade 2 level, I can easily push them to further. From the grade 6 level, you've got that, you get the multiplying fractions, the dividing fractions, and then, you know, making that relationship with decimals and stuff so um… I don't know… I think from using it for myself I've never found that area challenging. Its again, to me it's, I've always, I've found it straight forward enough provided you know what the kids already know and where to take them… um… Other teachers, my team this year, yeah, I don't think have found teaching the fractions difficult… but we're looking at basics and I've also planned it and they're using my planning so um… but I haven't had feedback from them like I've had in other areas, like, I think money and time is more difficult to teach… in the younger levels than fractions are… um… again, my experience is that they're tougher areas and the results never are usually as strong as what they are in other areas so… yeah, nah, I don't think so. Yeah… I don't know. I don't know whether I agree or disagree with that. My experience is that I disagree with it but I'm also a maths wanted person so yeah… and I think my kids generally do well at the fractions area cos I enjoy doing it too.

JD:

Just on adding to what you said there, just about how money is perhaps an area that they struggle more with, uh… why do you think that is?

TC:

Because you're looking at decimal fractions, you're looking at number… You're looking at a different sort of… it doesn't make sense to them with those decimal numbers and all that into the dollar and cents, um… calculating change with a decimal, um… it, you know, you look at it and say you're taking 40 cents but 40 cents is point, you know, zero point four (0.4) so um… that doesn't link. There's not a relationship there. You give someone 2 dollars and I give you 40 cents change, but when you look at it on paper, 2 dollars is two point zero zero (2.00) take away… there's no connection there necessarily… um… and you know, kids are learning, when they're learning change, they're also learning at the same time, how to do your vertical addition and subtraction and so you add the decimal points in there (makes a 'chooo' noise and mimes a swiping motion), and it throws them. They could do 200 take away 140 but then you make it two dollars take away a dollar forty… it throws them. So they don't just see it as the same process with a dot in the middle, they shouldn't anyway but, um… I think that's a bit tricky and time is, for me is, it's frustrating. It's the most frustrating area of maths to teach because they just don't cotton on. The kids just don't get it. And I'll find that every year, you've got, you're teaching hour, half, quarter to, quarter past, to the minute, 5 minutes… no matter what grade you're in, you know, especially from 2 onwards, um… it just doesn't sink in for some reason and I don't, I don't know why. And again, maybe it's because of the numbers on the clock don't match up with other things… I don't know. I find those two areas a lot tougher to teach at lower end… yeah.

JD (12:24):

Yeah, yeah… no that's fair enough. Yeah, I was just interested. Now… I do have an activity here [passes worksheet 1] and so again, feel free to go ballistic as far as how you approach this. So, how would you expect your students to approach this question here so: "James had a bag of marbles. There were 56 in the bag. He gave away 3/8 of them. How many marbles were left?" I recognise as well that this is perhaps a little bit higher level than grade 2…

TC:

Yeah… it’s certainly not grade 2…

JD:

But… uh… perhaps thinking back to maybe when you had a slightly higher grade, maybe grade 4, maybe around that level. How would you expect them to actually approach this task?

TC (13:00):

[As TC responds, he appears to be working out the problem as he writes and talks his way through the problem]

So I guess that looking at… um… so 56 marbles in the bag, so three eighths, and I’d be getting them going back to the three eighths [writes “3/8”] and saying that, um, how many equal groups do you have and there’s 8 equal groups [writes “8 equal groups”]… so I’d get them to sort the 56 marbles into 8 groups [writes “56 into 8 groups”]. And that might be… [draws 8 circles] having 8 circles or 8 little groups there and then, you know, if they’re, I mean, grade 4, there’s a chance they’ve got their multiplication or division facts already so 56 divided by 8 is 7, so you put 7 in each one [writes “7” in each circle]. Um, for those you aren’t that… that couldn’t make that connection, it might be that they literally are going, you know, 2, 4, 6, 8 and then divvying it out until there’s 7 and the 56 is all gone so they count to 56… not the smartest strategy but for your lower ones at grade 4 level, that would be okay, that would still work for me. And then, looking at your, um, your numerator, you want three of those groups so you know, I’d be ticking three of those groups [ticks three of the circled 7s] or crossing out the other 5 or something so for me, the three eighths are 56 and then you’re adding those up. 7 and 7 and 7 is 21 [writes “7+7+7=21”]…

[at this point, TC pauses as if he has completed the problem. He then briefly checks over his question and comes to realise that he still needs to complete one more step before arriving at the solution]

….so um, 56 marbles, he gave away three eighths of them, oh, how many were left in the bag [underlines “were left in the bag”], okay, so um, you got fifty… so 21 were given away and 56 take away 21 is… 35 [writes “56-21=”, pauses, then writes “35”]. Um, so yeah, bit of problem solving there too so I’d probably start them off with, um, underlining the important parts [underlines “56 marbles”] 58 marbles in the bag, gave away three eighths so that’s kind of like a take away there [underlines “gave away 3/8” and writes next to it “take away”], um, which, if I didn’t read it again, I wouldn’t have seen that and then… how many marbles were left in the bag [underlines “were left in the bag?”]. Um, so again, you’ve got your answer and you can go back and check it out. Make sure that they’re all there so I’ll solve this for the problem too, showing their working out is vital. I would say, um, at grade 4 level if that’s what we’re looking at here, you know, grade 6 level, they should be able to do that as a calculation, um, and they should, they would know if I’m giving that sort of problem but in this term, yeah, using a diagram in there, that’ll work beautifully. Linking it back to what they know. I would actually say that I’ve probably got a couple of grade 2’s, um, my, my strongest grade 2, the gifted one, she would probably nut that one out without support. But again, a rare mind, um, to be able to do that so… that’s what I’d be doing.

JD:

Yep… fantastic. Thanks for that. So… I guess, how would you teach that task to a class?

TC:

Well at grade 4 level, I would expect that they already know what three eighths is… um, and I would expect that they also know what a fraction of a collection is at grade 4

…so, for this one here, I'd probably go through exactly the same steps I just did then. I'd start with, um, what's a fraction? And so what does three eighths, what does three eighths actually mean? [draws an arrow to the 8 in 3/8] So um, you know, 8 is the total number of groups as I said and they're, all groups are equal in fractions and we're looking at three of them [draws an arrow to the 3 in 3/8]

…so, it might be that, um, you then draw your eight groups and that you put a tick or mark off three of them. It's asking three eighths of 56 so um, three eighths of 56 means that you're looking at 56 marbles into those 8 equal groups and then, you just want 3 of those so um… that's how I'd go there. And also at grade 4, I'd expect that, you know, this equation, I did it in my head but they could do the vertical subtraction to work that out also [rewrites the horizontal "56-21=35" into vertical equation and writes the answer "35"]… um… yeah.

JD:

Would you, would you model that to start off with or how does that work?

TC (16:54):

Once I've given it to them… I would have given them something simpler to start. So my explicit instruction would have been a problem similar. And it… my explicit instruction might have been something like… um… you might start off with half of ten and doing that because that's two equal groups so you've got two there and then you put 5 in each one and that's the sort of thing that a lot of them would know in their head [writes while speaking "1/2 of 10" and draws two circles]. Um… so they're not thinking too much about that but getting that process and then you might go with something like, you know, um… 2/3 of 15 maybe [writes "2/3 of 15" under the two circles]. And do that on the board too. So what is two thirds of 15? It means I have to have three equal groups and its 15 have to go in three equal groups and I want two of those so you're doing a simplified version so the explicit instruction at the start, that's what it is, um… you've modelled and then you might go and give this one and say, show me all your working and off you go.

[TC demonstrates two simpler problems as an introduction to the main problem that students will work on independently, scaffolding their knowledge and understanding]

And you can feel, like,… If that's your normal problem, your simplified version you'd have a simpler problem for this for your lower group and for your upper group you'd have something, um, a bit more challenging you might even say, you know what, I'm going to test my challenge… I'm going to challenge my upper group and I'm just going to give it to them and they're not part of the explicit but, I'd probably give explicit and then vary it up a little bit for them… so yeah, three levels of problems.

JD:

Yeah great, great. Um… so basically the reason I've chosen this kind of um, question is, as you said, it's a bit operational and as well as that, its differentiating between um, like, the number itself and a collection. So, a fraction and a collection. So how would you help your students to differentiate between representing, say, a fifth of a number line and a fifth of a particular numb… of one whole.

TC:

So, yeah, it's a fifth of a whole or a fifth of a collection? So can I start with the whole stuff first and let that… a fifth of both is… you've still got 5 equal groups. The difference is the fifth of the whole, you're breaking that one thing into 5 spots whereas a fifth of a collection, you're looking at a group of things and you're getting, sharing 5 equal groups out of those things. So, um, yeah and I would start with the whole one first because that's what they know. You know, I'd do the fifth of that one first and then, you know, [brief pause to draw on back of first worksheet; draws a fraction bar in 5 parts, shading one part noting "1/5" next to the bar]… we're looking at that. That's what one fifth of a whole is, we've got 5 equal groups because that's what this number is and we're looking at one of them.

[TC demonstrates first a fifth of a single whole as "that's what they know" and then goes on to demonstrate a fifth of 15 changing his visual representation from one whole [rectangle] in 5 parts to 5 circles with 3 dots in each]

And then, a fifth of 15 is the same sort of thing, is that you've got… this is broken into 5 different things, um, how many is… so if we're looking at a fifth, we've got 5 equal groups and there's 15 of those things, we're going to share them between them [draws 5 circles under the fraction bar noting "1/5" next to them and pretends to place a dot in each circle as he explains]. So, the relationship between them is the same. One's your sharing multiple items, the other one's your breaking one thing and, into multiple items, I guess, and we're still looking at one of those groups each time so, and that's effectively what we used to do with the grade 2's, um, we didn't delve too much into this [points at the collection drawing] because that's probably a grade 3 thing but, this one here [draws arrow to fraction bar], and then making that relationship between the two [draws arrow to collection drawing]. Because we do look at a collection at grade 2 but we don't spend that much time on it. You know, so, that's how I'd make the connection between the two of them.

JD:

Yeah… and I like the language you're using there to kind of relate those two. And obviously, do you have a specific group in mind, um, a specific class in mind?

TC:

When I'm doing…?

JD:

When you're writing out these [pointing to drawn graphics], is there a specific class you're thinking of or a couple of classes or…?

TC:

Oh… no, so our school has got 5 grade levels but when I plan the activities, I've got the curriculum, I've got 'below', 'at' and 'above' and, um, I guess I'm, you're planning for 'at' but you're catering for 'below' and 'above' so, you know, my 'below' students, we look at that one [points at fraction bar graphic], my 'at' level and 'above' level, we look at that one [points at fraction collection graphic]. And it'd depend on how strong the above students are, they just might need consolidating this, this might be new to them [points at fraction collection graphic]. So this year was certainly new to them. They had no idea what that was, um, my strongest ones. My 'at' and 'below' kids were still working through this [points at fraction bar graphic] cos they knew what a half was, not much more. There was, their knowledge was pretty low this year, um, but I'm confident now in saying that they could tell you what this is [points at fraction bar graphic] um, a good chunk of them could tell you what this is… the collection [points at fraction collection] um, not, not confidently they couldn't but, a good core group could whereas previously, we were looking at getting a good core group at doing this first one so they've certainly come a long way. But I would be planning for a grade 2 'at' level and then, once I've done that, I look at how to differentiate between the 'above' and 'below'. Um… 'below' is usually looking at something a lot simpler and it might be, do this, colouring a half of something, objects, that sort of stuff. And I think grade 2s: halves, fourths and eighths. That's in the grade 2 level so… and then my 'above' level students look at thirds and fifths and then look at collections and stuff like that too so, the core idea of the session, the learning intention and success criteria and then you adjust it slightly for the other two groups. And that's all based on pre-testing.

JD:

Fantastic… thanks for that. So, moving I guess away from the kind of knowledge side of things into the expectations part of this interview, in mathematics, what do you expect from your students and how do you set those expectations?

Teacher (22:13):

Um… I guess I expect them to give it all a go. Um, my expectation is that at the end of the unit, I've got growth. They've showed learning, they've improved. The pre-test and post-test are different. You know, I'd… whether they get two or three right or whether they get ten right, it's still showing improvement. And I'll, I'll expect most of my kids, my 'at' and 'above' kids to show good improvement.

You know, that they'd get… on a pre-test where they got not much right, I'd expect them to get most right in the post-test. My 'below' students, and depending how far below, um… you've got to be realistic in terms of what they can do and you've got to judge them individually so, I wouldn't expect my 'below' students to effectively jump that 6 months growth or 12 months growth in a subject area necessarily because that's not what they are going to do.

They're below for a reason so, um, well I expect my 'at' level student and my 'above' level students to grow that 12 months' worth, um… that's what I would expect. Now, if it doesn't happen, it doesn't happen and you… but that's what you're pushing for. Um… so I sort of push that the end of every unit so at the end of my fractions unit, I should be able to tick them all off to say that they could do grade 2 level fractions. Um… and there's going to be a couple that don't quite get there and there's going to be some that slide through and above. So, and I would expect my 'above' students um… to a show that they can do ‘at’ level but also that they’re ticking some of the boxes in ‘above’ and if they don’t, if that’s not their area, then they don’t. So, how I do it? they’re grouped, they’re grouped on ability, in maths they are, not necessarily the other areas but that one, they’re definitely ability based, based on pre-testing and then, you know, I would, based on my planning, get the stuff out and expect, you know, that they’re there. Small group focus, uh, for those kids who need it and vary it up too. So my ‘above’ kids would get sessions and my ‘below’ kids would get sessions and my ‘at’ level, you know, um, they get the support they need also. And we monitor as we go, you know, if three of my ‘at’ students aren’t getting it, then they get a bit more TLC because they need it. Yep… so… yeah, the expectation is that there is growth. How much growth? It depends on the students, it depends on the unit, it depends on, you know, that’s where, that’s why I find time and money hard. You don’t get… I find the growth there is smaller than, like this fractions unit where the growth was significant.

JD:

Yeah, yeah, fantastic. How would your expectations for your students differ from your expectations for your teaching?

Teacher (24:55):

[brief pause] I expect… I’d expect my students to… well we’re all learning. So, the expectation is that we’re all learning. I would expect there’s more learning for them um, especially the more you teach that particular year level or teach that unit in the same year level um, I would expect there would be more growth in them than in me, especially the more experienced I become… but, I would expect for me to be still learning at the same time.

Our school does a lot of learning communities, professional learning communities, PLCs, um, and we’re constantly improving, you know, our skills and our abilities and our knowledge and stuff in certain areas so, um, if it’s any area that, you know, we’re not strong in, we work hard to improve that area and then that filters into the teaching too so, um, yeah, look I would expect that I’m showing an improvement in how I teach, be smarter in how I teach, and I’m learning, even individually, what good students, what makes them tick and how to support them um… so, yeah, I would expect there would be growth in my learning too um, but I think they’re different. For the students that you’re looking at a whole heap of different things whereas for me, you know, I need to be improving my practice and if I’m not teaching an area very well, I reflect on that and go well why? And then you put that in.

JD:

Yep, yeah, fantastic, great. So, I think you already kind of mentioned what influences those expectations, it’s kind of those things like pretesting but knowing your students and all those sorts of things. Would you, what would you say has the greatest influence on those expectations?

Teacher (26:30):

Um… the goals you set them, you know, and trying to achieve those goals and giving them the resources, and materials, and the knowledge to achieve those goals so… um, setting them an individual goals which we do and they’re working towards trying to achieve that. Um… let them understand that you've got your learning intentions, success criteria. Them understanding what that means, what's expected of them in that session. Once they know what's expected of them, then, they kind of know what they're end goal is in a way. Um… and they all know what the expectation is in the session, um, whether they get there or not, or whether they think about it much, I'm not too sure. I think research says that, if they know what they're learning and where to get too, then that improves their learning but um, yeah, I'm not sure.

JD:

Yeah fantastic. Um, great so another activity for you: the final activity and perhaps a little bit more intense activity [passes worksheet 2]. So, as you can see, just a basic graph, just a timeline basically. Could you create a timeline indicating what fraction concepts you would teach, when, where and how…from beginning of foundation to the end of primary so end of grade 6. When and how you would introduce each concept?

TC:

[Throughout the activity, TC is quietly talking through each note written]

Whoo!

JD:

Take as much time as you need um, yeah, go ballistic!

TC (27:45):

Um… alright so… I've never taught below grade 2 before so I'm going to go, so that's 1, 2, 3, 4, 5, 6 [writes numbers by each bar]… you're lines don't make much sense.

JD (28:00):

Oh sorry, from the beginning of foundation through to year 1 and then 1 to 2 and then 2 to 3 and 6 to the end of 6 so…

TC:

Oh… okay. Gotcha… alright.

[TC mutters to himself as he breaks the graph into Foundation and grade 1; grade 2; grade 3 and 4; and grade 5 and 6; teacher notes "1/2, what is a fraction" above Foundation and grade 1, and "1/2, 1/4, 1/8" above grade 2. As he speaks, he notes "numerator of 1, name, represent as part of a whole, collections" next to the fractions for grade 2].

So, I'd say that starts there, halves, what is a fraction… and that's half, fourth, eighth because I've just done that. Um… that's naming them, represent as part of a whole, and we're starting with the collections.

[TC mutters the following slowly while writing "1/3, 1/5, collections, adding/subtracting same denominator" above the grade 3 and 4 section.]

So, 3 and 4 kind of… there content sort of merges together a bit and they're looking more at thirds and fifths. It's just some more of collections, probably a bit of adding and subtracting… um, same denominator.

[TC moves onto the final grade 5 and 6 section and notes “multiply/divide”]

Multiplying and dividing fractions, uh… along here somewhere you’ve also got uh… link to decimals… decimal fractions… somewhere in that space there…

[TC notes “link to decimal fractions” with an arrow first pointing between 4 and 5].

So, you’re looking at um… and you’ve also got number line too. So number line is not expected here so number line is about there… So… comparing… the size.

[TC notes “number line” between the sets of notes for the 2 section and the 3,4 section. The teacher then notes “comparing” next to it and draws a line to connect the two].

Down here’s looking at, um… different denominators… addition and subtraction, multiplication and division. About three to, four to about 6 and above, whatever…

[TC notes “different denominators, + - x ÷” under 4 and 5 section]

This is looking at more… um… numerator as 1 whereas here, start looking at different numerators and denominators… and comparing the size…

[TC points towards the start of the line and then notes “different numerators + denominators – comparing size” under section 3,4 and draws a line from the note to the 3].

Oh so also, at the grade 2 sort of 3 space is relating division, relate to sharing and division… which we’re introducing this year also in grade 2 which I haven’t done yet but trying to make that relationship with fractions too… I’m assuming that’s that sort of space there…

[TC notes “relate to sharing and division” under the 2 section and draws a line to the 2-3 bracket he drew at the start of this worksheet].

Yeah… I reckon that’s probably… I don’t know what I’ve missed there, I’m sure I’ve missed a few things but…

JD:

Yeah… I’ll just ask just quickly… decimals and percentages as they do fit under that kind of that fraction idea… where do you put them?

TC:

[TC suddenly and surprisedly realises that his continuum is missing percentages]

Oh percentages… oooh… I’ve got decimals here, decimal fractions are there but that sort of that, so we don’t do decimals in grade 2, grade 3 we kind of look at your tenths and hundredths, but I know when I taught grade 3, we never really looked at… if I’m looking at your percentages… around about here.

[TC notes “%ages” above the 5, 6 section and draws a line pointing to the 5].

Which is, you know, depending on your students, that 4 to 6 sort of, especially 5, 6 more so. Um… decimal fractions… yeah, I’d say decimals would be more in that area too. I don’t think you’d look at them…

JD:

… in the 3 to 5, is that right?

TC:

Yeah… it's kind of like that 4 to 5… space there… I'm just trying to think when I taught grade 3… oh no, you're looking at one, you're looking at tenth, a hundredth… so that's probably more… going to be more that way…

[TC crosses out arrow linking 4, 5 with "link to decimal fraction" and places a new arrow pointing at the 4].

More the grade 3, 4 sort of space because you are looking at tenths and hundredths and represent that now as one tenth, one hundredth… yeah… yep.

JD:

Fantastic… Would you approach this task differently for another maths concept?

TC (33:30):

Wha… look at continuum?

JD:

Yeah… or…?

TC:

Um… I wouldn't do this for a… I wouldn't do this method for a, um… teaching fractions. I'd look at the Vic Curric and whatever Vic Curric says and, you know, as well, you've got your pre-test, which would so describe for the sake… so if I'm teaching grade 4, my Vic Curric, I'd be looking at some grade 3, 4, 5 and then, um, you're going to have kids blow it, I know that, and you're going to, potentially you'll have kids, probably have kids above it but get your base level data um, what's expected at grade 4, put a bit below, bit above, and if you've got kids who nail the whole thing, I'd be looking at whatever the Vic Curric says for grade 6 or 5 or whatever… um… if they completely bottom out, I'm probably going to go back to back here… my grade 2, 3 stuff and then, build the basics up, understand what a fraction is, make sure they've got that, and then, again, using the Vic Curric, not using, obviously [gestures towards worksheet 2]… obviously I know this is an exercise but… um… I always have the Vic Curric in front of me and do it that way… at all maths concepts… um… irrespective of what the area is, I do it for all of it. You know, if I'm doing money, same thing, I look at grade 4 money and I go alright, change, whatever it is and then, you pre, post-test, um… I'm pretty big on the pre, post test for maths. Again I found it pretty black and white, I found it very straight forward, if they know it, they know it; if they don't, they don't. So… we can work that way. And then, I've got my starting point for my groups and also starting point for material because there is no point teaching things that they don't need to know, um, or if you think they should be here but there actually way down here like we found with the grade 2's this year, you know, their knowledge wasn't where we thought it would be, it was a lot lower. We started from further back and worked our way up so… yeah. But I would certainly look at the… a short continuum either side of the year level.

JD:

Yeah… fantastic and I like how you were kind of explaining that to me as you went. How would, kind of, introduce these different things… in the classroom?

TC (35:30):

Again, I'd be looking at what my main… so if I'm getting, if I'm teaching 2, grade 2 um… and I'd do the explicit instruction for that first 10, 15 minutes and I'd look at the data I'd go well, you know, most of the kids don't have a concept of what a fraction is yet um… and I'm using different parts of the Vic Curric because this is where we're going to start off but then, you know, I'd build in some explicit teaching, some modelling and then get the kids to go off and do it. So for this one here, it really was… they didn't understand what a fraction was, they knew what a half was because they know what a half is but they actually didn't know how to draw a half, they didn't know how to write it in symbol form, um… so get them to understand what the one is, what the 2 means in a fraction so, what your numerator and denominator is and then use that consistent language throughout… um… and then build up from there so… and that's where, you know, like for our pre-test, we could see quite, we could see very quickly, straight away, you know, they knew what a half was, they could draw a half, but that was about it. As soon as you got to something else, they had no idea what… say a fourth was, they had no idea what the four meant, um… they got some things right, some of it was a guess, some of it was just being clever, knowing how to answer a question um… but most of it showed that they didn't know much. So, that was my starting point and then build it up from there so if this was the correct continuum, and that's where I started, I would work my way down the line and, and do that, and then, you know, you've got some kids that are up here, so, they might listen to the intro and pull them into a small group and then you focus on what they need to focus on and shoot them off and then you go back to the rest and support them.

JD:

Great, now, I know this question is probably going to be a bit, just kind of come out of nowhere. Some researchers suggest you can teach fractions as early as foundation. Would you agree with that and why or why not?

TC:

Yep… yeah… it's another maths concept, why not? It's a bit like reading, you know, inferring is one of the hardest reading strategies. You can teach that from grade prep and you just teach it at their level. So I think that, yep, you can teach it at foundation and I think it's, you teach it based on their level. And it's just, for them, it's the basics of what is a half. It might not be introducing the symbol; it might be introducing a shape and they cut it in half. It might be introducing it with a ball of playdough, and you show me a half. How many equal parts do you have? Two. Yeah, so if you've got a half you've got two equal parts. Um… so yeah absolutely, 100%, you could even do it from foundation. You're teaching them what they need to know so, if they, if… you know, you're not going to teach them some of this stuff down here [TC points at the higher end of Artefact 2] because it's not relevant. But, you can certainly teach them the word fra… you can teach them the language and that language is consistent then from foundation up to grade 6. You know, when they come to grade 2, they know what a fraction is, they know what the word means, they know what the symbol might look like, from grade 1 perhaps, um… they can explain what a fraction is: an equal part. You know, a part of a whole and obviously you work on fractions when that time comes down the track so… yeah, I think you can, absolutely. Having said that, I've never taught Foundation so the prep teacher might shoot me for that one… but, yeah.

JD:

Yeah… no, that's absolutely fine. I think a lot of the people I've interviewed haven't taught foundation which is really interesting but just different levels of responses…so yeah… its really interesting. Just coming to a conclusion in the interview, just a couple of wrapping up questions: do you see yourself as a typical primary teacher, typical with the little quotation marks around that word?

TC:

What does the word 'typical' mean? Um… I don't know. I don't know what the word typical means… um… I'm a good primary teacher… uh, I'm strong in certain areas, um… I've got different career aspirations, I mean, a lot of teachers are probably happy to teach and do what they need to do and do their job really well, um, I want to go up the chain and that's the direction I'm going for, so, you know, learning strategies, learning strategist is my next cab off the rank so that's what I'm going for so um… yeah, I don't know what the word 'typical' means… like, could you give me a definition of the word 'typical' then I'd be able to answer differently?

JD:

I guess kind of your, your average, your everyday kind of teacher…

TC:

No… I think I probably put more time and effort in, I guess that's not the right word, more time in than what most do, certainly looking at teachers that I know and teachers around me, I certainly put more hours in than a lot would, um… I wouldn't say I'm doing a better job than most but I certainly put more time into it, put more time into planning, I'm pretty specific about what I want… um… I put a lot thought into different things and stuff which, you know, a lot of teachers do so yeah… look I'm probably, a lot of me is typical of most teachers and I would say certain elements of me are, are different. Um… but as I'm getting on, I'm more so looking at my career and go in a certain area where a lot of teachers aren't looking at that and they're quite happy with what they're doing and they don't want the extra responsibility where I'm happy to take that responsibility on and further myself and stuff so… yeah.

JD:

Fantastic… and I guess just another question, you mentioned previously about how you've had a lot of different experiences, particularly, I think, you said you worked as a charity worker?

TC:

Worked for a charity, yeah…

JD:

Yeah… Uh, how might you say that, that's what we typically refer to as a second career teacher where they've done something previous in a second career before they've actually done teaching. How might you say that being a second career teacher influences your practice?

TC:

I taught before I was at [charity name] although I did work for another job before that again. Um… you've just got different life experience, you see things differently, so obviously working for a charity for 7 years and I've worked with sick kids, um, I certainly see kids and treat kids a little differently than what most do, I don't have as much cotton wool um, I've seen what kids with cotton wool need and, they need tender, they need careful hands and stuff like that, and most kids in a primary school environment don't need that careful treating but at the same time, you also have a bit more empathy for kids and families and, you know, kids with not much um… you feel for them a bit more because you kind of understand what they're going through a bit more and I guess like, for me, I can, I think about the families a bit more than what some people who are just going straight into teaching and I understand a bit more because of the experiences I've had outside of that and look, I said its more to sick kids and so it's very different to what someone else might do in another, another environment. So yeah, I think I think differently to than other people would and I probably have, in some ways, more empathy than what others might um… but every individual is different too and someone might be a, you know, career teacher and, you know, that's what they are and, um, they again look at it differently so… but yeah, I think it could be called my second career, I guess you could put it that way… yeah, I do think I look at things a little bit differently in terms of conversations I have with families and kids and I guess, now also I come from a school who's affluent, you know, they've got money and money is not an issue to them um… and the school had money and the money wasn't an issue to them either and so, you could do anything and you had parents who were very well educated and you've now got a new environment where that's not the case and parents don't have the same abilities as other parents I've taught with so you have to change your thinking also and go okay, and you asked the question earlier about the expectations, well I've got different expectations of support coming from home, of what I need to do than what I did three years ago when I was at the other school. You know, I would expect parents to give me grief if a kid came home with lower results on their grades whereas I wouldn't expect that now. You know, it doesn't mean you change how you teach it. But I certainly, you don't worry as much because you know you're not going to get them knocking on the door because you don't, you know, that sort of thing, whereas, where I was, you'd expect them to knock on the door any day of the week. It's very different to what you think so, um, you also support the kids differently now because, you know, they're possibly aren't getting the support at home that they do need. It's all a bit different.

JD:

Fantastic… thanks for that.

TC:

No worries.

JD:

So, do you think this interview has changed your thinking at all about teaching mathematics or setting expectations generally in any way?

TC:

No… um, it was good to think about a lot of these things through. But I don't think anything that I've said would make me… you're pretty much asking what I think anyway. Um… it was good to get me thinking but, yeah, I don't think my expectations are going to change for the kids, I don't think, um, how I look at teaching is going to change, um, you know, as I said, we just did fractions so… this is all very fresh at the moment so if you asked me that in… 6 months ago, um, it'd probably be different results, different que… different answers because, you know, it, I certainly didn't know what fractions in grade 2 looked like 6 months ago but it was obviously very fresh at the moment. I do know… um, ask me about a different unit I haven't done yet, could be different responses, you know…

JD:

Fair enough, fair enough… is there anything you would like to add?

TC:

Um… no I don't think so. I think um… yeah, it could be interesting to see what other people from different backgrounds and different schools and you know, how much of the schooling and all that. I can say that I work with a pretty strong group of teachers and, inexperienced and experienced and, um, but they're all passionate about what they do and I don't, can't think of any that aren't and maths is a pretty strong focus at our school so we're constantly having PD, we're constantly looking at things and looking at how we can improve our practice and stuff. It's a very strong component of our school which I'm very lucky to be able to have that opportunity.

JD:

Great, great… fantastic thanks for that. And just out of personal interest more than anything, why did you agree to have an interview?

TC:

Um, because the person who sent me the link in the first place, um, she's helped me out in the past and we've obviously got a good relationship so, um, I thought well why not, yep, you know, help out because we've got a good relationship going and why not? So… yeah.

JD:

Fantastic… well, thanks for that, um, thank you again for participating, um, and your results and just your responses have been absolutely fantastic so thank you again.

TC:

I hope that they help with your goal.

JD:

Yeah… hopefully, well, your responses shape my… uh, my thesis.

TC:

No worries.

After completing the interview:
TC went on to just talk about teaching and teachers and discussed passion for 5 or so minutes and I requested to take note of the following quote:
"If a teacher is passionate, you can see it in their class."

Interview ran for approx. 46mins

Interview D: Damon

Interviewee: Damon
Interviewer: JD
Date of Interview: 07/09/2019
Location of Interview: Café, Bendigo
Acronyms: TD=Teacher D; JD=Jarah Dennison

Observation prior:

TD appears quite calm and relaxed albeit a little nervous.

JD:

Okay… so that's started recording. So, um, obviously there's the participant information statement, if you've got any questions, you just need to email me or whatever. Can we start off just by you telling me a bit about yourself and your current teaching role?

TD:

I'm a grade 1/2 primary teacher, generalist, I teach all subject areas except performing arts, PE, art…. And I think that's it. [TD laughs]

JD:

All those, just, kind of extracurricular kind of things… that's fair enough. Could you tell me a little bit about the school you're working in?

TD:

Um… it's a private Christian school, in Bendigo here, P-12, um… they've just done an expansion, so their potential numbers have gone up another 300 students so it's a big school, growing fast. It's got a good reputation; it has a long waiting list for all year levels…. Yep.

JD:

Okay… fair enough. Sounds good. What would you say are your perceptions about mathematics as an individual?

TD:

I guess they've changed since I've gone to uni and started learning about teaching mathematics. I guess my perceptions when I was at school and pre-university, pre-teaching were that maths is pretty discrete. Everything about maths is discrete. You have to know a specific formula and there is only one way to solve a problem and those specific answers are often very difficult or almost impossible to find.

[short interruption from a waitress; TD expresses an interesting perspective of mathematics here. In mathematics there's always a specific way to do things and a specific answer that's "almost impossible to find" and that understanding changes after university to many different ways to find answers]

After going to university, I guess I can see now that there is lots of different ways to find answers and it's my job to, I guess, demystify the process of maths for my students. A lot of maths anxiety out there… I think a lot of the issues with kids being engaged in maths is anxiety. I've seen that in my class. Um… I'm probably getting a bit off track here but, yeah, that's what I see… um, there's lots of different ways to solve the answer, lots of different processes and tools and strategies you can use in maths and its not as daunting as most people think and it probably shouldn't be as daunting… unless you're getting into quantum mechanics… yep [TD chuckles].

[TD addresses maths anxiety as a significant contribution to people's attitudes towards mathematics perhaps stemming from his own experiences of mathematics. He doesn't outright say that he is confident but he makes distinction between his level of comfort with mathematics and the maths anxiety out there.]

JD:

Yep… fair enough, um, would you say that your perceptions of mathematics as an individual differ from your perceptions of mathematics, of teaching mathematics?

TD:

[TD is very careful in responding to each question and often pauses before answering]

Um… yeah, they would, I guess. Yeah, I guess, lots of things in my individual views differ a little bit from my teaching because I have to teach certain curricular, certain ways and [TD pauses] anyway, um, how does maths differ as an individual to… what did you say? How I would teach it?

JD:

How you would teach it, yeah…

TD:

I guess there's still some things… about maths that I find difficult to remember, different formula, I guess not at the grade 1/2 level but different formulas for the area of… a cylinder and the volume and all that sort of stuff. I can't really do that off the top of my head [teacher clicks fingers repeatedly, clicking out a steady rhythm]. If I have the formula written down and I get warmed up, I can have a go at it. Um… I still feel like maths sometimes is a little difficult and some of the answers are a little bit unattainable if you don't have certain strategies. But I'm trying, I definitely don't let my kids know that I think that there's parts of maths that are difficult. I just keep telling them, "its all easy, lets have another go at it." Multiple exposures is good.

[The formulas and strategies here are indicative of a procedural understanding of mathematics with a limited indication of conceptual understanding. TD seems uncertain and a little nervous in his response]

JD:

Fantastic, thanks for that. I guess, um, just to build on that, what's your history with mathematics?

TD:

I went to a private Christian school of all things and, um, it was a P-12 school and I left in year 7 and went to a couple of other schools but I vowed I would never go back to school; I hated maths, not because I was a dummy, just because I don't think things were presented to me in a way that made it interesting, fun and engaging and with the real world connections. So much of what I remember at school, especially maths was just, "Why am I working out the area of a circle? I don't care, I'll never use this again so I don't bother remembering it." So yeah, I guess the big thing I remember was it's a bit difficult but difficult because I can't make a real-world connection so it's, it's useless to me.

[TD expresses his hate of maths with a lot of emphasis but its interesting that he follows his hate of mathematics with "not because I was a dummy." Does enjoying mathematics make you smarter? Is that the perception of mathematics?]

JD:

Yep… How would you rate the difficulty of teaching fractions as a concept?

TD:

Oh, we're doing that, we did that last week. Um… to the grade 1/2s, I think its pretty easy when you start off with wholes and halves. When you need to have halves, they have to be two equal, the same area, same size, that's a fairly easy concept and then when you go into quarters, that's half of that again. Thirds, fifths, sixths, that can be a bit tricky, there's parts of, you know, like, um, 7… 17 is bigger than 7 because it's got two place values, a 7 has one place value. 8 is bigger than 7 because 8 is just bigger than 7. When you go into fractions, one quarter is smaller [I think the teacher meant greater] than one 8th, even though the 8th is bigger… so that's difficult to teach my kids even though we don't do a circle and divide it into a thousand pieces, I can tell you that one thousandth is a lot smaller than one half… and they struggle with that. What else? At grade 1/2 level, that's probably all we do with fractions.

[TD identifies a common misconception in fractions here where students typically look at ¼ and 1/8 and think that 1/8 is bigger as the 8 is a higher number than the 4 when in reality, the size of the 1 in ¼ is larger than the size of the 1 in 1/8]

JD:

Yeah… fair enough. Would you say that you teach fractions differently from how you approach other concepts in maths?

TD (5:30):

[TD seems hesitant to answer straight away and repeats the question back to himself]

How would I approach other concepts? I guess there's a range of strategies that I encourage all my kids to use. We have posters around the room. If they get stuck, they can think of some of those strategies. I guess every maths concept is different and they have a different purpose, but they are all under the overarching idea of maths. They'd all start with a different introduction and I guess a different warm up game and a different real-world connection. So yes, they would be different, somewhat different. I'd like to think so… its not a copy and paste.

JD:

Yeah, exactly. There's not a copy and paste approach that you can apply… yeah, fair enough. How do you think students learn fractions?

TD:

[Unlike many of his responses so far, TD is not hesitant to reply and answers straight away]

With real world connections… I think it's a, a little bit of a, not abstract but if we're talking about objects in the classroom, right, everyone go around and find an object in the classroom that could be divided into halves. They're not actually dividing it into halves so you've got to kind of picture it and use your imagination a little bit, or think about "I've seen one of those and I've also seen half of one of those." Um… what was the question again?

[TD seems hesitant to ask what the question was]

JD:

Um… how do you think students learn fractions?

TD:

[Again, TD is quick to answer]

Oh, um, yeah… real world connections so… I like to engage them in conversations and discussions about their experiences. I think kids come to the classroom already knowing a lot but you kind of just have to remind them of the things that they know. If you say to a student, "what do you know about fractions?", they all say "uhhh"

[TD says this in a very dopey kind of way]

or "everything"

[TD says this in an excited way] and then, "tell me what it is", "Oh, I don't know"

[TD again says this in a kind of dopey way]

But then, a bit of coxing and warm up games and that sort of thing, they tend to remember and make connections "Oh yeah, mum made a pie yesterday and dad's such a guts and he hate half of it. There was four pieces and dad had two so that means there was only one for my sister and I." Things like that.

JD:

Yeah, yeah, fantastic. Um, so basically I'm asking these questions because research shows that fractions is often a concept that both students struggle to understand and teachers may struggle to teach. Would you agree with that?

TD (7:30):

I don't know… I'm not all teachers. Its really hard to make generalisations in education. And I guess generalisations are general so for most or many but I haven't been in most or many classrooms. And at the 1/2 level, I guess the teachers that I work with, there's three 1/2 classrooms, I guess we plan and discuss what we're going to do together although we have a different slant… if you watch all three of us teach, it would be slightly different and it would be directed at our students… um… I don't know that…. I don't know that… maybe, I'd probably say half, I'd say half of the teachers that I've met or spoken to find it fairly simple, I don't find it daunting or scary: Fractions, especially at 1/2 level, I think it's quite easy to make real world connections with fractions. I think when…. Once it starts to become a little bit abstract, like thousandths and… yeah, a bit beyond that, if you can't actually do it or make it or see it or build it, that might be tricky. But I guess, for teachers, if you're feeling a little bit daunted about teaching a certain topic, do a little bit more research, watch a few more videos, talk to a few more teachers, and just teach where you're comfortable because if you're teaching something and you're feeling like, "I actually, I don't get this, I'm not sure", just take a little step back. I think it's okay to, to spend a bit of time in the same area just going over it different ways.

[TD's approach to responding to this question was interesting. He seemed to cringe a bit when he responded, particularly when he said, "I'm not ALL teachers." He goes on, however, to say that it's probably half/half but overall, his demeanour throughout his response seemed initially uncomfortable with the question but gradually seemed more comfortable in answering]

JD:

Yep… fantastic. Thank you. Now, I do have some activities for you to complete, um, feel free to take a minute to think about it or um, just go ballistic as far as your notetaking on this one [passes Artefact 1]. So, basically, how would you expect your students to approach the following question? Now this question is probably aimed at a bit of a year 3, year 4 classroom so perhaps a little bit higher level than what you might be used to in the classroom but then sometimes, you might have students that are gifted as well so… "James had a bag of marbles. There were 56 in the bag. He gave away 3/8 of them. How many marbles were left?" How would you expect your students to approach that question?

TD:

Um… I've… um, told my students if we're looking at fractions, and I would probably write this three eighths the way you've done, three at the top with an [TD seems unsure] 'inculum' is that?

JD:

Yeah… a vinculum

TD:

Yeah, a vinculum…

[TD is quick to respond with strategies for solving the problem]

…and the eight below it and the number at the bottom is how many parts all together so I'd probably… I like to get them to draw things or use counters and I've told them, "If we get over a sort of 30, 40, 50 counters, it can get a little bit tricky" but if they want to use counters, I've got hundreds of counters there they can do. I'd probably get them to draw some sort of bag or a box and maybe do 56 dots in there…. And then see if they can divide it into 8 equal parts so that there's eight eights all up and you need to give away three eights of those, the three parts of that. Or draw a box and have 8 sections in it and go one for one until you get 56 counters or 56 dots, move one into each box, 8 of them, and then you cross those 8 out and start again… I don't know, systematical, make it simple, don't just have 56 and decide, alright, three eighths, I'm gonna divide this by 4 and blah blah blah… they'll get lost… just really simple… so, I could… do you want me to do it?

JD:

Yeah… if you'd like to and you can just kind of, um, yeah, draw how you'd approach it…

TD:

[TD starts to draw on activity one for approximately 30 seconds and mumbles as he works]

… um… 1, 2, 3, 4, 5, 6

[draws a rectangle and divides it into 8 sections]

… so I've got 16, 17, 18, 19, 20, 21, 22, 23, 24

[continues to count under his breath, drawing dots in each of the 8 sections].

And when I got to forty, I knew that there was going to be 2 more but I just thought, for the sake of my kids, I'd like them to do all of it, rather than just stopping half way and thinking they've got it and then their working memory drops something out… so in each one I've got 4… 7… and I could probably work it out 56 divided by 8, seven eights are 56 so I could have done that off the top of my head but 1/2s… only my extension students have a times table chart and we're only working on 2s and 3s so that's how I would expect mine to do them but I could use just seven eights are 56 and seven threes are 21, give away… yep.

JD:

Yeah… fantastic, great. So, how would you teach your students to actually approach that?

TD:

That problem…? I'd say we're looking at three eights, so I want you to divide something into 8 equal parts and they need to have the same amount in each one so one of those parts is one eighth, the other one is two eighths… well, they're all one eighths but together, two of them are two eighths, three eighths, four eighths… which is a half. We've looked at the fractions wall and we've gone down to eighths with the grade 2s so I like the grade 1s to be part of most of the grade 2s explicit instructions so when we talk about eighths the next year, they don't think, "What the hecks that?" … Yep… so a fraction wall has really helped.

[TD approaches this question in very much a part-whole way by drawing a rectangle, and then dividing the rectangle into 8 equal parts. He takes this further by placing 7 dots in each of the 8 parts, representing the number of marbles in each group]

JD:

Yeah… absolutely, cool. So, the reason I've kind of chosen this question is because it steers away from kind of the part-whole model into what we call the computational or operational model and as well as that, you've got a collection rather than just, uh, a part of a whole. It's a part of a collection. So how do you help your students differentiate between representing a fifth of a whole and a fifth on a number line?

TD:

[TD pauses briefly and slowly repeats the question to himself]

How do I differentiate between… representing a fifth of a whole and a fifth on a number line…?

JD:

Yeah… helping your students to differentiate?

TD:

[TD again repeats a part of the question to himself]

One fifth of a number line? I guess we haven't gone that far in fractions yet. How would I do that? With 2/3s last year… I guess it's good to explain it one way and at least most of them get it or are getting there with it and then offer another way of explaining it or representing it so a fifth of a whole, I'd tend to start with rectangles or circles… a circle and… or maybe a rectangle would probably be easier for fifths and divide it into 5 equal parts [participant draws a circle and then draws a rectangle and divides it into four parts] and talk about one of those is one fifth and I guess you could go to a number line and you'd probably only need to start with zero, 1 and, I don't know, maybe 3 just for the sake of… and may… nah, you probably wouldn't go negative 1 [participant draws a number line with labels "0", "1", "2" and "3"] and just divide space between zero and one into 5 equal parts so one of those is less than one… yep. There's a difference obviously between dividing an… one object and a collection as you said before… some of mine are still dividing one fifth of 5 counters into halves or a half of two counters, they're still dividing each counter in half… so we're still going over that.

JD:

How do you get the students to kind of, I guess, move from that part-whole, part of a single whole to part of a collection?

TD (14:30):

I guess if they're looking at the picture and they can see more than one, more than one thing, try not to break up the object as much as you can but it's tricky. You know, when we talk about halves of a… an apple, I want you to cut it, half of an orange, half of a pizza, a quarter of a pizza, we're cutting things up all the time and then when I show them two apples and say "give me a half", but for the last week, you've said cut them in half so I'm going to cut them in half and now you're telling me that I'm wrong… how did we, how did we discuss that? I'd just say half of it, I guess, if you don't have to cut them in half, don't cut them in half. Show me half the collection, don't show me half the object. I guess it's just that language, the language is really important around mathematics. And we seem to change the language every few years and some university lecturers have different language to older teachers… and kids hear different things. I know we're not really supposed to say "plus, minus"; its "add, and take away" but even I think exposing the kids to language that's not correct so when they hear it, they still know what it is… I don't know, I kind of just feel my way through the dark too and see what happens. You don't know what year levels going to respond to what. They can all do… respond different ways.

[TD emphasises different words as he speaks "collection", "object", "plus", "minus", "add", "take away"]

JD:

Fair enough… awesome. And obviously, you're probably thinking of your year 2 class, did you say or are you thinking of a different class in… as you work through that?

TD:

Oh… last year I had a 2/3 class at a different school…yep.

JD:

Okay… great. So just moving from more the knowledge side of this interview into the expectation side, in mathematics, what do you expect from your students and how do you set those expectations?

TD (16:20):

[TD is quick to respond]

I expect them to listen, and participate, and have a go and don't give up. How do I set those expectations? I just keep encouraging them. And I say at the start of the year, you know, like any other subject, PE, Maths, English, Science, the expectation is that you're listening and participating and having a go and we always talk about the growth mindset, that mistakes are great, I want to see lots of mistakes and I'm not going to, I don't say this to them, but I'm not going to reward students who just [TD swiftly clicks fingers] get the answer and they know seven eights are 56… that's great, wonderful, you got the right answer but I really reward kids who struggle through it. Looking for different ways and looking, oh okay that way didn't work for this one, but I'll try something else and also because they kept pushing when it might have pretty hard. I like to see kids working hard and, and having that personal struggle. "It's not working, I can't make it work, I feel like I'm a bit of a dummy but I'm going to keep going anyway." So the two parts to that struggle, um, and the expectation… oh I guess I'm, I try to be really excited about everything I teach, and I try to make it really simple and offer them mastery experiences, especially early on. And are students on the floor who I think might not know the answer, but I can help coax them to the answer in front of the class and give them that, "Oh, I got it right in front of everyone." Those sort of things. I think just telling them, "This is what I expect, go and do it and don't complain about it," they might not. You've gotta make it fun, interesting.

[Like other teachers interviewed, TD approaches this question as what are my expectations and how do I communicate them rather than what causes me to have that expectation.]

JD:

Yeah, yeah, fair enough. Would you say… How would you say that your expectations for your students differ from your expectations for your teaching?

TD (18:00):

I guess the same principles apply. That I would expect my kids to be engaged, to participate, to have a go just like my teaching. And I have high expectations of myself, and I guess I also have high expectations of my kids. How does it differ? I don't know… teaching adults is, I guess, different to teaching kids. Adults tend to have an intrinsic motivation; kids tend to have more of an extrinsic motivation. Um… kids often don't know what they know but they often don't know what they want to know and it's hard for them to make connections to previous experiences so we're trying to build those… I'm pretty good in my teaching and my learning to make connections all over the place and… I want to change the world but for kids, you kind of have to help guide them to make those connections. But the expectations are pretty much similar. Have a go, be in it, don't give up, work hard, enjoy it, find different solutions, don't give up…

[TD is very careful in the way he answers and speaks at a slow pace as if he's carefully thinking about each word he says. He identifies his expectations for himself and his students as high expectations.

JD:

Fantastic… great. Um… what do you think actually influences your expectations?

TD:

My previous experience at school, in maths, and all subject areas. My parents in… um, I guess, expectations on me and we could probably take this a lot further than just teaching maths in the classroom. But… what I think is the status quo or the norm is my personal experience, all of my beliefs, so definitely a lot from my parents, from my schooling, from my experience. A little bit from university and, you know, I guess in the first few weeks or months of uni, I took everything as gold and once you have a few experiences and make connections to your own personal experience and what you see and hear and you tend to think, "well, I, I appreciate what you're thinking and I'll write it down and submit the assignment, but I don't know that I'll use that all the time… yeah, my experiences influence my expectations, not what someone else just tells me.

[TD's response to this question is a little closer to the intent of the question, outlining a number of things he believes influence his expectations. TD's initial response is very strong and as he approaches his thoughts on university, he seems less convinced of its impact on his expectations]

JD:

Yeah, yeah, fantastic, great. Um… I guess you've mentioned a couple of different things there that influence your expectations. What would you say has the greatest influence?

TD (20:18):

[TD seems a little confused and is quick to clarify]

On my expectations of my kids or myself or both?

JD:

Either or…

TD:

[TD answers in a tone that initially seems exhausted; as he approaches the broader, more general response about "humanity", his tone becomes a little more light-hearted but quickly comes back to a serious tone]

Um… I guess there is the expectation of the curriculum which I find is almost a bit… there is just not enough room in the day to do things nicely and have good reflections and good conversations. It's just quick, quick, quick, rush, rush, rush… we only get a week on each topic, two weeks if we're lucky… so the curriculum I guess tells me how fast I have to work and what I have to get through… Um… definitely my parents, they're hard workers, they pushed me hard, they have high expectations… um… I guess, where, where students are at, not just my students but, I guess, huh, it sounds weird, humanity, where the general Australian students are at, that, that pushes my expectations a little bit, influences my expectations on them… Um, and if you ask me tomorrow, the answer might be a little bit different. I guess my teaching is motivated by wanting to see children excel and learn and become better versions of themselves, not better versions of me, which is something interesting to think about when you're teaching… this is what I would do and this is how I would do it so I want you to do it just as good as that but that's not how it works… so, yeah.

JD:

Fantastic… thank you… um, what am I thinking? Oh, another activity… sorry, uh, have I got it here…yeah, I've got it here… so, I'll just give you that one there… so basically quite a simple just… line from the start of foundation right through to the end of primary so end of year 6 and just kind of a bar there for each, I guess, finish one grade start the next grade, so on and so on. Could you create a timeline indicating what fraction concepts you would expect to be taught from foundation to year 6 and perhaps, when and how you might introduce those?

TD:

[TD is quick to clarify my question making a distinction between his expectations and the curriculum's expectations]

What I would expect or what I think the curriculum expects?

JD:

Up to you how you want to approach it.

TD:

[TD lets out a long sigh and makes some clicking noises with his tongue as he looks at the blank paper]

JD:

And take as much time as you need to just think about it or, or jot some notes down or whatever you'd like…

TD:

[TD again clarifies how he should respond placing an emphasis on the underlined words]

So, what I think the <u>curriculum</u> says or what <u>I think</u> should be done?

JD:

It's, it's really how you expect students to come… because sometimes the curriculum might say something, or it might not say something and we still…

TD:

[TD seems a little irritated by the task]

But these questions have been very difficult, only because, um, education is very… it's based on mind and experience and humans and… it's not a machine… so some students in grade 2 could understand fifths and eighths and they could be able to divide any object into 8 equal parts but other students in grade 6 are still struggling with halves. I don't know… I would probably say that decimals could be somewhere around here [lightly circles the last two segments of the line]. And concrete manipulatives somewhere down here around foundation, 1 and 2… even 3 [lightly circles Foundation, 1 and 2 segments and draws an arrow to each bar].

[TD's response here is interesting as he seems uncomfortable doing the activity at all; he points and circles as he talks but is reluctant to be too specific]

JD:

Do you mind noting that down? Just so I've got it.

TD:

Rather than circles?

[teacher notes "decimals" above the grade 6 bar and notes "concrete manipulatives" above Foundation, 1 and 2 segments and draws an arrow to each bar]

And… you know, concrete manipulatives can still be used in high school, I think, I think there's a bit of a [makes a click noise with his tongue] um, uh, stigma around concrete manipulatives are there for the spaz kids but they're not. I still like to count things and see it and do. We're all about… humans are about experience. Concrete manipulatives I'd say for here…

[recircles Foundation, 1 and 2 segments]

…decimals here but I still don't like to limit my kids by what I think they can do. I talk about, um, the googolplexian every now and then when they me questions and I say, "alright, let's just take a little sidenote and just talk about this and how many zeros does this number have and what happens if we divide it by this and that." Then they go, "Oh, I don't get that." "Cool, we'll do it later in school. Now back to where we were." I just like to throw things in and keep the interest out there. I don't know… halves and quarters down near grade 1, grade 2, thirds and fifths, um, parts of a whole and collections

[notes "1/2, 1/4" near grade 1 segment and "1/3, 1/5, parts of whole, collections" near grade 2 segment]

But you know, when we're teaching, we're really teaching for the individual and not the Australian population so, I don't know, I'm doing what you've asked me to do and put where I think we should be teaching but it doesn't really work. [brief pause] yeah, yeah that's as far as I'm going to go because I just don't think… yeah.

[TD is very reluctant to make notes on the activity even commenting that he's simply doing what I've asked but it doesn't really work before eventually stopping altogether]

JD:

Yeah, no, that's fantastic. Um, would you approach something like this differently if you had another maths concept?

TD:

[TD is quick to respond]

No… nah.

JD:

Yeah… same approach…

TD:

Look, no, if I go into my classroom next week and teach a unit that we haven't taught yet, and I've already got this in mind, I'm kind of limiting what they can and can't do and I've got preconceptions on their ability and I'm not really giving them… they're starting off with the worst chance possible because of their teacher says, "Oh, probably they won't be able to get that."

[TD's response here is really important and explains why he was so uncomfortable with the task. The preconceptions here seem to be low expectations that prevent students from achieving]

JD:

Yep, yeah… fantastic. Um, so the reason I'm kind of asking these questions is some research suggests that fractions can be taught as early as foundation. Would you agree with that statement and why or why not?

TD:

[TD responds so quickly that I barely have a chance to finish asking the question]

Yeah… why? Because we do half… we do fractions with everything. We talk about half a day, half a minute, half a sandwich, prep kids have… foundation kids are very very smart. They know lots of things and… of course, we should start all concepts earlier than the curriculum says. Start everything early, give them a go, if they don't get it, well, that's fine, try it again later.

[TD's tone is very genuine. He seems fully convinced of what he's saying]

JD:

Great. Um… okay, so just coming to the end of our interview then, kind of moving out of the main topics we've been talking about into a conclusion, um, would you say that you see yourself as a, and I'm putting quotation marks around this, 'typical' primary teacher.

TD:

[TD very speedily responds] no…

JD:

No… why not?

TD:

Because I see the typical primary school teacher as really great and passionate but likes to teach stand-alone subjects and not really make cross curricular connections, um, often weighed down with expectations from the curriculum and the school and… I am too, um, and maybe not willing to step out of their comfort zone and do something really out there with maths and try something different every time you teach and be willing to be a little bit uncomfortable in, not out of your depth, but a little bit uncomfortable in your approach and, and a little bit more open to the possibility that kids know a bit more than you think and giving them more chance. So I like to get a little bit messy in the classroom. It doesn't happen every day because… if I put planning into every lesson that I would like to, I would never sleep. That would be impossible, but I just like to go out of the boundaries of the "norm", I'm putting that in quotation marks. Just to give the kids a go, see what happens. What's the worst that's going to happen? They don't get it? Or you make a mistake? So just tell them you made a mistake and… have a go tomorrow.

[TD again responds quite quickly and with quite strong conviction. His response indicates quite a lot about his beliefs as a teacher and also makes a clear distinction between the type of teacher he is and the type of teacher he believes to be "typical"]

JD:

Fantastic… cool. Now, I saw when you, in your questionnaire responses, you're a second, what we call a second career teacher, so you've had one or more other careers. How would you say that influences how you teach?

TD:

[TD answers very reflectively and seems to carefully think about each word]

A lot of my life experience… it's really hard to pinpoint which life experiences… are helpful. I guess I've seen a lot of uni students who've come straight out of school and go into university and… I guess that's all they know and whatever their lecturer says, that's probably what they're going to teach and how they're going to teach, um, I guess I've been around, seen a lot of things, experienced a lot of things, been underestimated by lots of people… and that all happens to us, I'm not sad about it but… going back into teaching with all of my experiences in mind, thinking "how did I respond to those things and those people and how am I going to make it different for my kids… if I can, putting myself in their shoes?" I think there's a lot to be said for having a bit of life experience before you go into teaching especially… yeah.

JD:

Fantastic… thanks. Now, has this interview, do you think, changed your way, uh, you're thinking sorry about teaching mathematics or setting expectations generally in any way?

TD:

[TD seems hesitant yet sincere in his response]

Not really… I wouldn't say it was a worthless interview, I've enjoyed it but… its, its, I guess nice to have a chance to verbalise motivations and your thoughts and I guess I've been, probably not changed the way I teach but just reminded me of a few things that I have believed in that maybe I forgot last week… just to remind myself to keep those high expectations and… be a brave teacher.

JD:

Great, fantastic. Is there anything you would like to add at all that we haven't covered?

TD:

No, I don't think so.

JD:

Great… and just out of more personal interest, why agree to an interview?

TD:

Uh… I did honours research and I'd really like to do further academic research in the future. I don't think I'd like to be an academic and if I did, I'd like to have one foot in the school as well… but, you know, I'd love to do Masters or PhD later on… and, because research like this does change general views of education. If no one did research, nothing would change. If everyone is doing research, getting different ideas and opinions, things can change and influence the education system so that's what I want to be a part of. So I'd always say yes to helping out a fellow researcher.

[TD again seems really genuine and thoughtful in his response]

JD:

Fantastic… no, good to hear. I can completely understand. Thank you for that.

Interview ran for approx. 30mins

Interview E: Annie

Interviewee: Annie
Interviewer: JD
Date of Interview: 30/10/2019
Location of Interview: Café, Coburg
Acronyms: TE=Teacher E; JD=Jarah Dennison

Observation prior:

TE appears nervous but relaxed and smiley.

JD:

Okay… fantastic. So, I've gone through that explanation of just the participant information statement so you've got all the details there.

TE:

Yeah…

JD:

Um… we'll just start off… could you tell me a little bit about yourself and your current teaching role?

TE:

Okay… so at the moment, I've been teaching since I graduated, or actually no, I graduated in 2016, yeah, since 2016. I signed up with ANZUK for emergency teaching and that was across early childhood and primary so I was across… uh, teaching in kinders and primary schools and then I landed a job just here at [school name; primary school] …

JD:

It's just around the corner, isn't it?

TE:

Yep… yeah, it's just like behind here… um, but uh, that was for three terms. They just threw me in there because a teacher was… decided to leave so from term 2 to term 4. Um, and then, they didn't want to keep me on, um, because…

[TE pauses and seems hesitant to continue]

…I wasn't Catholic [chuckles]… I wasn't sure if I should say that but yeah… so, um, and then parents started to find out, they sort of kicked up a stink so she, to please the parents, she kept me on part time two days and then every other day was like an emergency day in other classrooms and at this point, a teacher in term 2 left because of mental health so I replaced his class, um, this year and I'm there now, working with 3/4s and hopefully a job next year. We don't find out until a couple of weeks but yeah… so that's how, that's how my teaching journey has begun [laughs].

JD:

Yeah, no, fair enough… so grade 3/4?

TE:

Yeah, yeah, this year. Last year I had 1s and 2s. Yeah.

JD:

Yeah… is it single sex classrooms, is it uh…?

TE:

It is mixed… yeah, mixed.

JD:

How many students roughly would you say in each class?

TE:

Uh… the 3/4 class I have its just 25 students; last year, I had 22… yeah, so… roughly about that mark… yeah.

JD:

Yeah… awesome. So basically, this interview is divided into two parts. There's a knowledge part and there's an expectations part. So, I'll just jump into the knowledge section… um, what are your perceptions of mathematics as an individual?

TE:

[TE pauses briefly and her face cringes slightly]

Um… not… it straight away brings negativity to me, only because I struggled in maths when I was younger, um, never understood it, even in high school, I never understood it. I'd just scrape by with results. Um… so yeah, I don't have a positive outlook on it. In saying that, I try and make it positive for the kids cos I went through the negative side of it, so I try and make it fun and interesting for the students. Um… at this point with my 3/4s, I've got the top group because the students, uh, we group the students according to their ability. So, um, one teacher has the weaker group, the middle group, this year, this term, I've got the stronger group so 3/4s that are sitting at a level 6, 7, maths standard, like, really high so even I was struggling to challenge… to challenge them in that area, especially me being weak in that area but yeah, so, yeah, that's sort of my perspective of it… yeah.

JD:

Fair enough… would you say that your perceptions of mathematics as an individual differ from your perceptions of teaching mathematics?

TE:

Yeah, as an individual… I think so, I think… only because I don't find it interesting for myself. I try and… yeah, I don't think, for me, like, reading and spelling, individually, is more important… does that make sense? As long as you can calculate and add and just the little things to get you by, it's enough. But I do see, definitely, the purpose of why it, it needs to be taught and… yeah…

JD:

Fantastic… great. Thank you. How would you rate the difficulty of teaching fractions as a particular concept?

TE:

I find it difficult, like really difficult with weaker students that like, have no, like, that are level 3/4 but they're sitting at a level 1/2 standard, like, really behind… it's really hard, even like having concrete materials to show them: this is a half, this is quarters. You know, even with, like, you try and make it interesting and introduce with like, lollies or whatever and they still don't get it. In that aspect, it's really hard. And I find it really hard with the top, top group that already can do it blindfolded, you know, like they already know how to convert fractions to decimals, like, you know what I mean. So in both aspects I find it really challenging, like, simplifying it and still not understanding and then making it really challenging and still breeze, like they breeze through it… um… yeah… so… yeah. They're the sort of ways I find it really hard to… [chuckles]

[TE is quite quick to say that this topic is hard to teach to students]

JD:

Yeah… fair enough. Would you say that you teach fractions differently from how you teach other maths concepts?

TE:

[TE is quick to answer but pauses briefly to think before continuing her response]

Not really… oh… not really… yeah. We were actually last week and this week's, our two-week focus has been on fractions and then this week, we're converting fractions to decimals. Not really, I find it, with the type of group, I'm finding it a bit boring… to teach. I don't know how to make it interesting. It's like this is a fraction. These are the steps to convert it into a decimal, you know, unless there's… I've been meeting with the maths leader to sort of give them open ended tasks to sort of challenges where they're, you know, there's no right or wrong answer and things like that, um, but yeah, that's an ongoing process with the maths leader as well. Yeah, yeah so…

JD:

Brilliant, brilliant. So how do you think students learn fractions in particular?

TE:

[TE seems a little caught off guard with this question]

Um… good question. Um… again, I think that using the concrete materials just like visually… seeing what it is and how it looks like so they're having a visual… a visual image to match whatever you might see written. Um… I think that's, that's definitely a good way to start but then, when it starts to get more complex, adding fractions together, subtracting fractions together, yeah, it starts to get a bit, yeah, not visual anymore. Yeah… you know, they see the fraction and they just see, you know, the plus the two, plus the bottom and that that's the answer but really, it's not… so yeah, I think it starts to get more harder that… when it leads to, leads to that. Yeah…

JD:

Yeah, no, fair enough. Um… okay, so essentially, I'm asking these questions because research shows that fractions is often a concept area that's widely misunderstood by both teachers and students. How, how do you feel about that?

TE (7:05):

[TE is very confident in her response stressing that this is "easy" to see]

Yeah, I can see how its misunderstood, easy, easy. Definitely. Both from teachers and students really… um, depending on how the teacher delivers the lesson and the teaching to the students about fractions is what's going to avoid those misconceptions. So if a teacher is not that confident, like myself, obviously those misconceptions are going to occur within one lesson. So yeah, I can understand that. If that's the research… yeah. [chuckles]

JD:

So why do you think students struggle with this concept?

TE:

Oh… I just think, I don't know, I just think maybe even the language. Like, you know, having quarters, thirds, you know, all that language and maybe, maybe just trying to match it with the visual representation… like, it just gets maybe too much for some students. I know that, um, majority, like when we test the students, um, on maths, majority of their misconceptions have… in about maths leads to the literacy side of it… not… their comprehension. So their reading skills… so when it comes down to their reading skills and language and understanding what the question is asking, they can't even grasp that so when the teacher sits there and explains it to them, they're like, "oh yeah" and then they're able to answer the question but if it's just them and the paper or the computer, they're not understanding what the question is asking. Yeah, so I feel like maybe the language and the types of, the terms used, you know, in maths… that they're, they can't understand it which is why they don't understand the concept and the ans… the ability to answer the question so yeah, I think that's a… what I've noticed with some kids, yeah…

JD:

Yeah, no, fair enough. I just want to check that this is still recording… yes, it is. Fantastic… I was like, "Is this still good?" Um… okay… so I'm going to jump into our first activity….

TE:

Done

JD:

…um… it is a maths question

TE:

[Upon hearing that the activity is a maths question, TE is quick to reveal some nerves about the task and repeatedly exclaims the following while chuckling nervously]

"Oh my gosh…!

JD:

Have you got the pencil there?

TE:

Oh yeah…

JD:

Yeah… so I'll pass that one to you [passes worksheet 1].

TE:

Oh my gosh… okay…

JD:

Okay… so essentially, this is not… like how you would do it but how would you expect your students to approach this question… um, so James had a bag of marbles. There were 56 in the bag. He gave away three eighths of them. How many marbles were left? And feel free to, you know, draw and write and do whatever you would like to… as you work through it.

TE:

See… when I see something like this as a teacher, I start freaking out because I second… I start second guessing the way I'm going to work it out, the way I'm going to teach it, like, cos when I know what I'm teaching to the kids, I do… I like, I do it myself first so when I'm sort of put on the spot, I'm like, "Oh gosh… am I going to do this right?" um… but def… like, for the weaker students, I'd definitely get just to draw out 6… 56, um, marbles just so it's a visual, it's visually there for them and then to show what three eighths of them would… what three eighths of them would look like so, um, definitely drawing it, like, just sketching it out or just, you know, um…

JD:

Feel free to draw it or however…you think a student could work with this problem… feel free to… write it or draw it…

TE:

Yeah…. I'm just trying to think of what students, see my, my top group would be like, straight away, they'd answer that question without… they'd look at it and they won't even work it out and that's another thing that I've been teaching them, like, they really have to, yeah, they know the answer, but the answer is sometimes not good enough. You need to show your working out. Like, you know, when they get to the higher years so, um…. Who can I…? I'm trying to think of one of my students and how they would work this out…. Um… [5 second pause; TE pauses briefly to think about the problem] alright, so…

[TE is silent for 1min 18secs occasionally muttering to herself and simply draws a series of small circles in 8 groups; there is 8 circles in 7 of the groups and 6 in the last group]

So I'd get them to show… or even using concrete materials, like, having 58, um, concrete materials and then three thirds…

[TE seems to be confusing the 3/8 with the 56 marbles]

JD:

Oh… sorry, 56…

TE:

[TE laughs at her mistake and continues her explanation. Midway through explaining, she begins to struggle to explain, laughing as she apologises]

Oh sorry… I'm looking at the… sorry 56 whatever it might be, those little teddies or something… um and then, three thirds… sorry, I'd show them the fraction of three thirds or three eighths, sorry. See… I'm even getting confused. This is not my… not my strong suit at all.

JD:

That's alright, that's okay. Take your time.

TE:

Um… three eighths, um, and then, how many marbles were in the… were left in the bag and then that'll give them, um, the answer… is how I'd um, sort of, sort of teach that concept. Definitely with the weaker ones, I'd… there'd be no way I could teach this… without using concrete materials. They'd need to have that. Um… but then with… like I said, with the top group, they'll be like yep, straight away that the answers, you know…

[TE's explanation so far is a little unclear as to how the task is actually completed and her drawing of the problem so far doesn't seem to match her explanation]

JD:

Yep… so they'll, they'll have their counters, and they'll count out their counters so they'll count out, what, 56?

TE:

56 yeah… and then from there, they would just I'd show what three eighths looked like, just so they know where they're heading to or, you know, and yeah…

[TE whispers]

Did I say that properly?... I hope so

[TE laughs]

JD:

That's okay… you're alright. Um… so essentially, they've got their counters, um, then you show them what three eighths is, um, how would you show them what three eighths is?

TE:

Um… [pause for 5 seconds and looks over her drawing] … how would I show them what three eighths is?

JD:

Like, I guess, how would you teach this problem?

TE:

Yeah… good question. Cos, I keep thinking back to like, the weaker kids, like, some would not even be able to answer this. They'd just stare at you like, what are you… what are you…

[TE seems to get lost in thought]

JD:

[attempt to finish sentence] Like, what are you saying?

TE:

Yeah… um, [TE again briefly pauses for 5 seconds] I'd show them a visual representation of three eighths, so I'd definitely bring up or even draw what three eighths looked like or looks like, sorry. Um, and then, get them to work out from there… how or where it could possibly lead to. Um, and then, if students are still struggling, I'd just bring them all to the floor, sit in a circle, and then, you know, "what do you think?" and then sort of, yeah, lead the discussion through what they know and then, yeah, go from there… yeah.

[TE's explanation is quite generic at this stage, and she is not referring back to the drawing she completed of the problem.]

JD:

Could you explain for me just what you've draw here…?

[points at the circles TE was drawing in groups earlier]

TE (15:08):

[TE starts out very confident in her response but stops midway and questions herself, realising that her drawing doesn't match the question]

Oh… so here I've just drawn… I've just grouped them, so I've just grouped… actually no, what have I done? I don't know why I've done it like that… I've just drawn 56, you know, marbles… um… I don't even know why I've put them into groups like that because this is not even…

[TE's tone of voice moves into a higher pitch as she explains and laughs]

JD:

Okay… so essentially, you've got your 56 marbles and you've essentially already put them into…

TE:

… into groups but then they're groups of, yeah, 8 so I don't know why I've done that. Um… yeah, just to show them if you group and then sort of, sort out what the fraction would be, um… I think that's a good way… that way there's like one group here, one group here, one group here… just so they're not all, you know, so their ideas or their knowledge is all sort of put together instead of having it all just loose… um, yeah, that's how I sort of would've drawn it, but I don't know why I've put them into groups like that. I'm sorry… [TE again laughs at herself as she apologises]

JD:

Yeah, no, that's okay, that's okay. No that's fantastic, um, is there a particular model or approach that you would use to teach this?

[TE seems confused and doesn't respond]

I think you mentioned already modelling it up on the board or drawing it but…

TE:

Yeah, um, a model, um, I'm just trying to think… not, not that I know, like, not that I would straight away, like, refer to. I know maybe, at work, we've got this program that's called "essential assessment" … so, um, there are like, free questions and like, quizzes on there so I definitely look up something there, um, to like introduce these, like, type of problems. Um… just to sort of get there mind ready for what type of… but I would probably start off with something veeery [TE stresses this word "very"] simple like halves and things like that just so they're, you know, and then gradually bring up the, you know, the three eighths, the more, bit more complex things like that… yeah, in terms of like, a specific way to teach it… not really…

[TE seems tentative in providing a response of "not really" but is quick to confidently continue]

yeah, I, yeah, I just sort of know, oh this is the way you do it and that's it… um, yeah.

JD:

Yeah, yeah, and what you just said, starting off with something simple to introduce the question.

TE:

Yeah… something really, yeah, really just basic like half or quarters and that's sort of it… and then once they get the hang of problem solving the simple stuff, then sort of gradually moving them into the little bit more complex or a little bit more challenging side of things… yeah, yeah…

JD:

So essentially scaffolding them?

TE:

Yeah, yeah…

JD:

Fantastic, um, so essentially this question, it steers away from the typical part-whole construct of fractions, so like part of a pizza or part of a pie, and it moves into what we call an operational construct where the students are no longer looking at part of one whole, they're looking at groups in a collection and a collection of wholes… um, so that's why this problem is slightly… it's a different frame of mind that they've, the kids have got to think in. So thinking about that, how do you help students differentiate representing a fifth of one whole and a fifth on a number line?

TE:

[TE pauses to think and clarify] How do I differentiate that? So a fifth on a, in a… sorry repeat the question…

JD:

A fifth, uh, how do you help your students differentiate, so determine the difference between, representing a fifth of one whole as opposed to representing a fifth of a number line?

TE:

Oh like on a number line… yeah. Um… so to determine the differences between the two? [TE asks in a quizzical tone] Yeah… so um, just the value of it… so where exactly would you put, like, the fifth, was that what you… yeah, the fifth on the number line and what its value is, what comes before, what comes after. It will be different to what it looks like in, as a… fraction? As a…

[TE seems to second guess herself and again seeks affirmation]

JD:

As a fraction, yeah…

TE:

As a fraction, yeah, sorry, I get… see I'm even getting confused

[TE again confesses that she gets confused by the concepts being discussed and speaks in a tone that sounds as if she were holding back a laugh]

…yeah, so, as a fraction, it might look that way but on a number line, the value of it is, depending on where or how or the value or the whole of your number line, where exactly you would put it would be different to what it looks like… so… yeah. I try my best to emphasise that because a lot of them just, you know, think, "Oh, the least value" or the least numbers, the least value numbers in a fraction straight away goes at the end of the number line…

JD:

So by least value, you mean…?

TE (20:00):

Oh, like, if there's um, I don't know, like, I can't think… I should have brought some of my students' works but um…

JD:

So maybe like a half and a third…?

TE:

Yeah, so, because they see like, one and two, it's lower numbers than one and three, like, you know, so they might put it at the start of the number line… so just making sure that they acknowledge the value [emphasises "value"] or like, how much that fraction or that fraction is… um, yeah differentiating that on a number line would be a… is a good way to sort of, yeah, even with, like, the decimals as well, putting decimals on a number line, I've noticed that some kids were like, "Oh, yeah, that numbers zero point whatever is lower than, you know, um, whatever it might be, so, yeah, trying to get them to understand the value would be a good way to differentiate between the two… yeah…

JD:

Fantastic, awesome, and obviously, do you have a specific class or group in mind as you work through this particular problem?

TE:

[TE responds straight away but seems to still be processing the question; she regularly stumbles over her words as if her mouth can't keep up with her mind]

Yeah… yep. I'd aim this sort of… the younger, the younger, the… weaker ones would definitely struggle with this. The middle group, they would be able to work it out and show their workings out but then my top group would look at that and be like, "Yeah, okay" like, too easy… like, yeah, so that's another thing I struggle with, trying to find that balance of challenging the higher kids, simplifying it for the little ones, er, the weaker ones… yeah.

[After TE has explained this problem and we've discussed it at some length, I realise that the idea of the numerous operations involved in this problem hasn't come up in discussion, so I prompt TE in this direction]

JD:

Yeah, yeah, and I guess just one more question on this activity and then we'll move on. Um, what operations do you actually see going on in this question?

TE:

Um… what operations do I see?... um… [TE pauses for a long 10 second pause before stating her idea with confidence] I see that there's subtraction, you're subtracting three eighths from 56 so being able to… subtract, um, an even amount of… the…or… of… sorry, three eighths from a number, er, an even number is definitely something that I can see [TE again pauses to think before again seeking affirmation] um… yeah, is that…? [TE laughs]

JD:

Yeah, yeah, yeah… so obviously you've got your subtraction and then as you… you kind of indicated it already… but there's also that division going on…

TE:

[TE jumps in as if to reiterate that she'd mentioned this earlier] Yeah, yeah…

JD:

All good… okay, so jumping then into the expectations section of this interview, um, in mathematics, what do you expect from your students and how do you set those expectations?

TE:

[TE pauses briefly to think before answering] Okay… so… as, for me, as long as the students understand… understand their where they're meant to be, where their standard of learning is meant to be, especially with maths, it, it, it's good, like, for me, its, it's great because it's a hard concept to understand. Um… I really do focus more time in the kids that don't understand or are a bit weaker because, if they miss one little thing, they're, like, gone, like, its, it's hard to get them back whereas with the students that already know, it's like, great, just keep sort of challenging them, set work that's like a level or two higher than where they're at. Um… but I expect that a lot of them should be at their normal standard. Whereas I know that there is a lot at work where a lot are just way below their standard um, and that's what the school is trying to work towards. How can we, um, bring these students where they're meant to be, you know, they're at a, you know, year 4 and their level of maths is a year 2. So that, you know, they've sort of missed that train [TE's tone of voice heightens in pitch and she smiles before quickly coming back to her normal tone] and it's like how to quickly bring them back to their level so for me, as long as they're at their standard and you try and challenge them and they just, they get what they need to get at that point, I think that's a really good sign for me. Yeah, yeah.

JD:

Yeah, fantastic… um, are your expectations for your students different from your expectations for your own teaching?

TE (24:50):

[TE responds quickly and confidently]

Yes, yes, yeah, definitely, yeah. Um, for me, I… the way I want to teach the students is the way I sort of, especially the weaker ones, is the way I struggled learning maths and not understanding it and things like that would be a… would always be at the back of my mind teaching the younger ones. So, in my teaching, I'd always try and make it, you know, make sure they understand and make sure that it's fun and make sure that it's not just in a classroom. It might be going outside and doing fractions with chalk on the floor, you know, just really trying to make it fun. Um… but yeah, in my teaching, definitely the way, the expectations for myself are more higher for me because it's in my hands that the children either get it or don't get it, you know, and if I'm not that strong in it or that, you know, that good in it, I'm held accountable for either them falling behind or, you know, excelling so, yeah, my expectation, I put a… yeah, that's why maths gives me so much anxiety [as TE recounts her math anxiety, she smiles and speaks with a laugh at the back of her throat] cos like, I put so much stress on myself because I'm, like, I really need to, you know, if I'm not that confident in it, how am I going to teach it so when I plan for each topic that we learn every two weeks or a week, I'm making sure that, yep, I've got it, if I'm questioned by a student, I know how to answer him, you know, or her or… yeah, yeah…

JD:

So there's a lot of planning and preparation that goes into that?

TE:

Yeah, yeah, definitely, yeah…

JD:

Yeah, fantastic. What do you think influences your expectations?

TE:

[TE pauses before answering very seriously]

My lack of knowledge, I think, especially in maths, yeah. The… my expectations are influenced because I feel like I don't know enough or I feel like I don't know how to explain it well enough or as well as other teachers might be able to… the way they might deliver the lesson, um, is different to the way I do. They might, you know, I know another teacher who uses like, easy terms or, you know, just an easy way and the kids are like, oh yeah, but then with me, sometimes it's like, um, what are you saying, and that's probably because my ideas and thoughts are everywhere and I'm just nervous because I'm teaching something that I'm not that confident about, um, but yeah… so… yeah. [TE laughs]

JD:

Yeah, no, awesome. What do you think has the greatest influence then on those expectations?... would you still say…

TE:

[TE repeats the question to herself]

Greatest influence? I'd say just the dedication that I'm putting into planning the lessons, um, making sure the students understand, um, and being on top of their learning so if I know that a student is not getting it, I'm quick to call out for help from another maths leader or another teacher saying, right, they're not understanding, they need to move down to your, like, to your maths class or, um, yeah, just… yeah, yeah… just keeping an eye on all of that because if they're in, for example, the top group and they're, like, more than half of the class is sailing and they're sinking, its, and I'm not there, and I'm not picking it up, well then they're just going to suffer and struggle, you know, later so just identifying where the students are at and whether they should be learning at that standard or whether they should be in another class learning at, you know, a middle, average standard or a lower standard. Yeah, yeah…

JD:

Fantastic, thank you. Just another activity for you…

TE:

Okay…

JD:

Um, so this one is a little bit more open and then obviously feel free to um, go nuts or whatever in how you do this activity…sorry…

[Researcher moves a water bottle out of the way, apologising]

TE:

That's okay.

JD:

So on the following graph, could you create a timeline indicating what fraction concepts can be taught between foundation, the start of foundation to the end of level 6 and when and how you would introduce each concept?

TE:

Okay…. [TE looks very confused]

JD:

It's a big task…

TE:

Yeah… I think I might get you to repeat it to me if that's okay… [TE chuckles]

JD:

Yeah, so create a timeline indicating what concepts, what fraction concepts can be taught between foundation to level 6 and when and how you would introduce each concept? So basically like, almost like a continuum…

TE:

Yeah, so I think from foundation to 2 would be the really simple stuff… do I just… write it or…?

JD:

Just draw away, write it, draw, scribble, whatever you'd like to do…

TE (30:00):

[TE begins to write notes on the page, muttering to herself and pausing to think here and there]

[10 second pause] alright, so from foundation, I think at foundation, level 1 and 2, I think would be… um…

[further 25 second pause; TE writes "simple fractions whole, half, quarters" below the first and second bars indicative of foundation and year 1]

and then from… so 1, 2… foundation, 1, and then 2 I'd move on to, um…

[further 20 second pause; TE writes "whole, half, thirds, fractions quarters" above the third bar indicative of year 2]

quarters, 3 and 4… 3 and 4 I'd start to um, …

[pause 1min 15seconds; TE writes "Introduce adding + subtracting fractions. Converting them into decimals" below the fourth, fifth and sixth bar indicative of year 3 and 4].

So at the foundation and 1, I'd really focus on just simple fractions. I wouldn't really go too much in depth. Just allowing students to know this is a whole, I'd actually just introduce whole, half, and quarters. Just in that. Then in 1, sorry in year 2, um, I'd start to go into thirds, um, and really start to make it a bit more complex, um…

[TE pauses briefly]

…3, 4, I don't know, and maybe thinking 5, I think it just depends, like, how strong the students are, but generally I'd introduce, or start to teach, um, adding and subtracting fractions and then converting them into decimals but just maybe getting their head around first adding and subtracting and how to work that out and then ease into converting them into decimals, um…

[TE pauses briefly before explaining]

I've never taught seniors, how weird is that so, I don't know what they learn or what the standard is for, um, fractions at that higher level, um, but yeah, I think that's where I sort of, that's where I sort of look at everything at this, at this point… I'm just trying to think of… I think maybe even year 2 start introducing them to problems like this… like, simple, yeah, simple worded problems just so that by the time they get to year 3 and 4, it's not gibberish to them. Like, you know, like, if you give them like worded problems and scenarios, like, if, you know, I had half and you had half, how many do we have together… um… I might just write that…

[TE pauses and proceeds to write "Introduce to worded fraction problems" above the third bar indicative of year 2].

Yeah… but, like, I don't know what I would put for 5 and 6 cos I don't know what…

[TE pauses and speaks in a thoughtful tone]

…yeah, what is expected at a 5/6 level in regards to fractions and decimals or fractions… um…

[TE pauses again]

…maybe even what, maybe…

[TE pauses]

…I'm just trying to think what, um, concepts there could be…

JD:

That's okay… take your time…

TE:

The end of year 6… years 5 and 6… [20 second pause] yeah… I think I'm stuck on your seniors; I think I'm stuck on the 5/6… I'm not sure…

[TE speaks in a quizzical tone]

JD:

I might just ask when you would introduce multiplication and division of fractions and also percentages, where they might come in…?

TE:

Oh… multiplication, that's… multiplication and division, yeah… I'd say… I'd actually say that's year 4, end of or middle of year 4 for that um, and then through to year 5 and

6… um, I know that my top group for the year 4s, they would be probably able to do or more than capable when the concepts are taught to sort of, um, times the fractions and then convert them into… or… yeah, convert them into percentages and things like that… I mean, they're already converting fractions into decimals so taking that, taking it to that next level um, with percentages, um, would definitely be, I think, yeah, end of year 4 or middle and through to year 5 and 6 would probably be the way I go…yeah…

JD:

Do you want to just jot that one down?

TE:

Yeah, yeah… oh… ah… yeah…

[TE pauses for 35 seconds, muttering to herself and notes "Multiplication + division of fractions. Converting into percentages" above 6th and 7th bar indicative of year 5].

JD:

One thing that I don't see on there, um, where would you introduce something like a number line?

TE:

Ah ha… I definitely do that but very simple again at maybe year 2, year 3 just maybe, um, giving them the simplest number line so that's one whole, where's a half? In the middle… you know, yeah, and really outline that and then just maybe leave that there for sort of year 2… did you want me to write that down?

JD:

Yeah, yeah…

TE (38:00):

I'll write that down…

[TE pauses for 15 seconds to write "Year 2 Introduce number line"]

Yeah… yeah, I think that's where I'd sort of have it all…

JD:

Yeah, fantastic… how would you approach this differently for another mathematical concept?

TE:

[TE takes a 5 second pause and repeats the question to herself]

…how would I approach it differently for a different mathematical concept?

JD:

Like, this activity… would you approach it differently or…?

TE:

I think I would only because I think that some mathematical concepts are a bit easier to understand so, if that's the case, you know, I'd… for example, money or, you know, those fun [TE laughs] those fun math tasks, I'd definitely bring it, bring it down, like, introduce it earlier to, you know, the year 2s or, or whatever it might be. Um, yeah, I think, yeah, different mathematical concepts, I think, would vary, like, putting them on a number line and where you would teach it, just in regards to, you know, how difficult it might be, how, how easy it might be, the easier that it might, the easier that it might be, you might introduce it because it's quite easy to the… earlier on, that way when they sort of get up the higher years, they sort of know it and they're ready for the, the harder stage of it… yeah, yeah.

[I notice that TE makes a comment about money being an easier concept to teach than fractions which runs counter to comments in an earlier interview, so I prompt this point further]

JD:

I will just prompt just a little bit further on what you said about money being an easier concept. Um… because I've had a bit of a controversy with teachers… some of them say that it's really hard to teach money and others say it's really easy to teach money. How do you think a concept like money relates to fractions?

TE (40:00):

Um… just the fact that like, one dollar is a whole one dollar and then if you put it in quarters, you have um, 25 cents, you know, so just having that… yeah… actually that's a good… [TE laughs as she realises the connection she's made] that's a good, um, a good idea… to… and actually when I taught money, I never taught it in a… I never said, oh it's like fractions, you know, um, but yeah, I do find it a lot easier because I think it can be more fun, you know, you have the fake money, there's more games to play with money other than fractions. Yeah, I found money a bit more easier than teaching fractions, yeah, but yeah, I think if you… yeah, like I said, having those concrete materials, you have a dollar and then you have 25 cents four times, you know, that's a… that's a good way. [TE laughs and seems genuinely grateful] thank you, thank you.

JD:

No worries… so, um, obviously you've already kind of explained your graphic, um, some researchers suggest that fractions can be taught as early as prep and you've got a bit of information down there at the foundation level. So I guess, would you agree with the fact that researchers say that you can teach it as early as foundation?

TE:

[TE responds tentatively] Yeah, I do but as long as it's just simple, like, just the whole, half and quarters. Um, just maybe yeah, introducing them to that language, especially in prep, I think that gives kids in prep a good idea, um, because then they're familiar with it by the time they get to 1 and 2, it's not like, "but what's that?" you know. At least they would know what half a cake or, you know, um, yeah, I could agree with that, yeah, yeah…

JD:

Okay, fantastic. So coming to the end of our interview today, um, would you see yourself as a ‘typical’ primary teacher and I’ll just kind of put that in quotation marks “typical” and if so, why or why not?

TE (42:00):

Um, I do in the sense of maths and that’s because I’m not a confident person when it comes to math. So that’s probably why it’s hindered me to think I’m just a typical teacher, um, when it comes to maths.

JD:

So would you say the typical teacher is competent with maths or…?

TE:

[TE seems to be describing herself]

Not confident… yeah, the typical teacher that’s not confident with maths unless I’m prepping, like, the week before and I’m like, okay, this is what we’re learning. I’m confident in what we’re learning and what we’re, what I’m going to teach and then I can deliver the lesson, you know, accordingly. Um, but if I, if it’s like a spur of the moment maths lesson, I’m freaking out. [TE laughs nervously]

JD:

So what makes you, I guess, not typical?

TE:

Not typical in the sense that, um, I believe every student can be great at maths, like, I don’t think, “oh, this person is born to do maths and he gets it whereas not everyone… like I don’t have that concept… everyone can learn maths, everyone can be able to do it. So, yeah, that’s where I’m sort of different and I like to push that on each student because, yeah, going back and, like, my learning, I was, like, in high school, I was like “you’re not good at maths, it’s not for you” but it can be for everyone. As long as there’s good ways of teaching it and delivering it to the students, I think that’s… yeah…

JD:

Yeah… fantastic. Now you mentioned in the survey that you’re a first career teacher, so teaching is your first career or first profession. Would you say that has an influence on your teaching?

TE (44:05):

I think… I would say definitely because throughout my uni years, I was just retail job so the bare minimum of that is, you know, money and that’s just, you know, an easy concept so yeah, I think that that does definitely influence um, also being just, you know, thrown in the deep end, sort of thing, with regards to last year with work and things like that… um, I look back now, like this year I was thrown in the deep end too, I look now that if I ever have my own classroom next year for a full year and starting fresh, all those experiences will come into place that year that I have my own class, yeah, because I, you know, placement throughout uni was very, a bit different. You know, I had all my placements with younger years so 1s and 2s and then kinder. I never had 3, 4, 5 and 6 so, um, yeah, definitely, yeah…

JD:

Okay, fair enough and last question, um, has this interview changed your thinking about teaching mathematics or setting expectations generally in any way?

TE (45:30):

[TE pauses before answering confidently]

Um, yeah, it has because, for example, money and fractions can link in, um, together [TE laughs] and that can be a lesson in itself, um, but not, not only that, I think, um, I think knowing the importance and how important it is, like, sitting through this interview and thinking about my class and thinking about me as a teacher, there's lots of things where teachers can improve on, there's lots of things where we can be better at doing so yeah it… yeah… [TE chuckles]

JD:

Is there anything else that you would like to add that we haven't covered?

TE:

Um… nah, all good… is it just that fraction concept for maths that… for research?

JD:

Yeah… that's the focus that we're looking at in this project… maybe in future projects we can look at other concepts but, um, and I guess just a final question, um, just in personal interest, uh, why did you agree to go to an interview?

TE:

Uh… [TE pauses to think] … hopefully there'll be a change out of moving forward, um, with teachers and student learning, um, it's always good to have research and evidence, um, especially *with* [emphasises the word "with"] teachers. I don't think enough is said… I think a lot of teachers are just like, I'm a teacher, it's all good… you know, but really, like, we don't know everything. You know, we're still learning. We only learn as the days go by within the classroom, um, forever learning when you get different students, every child is different, you know, so… yeah…

JD:

Fantastic… well thank you for taking the time to do an interview…

TE:

[TE laughs and responds in a friendly tone] Thank you… it was great! Thank you very much for having me… [TE laughs again]

JD:

No worries… all good…

After completing the interview:
TE went on to just talk about teaching in general for 5 or so minutes and I requested to take note of the following quote made by TE:

- *"This is the reason students are falling behind, because teachers are not confident."*

Interview ran for approx. 47mins

Interview F: Cathy

Interviewee: Cathy
Interviewer: JD
Date of Interview: 07/11/2019
Location of Interview: Café, Melton
Acronyms: TF=Teacher F; JD=Jarah Dennison

Observation prior:

TF appears quite relaxed and friendly at the start of the interview.

JD:

Okay… so first off, I just want to thank you for coming. It can be really, really hard to get teachers to actually want to interview. Um… because obviously teachers are very, very busy people so, uh, getting teachers to come and do an interview is really, really great. So just thank you for your time. Um, obviously I've explained the participant information statements so if you need to withdraw or anything like that, you've got that there. Um, so I'd just like to start by asking if you could tell be a little bit about yourself and your current teaching role? And I will make sure that this one [the audio recorder] is sitting right in front of you…

TF:

Cool… um, yeah, so, I am currently teaching grade 4s so generalist in the classroom, teaching reading, writing, maths, everything, yeah.

JD:

Yeah, fantastic and just in… primary, uh, public school?

TF:

A public primary school…

JD:

Fantastic, awesome… how long have you been teaching? Any of those sorts of things?

TF:

Uh… This would be my eighth year… of teaching, yeah. Yeah, eight minus one. I was CRTing for one year…

JD:

Well that's still teaching… [laughs]

TF:

[TF laughs] Yeah, that's still teaching… yeah, I was… yeah.

JD:

[laughing] I'm a CRT [relief teacher] …

TF:

[TF laughing] Yeah…

JD:

Yeah, no, that's fair enough… awesome. Uh, so basically this interview is broken into two parts. There's a knowledge section and then there's an expectations section. So I'll just jump into the knowledge section…

[briefly interrupted by waitress with coffees]

So just jumping into the knowledge section, uh, what are your perceptions of mathematics as an individual?

TF:

My perceptions of mathematics as an individual?

[TF repeats the question slowly to herself while stirring her coffee and looking intensely into the cup before licking the spoon]

… um… that maths is in everyday life

[TF says this slowly as if she's trying to recall something].

Um, I guess, as a kid, I found it really hard to get my head around. There were particular concepts that I didn't get… um, I know that… you've got to learn maths in lots of different ways, um, and, as a teacher, there's like a lot of content

[TF places emphasis on "a lot of content"]

…you need to get through to teach… yeah, yeah.

JD:

Yeah, fair enough, cool. Would you say that your, I guess, perceptions of mathematics as an individual are different from your perceptions of teaching mathematics?

TF:

[TF pauses briefly before responding confidently]

Yeah, yeah… like, even though, like, I might, you know, I might go, "okay, we've got to teach, like you know, fractions and decimals and, you know, harder kind of subjects, that

I consider harder", when I'm actually teaching it, it's a bit different. Because, yeah, I guess, there's a point where you need to know what you're doing but then there's a point where you can still teach and facilitate learning as well… so yeah, and sometimes, like, your own perceptions, you've got to kind of put aside. So even though I might not like doing a particular concept, I've still got to teach it. Yeah, yeah…

[TF has already revealed a bit of her attitude towards mathematics as an individual; the way she describes mathematics and "putting perceptions aside" indicates that TF doesn't necessarily enjoy teaching mathematics but understands that she has to put this aside when teaching]

JD:

Fantastic… and you mentioned there a little bit about your history, some of the challenges you might have had as a kid, um, how would you rate the difficulty of teaching fractions as a specific concept?

TF:

[TF pauses to think and clarifies the question]

Um… teaching it as in… like the act of teaching the concept to the kids or how hard it is for a child to get the concept?

JD:

[I laugh] I guess a little bit of both…

TF:

[TF laughs] Both, yeah, so teaching fractions can be quite difficult…. Um…

[TF speaks slowly as if she is thinking through each word]

…and I guess from a child's perspective, it can be quite a difficult concept to get your head around and um, depending on the child and depending on your method, they'll either get it or they won't get it. And there's lots of different ways to teach it, like there's the area model, the collection model, there's lots of different models… um, and I guess when you start getting into adding fractions together, it's just, it's a very difficult concept. And then you kind of question, well, why do I need to multiply fractions? Like, you know, you kind of get to that point… where, yeah…

[TF stops here as if she realises that she's already made her point]

JD:

Yeah, no, fair enough. I can understand that. Would you say that you have to teach fractions differently from the way you teach other math concepts?

TF:

[TF says "um" in a long, drawn out, almost humming tone before saying "yeah" in a quizzical, questioning way]

Um… yeah?

[TF’s tone changes to a more confident statement]

Yeah… yeah.

JD:

And why do you think so?

TF:

[TF pauses before responding and starts to answer before stopping and exclaiming “oh” and restarting her response]

Well, each… oh, I guess different mathematical concepts lean to different models and ways for learning…

[a loud machine starts in the background, TF laughs]

…um, yeah, so like, yeah. Kind of lean towards different things. So, if you’re teaching fractions, you’ll lean more towards the concept of sharing and then if you’re trying to put concepts together, then you might combine it with chance. So, it depends on the context. Yeah, so with fractions, you probably lean more towards visual models and building and breaking things up… if we’re going to talk how you would teach it differently, but then you would still use visual models and breaking things apart for like shape and area and things like that… so, yeah.

JD:

So it’s like yes, and no?

TF:

Yeah, yes and no, yeah.

JD:

Fantastic… um, how do you think students learn fractions or fraction concepts?

TF:

[TF responds in an almost exhausted tone]

Oh god… um…

[TF pauses briefly before continuing in a very confident, almost persuading tone]

…the most success I’ve had in, like, the year levels that I’ve taught… it has, they have to do it. So, if you, if you, let’s say you’re, yeah, let’s say you’re doing fractions and you’re doing, um, either the area model or the collection model, they need to do it. They need to have the bag of lollies; they need to have the cake to cut up; they need to have the, they need to physically do it to conceptually get it. And then from there, it’s either drawing those models as well…

[TF's tone and body language changes slightly as she provides a counter argument, almost as if the thought just hit her]

…but then sometimes you find kids that just, their number knowledge is so good, they can just work in numbers, so, yeah, it really actually depends on who's in front of you. But I always find that its, they've got to do it to get a better understanding of it… yeah, yeah.

JD (7:00):

Fantastic… thank you. So basically, I'm asking these questions because research shows that fractions is one of those concepts that's often widely misunderstood by both the teachers and the students. How do you feel about that… statement?

TF:

[TF begins her response with a drawn out "um" and a slow "I think that" and then returns to a normal pace]

Um… I think that that can be the case. Like, I didn't get fractions, and I know this is so silly, I didn't get it until I learnt about it in university. So we were looking at different models and different ways to, um, conceptualise fractions and part-part-whole and it wasn't until I got to uni that I conceptualised it much better than whatever I learnt in school. Because I think when I learnt it when I was in school, it was all just numbers. The models weren't there, the visual models weren't there. Um, and, yeah, there's some… and depending on your experience and you've taught and how you've taught and who's been your model and what uni you went to, it's going to really depend on how you teach fractions or any concept really. Yeah…

[TF seems a little embarrassed but confidently explains her experience]

JD:

Fantastic… Thank you. Great. Uh… [as I look over my notes and prompts] I've already asked that question. I was looking down and I'm like, "no, I've asked that one." So yeah, thank you for that. So I've got two activities that I'll ask you to do throughout this interview and this is just the first one. Um, so how would you expect your students to approach this question: "James had a bag or marbles. There were 56 in the bag. He gave away three eighths of them. How many marbles were left?" And feel free to… I better give you a pen, um, feel free to, to draw, or to take notes, or however you'd feel comfortable just in explaining how you would teach this or expect your students to approach this question.

TF:

[TF pauses to take a look at the activity before responding, almost as if she is correcting me]

Well there's different ways…

JD:

Yeah, feel free to show me as many as you'd like…

TF:

[TF seems a little daunted at first and pauses to again look over the activity]

Oh… Okay, so, you could, um…

[TF confidently jumps into some explanations]

…you could have like the physical model…

[TF writes "physical model" on the activity]

…okay… so they could actually have the 56 marbles and then, um, start to break them up into different groupings, um, to find out how much they gave away. You… so that's like physically. Then they could also…. they could, um… well, if it's a physical model, then they can draw that model…

[TF writes "draw" next to "physical model"]

…so sometimes kids might do that. I've seen it where they've…. They might draw… because they'll know that, potentially they'll know that, you know, three eighths has been given away which means they need to put the 56 into eight groups. So I wouldn't be surprised if some kids were like "oh, okay, so eight groups and then they'll divvy them out," they might work that way. Um, they might use, um, their multiplication facts… their multiplication and division facts…

[TF writes "x/÷ facts"]

…because if they know, um, how many times 3 or 8 go into 56 so then they'll be able to figure that out. Um, would you use a number line?

[TF seems to say this almost to herself before coming to her own conclusion]

You could use a number line… because it's in eight… its eighths. So half, half, half again…

[TF draws a number line, draws a solid line at half, then quarter and small lines for eighths]

…They could figure it out that way, potentially. Yeah, so there's different ways that they could go about doing it, yeah.

JD:

Yeah, lots of different ways that you could approach it. Yeah… fantastic. So, I guess, how would you teach this problem?

TF:

[TF repeats the question as if to double check she heard me right but also to question herself]

How would I teach this problem? I would… I would teach the ways…

[TF places a strong emphasis on "ways"]

…to figure out… how to… ways to solve rather than teach to the problem… yeah, yeah.

JD:

Fantastic… yeah, great, cool. And I guess you've very clearly given me a number of different models and approaches to that question so thank you for that. And I guess what I'm leaning toward in this question, this is a very… this is what we would call an operational construct or as you said, it's also using a collection rather than a part-whole model of fractions. Uh, how do you help your students differentiate between representing a fifth of a whole and a fifth, say, on a number line.

TF:

[TF seems a little confused and pauses briefly before re-asking the question to clarify]

So a fifth… so a fi, so a fifth on a what? As a whole? Of a whole?

JD:

Of a whole, of one… of a single whole as opposed to a fifth on a number line?

TF:

[TF responds quickly and confidently as if I've tried to trick her into thinking they're different]

It's the same thing… so I… I did this the other week actually. So a number line… like, when I teach number lines, um, a fraction sits between zero and one so it's all the number, numbers in between zero and one…

[TF draws a number line with arrows on either end and a notch with "0" and notch with "1" on either end]

…and then I'd link it to an area model. So it's similar to an area model so I might, usually when I do stuff like this, I like to use rulers, um, because rulers, they're familiar with rulers, um, and they can kind of make the link to that as well. So a fifth of a whole… I kind of place the area model onto the number line…

[TF draws an area model over the number line]

…but I really make the distinction that it is… that a fraction is less than a whole and its between zero and one, yeah.

JD:

Yeah, and then I guess an extension of that, how would you get them to differentiate between say that fifth of a whole and then a fifth of a collection that's more than one?

TF:

[TF responds in a contemplative tone and motions to me as if agreeing to something]

Yeah, see that's tricky. Cos I... the group that I had a couple of weeks ago had this issue as well. Um, I find that it's hard when you have a collection, …they… they do find that that's a whole.

[TF writes "1/5 of a whole" and "1/5 numbers"]

That's a very… it's a diffi… usually what I do is I bag it up…

[TF draws a bag with a number of circles in it]

…it's in a bag, 1 bag

[TF writes "1 Bag" above the bag drawing]

Okay, so you've got a whole bag of lollies. Like, that, that is… sometimes… that is tricky. This is… going from a whole, going from an area model to a line model, you kind of can make the comparison because that's easy to divvy up but, yeah, once you start going to collections, the concept of a whole gets a bit confusing because there's all these parts… yeah, mmm.

JD:

Fair enough, thank you for that. Um, and are you thinking… I'm assuming you're thinking of your grade, did you say grade 3, 4 class as you worked through that example?

TF:

[TF responds nodding her head and proceeds to answer as if she's double checking her memory for as accurate an answer as possible]

Mmmm… yeah, I think I was working, this example, yeah, they were 3s, level 3s, because we do the workshop model. Yeah, 3, 3, yeah, 2 and a half, 3, yeah.

JD:

Fantastic… well, thanks for that. And that's… I love your visual illustrations there, that's really, really good.

TF:

[TF responds expressively before laughing]

Oh, I have to. It's how I am…

JD:

No that's awesome. It makes it very, very clear for later on when I'm transcribing. Um, so just moving from the knowledge side of the interview straight into the expectations side, uh, in mathematics, what do you expect from your students and how do you set those expectations?

TF (14:50):

[TF mutters the question back to herself before responding]

What do I expect from my students? Um, I guess the one thing that I expect… I expect from my students is that, um, that…um…

[TF pauses a few times before proceeding]

…it can… maths can be hard, and tricky, and challenging and not to give up when you have those challenges. Because a lot of kids can look at something and go, "That's too hard. I'm not going to do it." So, one of the things is like, I always go, I always pre-empt my kids and I'm like, "This might be a little challenging for you today, but I want you to work through it, keep at it, keep going." Um… yeah… and I guess I… its hard but I, one of the other expectations is to try different ways of solving which they tend not to do with, like, the kids that I work with but, you know, if this model isn't working for you, then try something else. You know, try different things, or try it a different way or double check it a different way but kids tend to get into habits of just doing the same thing. Yeah, the same way of solving it and yeah, yep.

JD:

Yeah, fantastic. Um… would you say that your expectations… well, how do you… do you see a difference in your expectations for your students versus your expectation for your own teaching?

TF:

[TF pauses before responding]

Um… if I want my kids to solve in different ways, then I need to show them to solve in different ways. If I'm, if I'm asking them to challenge, like, I need to show that. I make mistakes too; some problems are tricky to solve so I need to be able to show that to them or work with them to do it. So I think the expectations would be the same… yeah.

JD:

Fantastic… great. Um… what do you think influences that expectation or those expectations that you mentioned?

TF:

I think it comes from my own struggles with maths growing up. Um, and I was never the, never the one to solve problems by myself. There was lots of concepts that I didn't get, lots of things that I couldn't remember so when I work with my kids, trying different things and finding what works for you is important. Trying different things when it's not working is important because I know that's what I have had to do if maths is something that you struggle with and um… yeah.

[As TF responds, she initially nervously taps her pen on the table before gaining more confidence as she responds]

JD:

So what would you say, then, has the greatest influence? Is it, as you said, your experience or…?

TF:

[TF seems confused]

Influence on what…?

JD:

Influence on your expectations for students…

TF:

[TF seems confused, as if she's lost her train of thought; she places a strong emphasis on the phrase "my expectations"]

So what, what's influenced my expectations on the students? Are you saying that it's my experience?

JD:

[A little caught off guard by TF's confusion and afraid of putting words in her mouth]

Is it your experience or…? What has the greatest influence there?

TF:

[TF seems to have got her train of thought back and is more confident in responding]

Um… I'm going to say, yeah, it's my, it's a combination of my experience with maths and what, like, I've experienced with the kids over the years… yeah.

JD:

Yeah… so teaching experience as well.

TF:

Yeah… it's both… yeah.

JD:

Fantastic, great. Um… so, next activity for you. This one is quite a big task so feel free to go ballistic on it. On this graph, could you create a timeline indicating what fraction concepts can be taught from the start of foundation right through to the end of year 6 and when and how you would introduce each concept?

[As I introduce and explain the activity, TF makes a couple of "ohs" and "ahs" seemingly daunted at the task]

TF:

[TF pauses for 7 seconds]

…well, I need to know what the concepts are. Where's the curriculum?

[TF asks rhetorically and laughs]

JD:

I’m pretty sure every teacher has asked me that when I’ve brought that one out…

[I laugh]

TF:

[TF responds initially in a very laboured tone as she looks over the blank paper]

Yeah… well what do they…

[TF notes the following list at the top right side of her graph: “sharing, collections (m), area (m), number/lines, counting fractions, fraction/decimal/%s, + fractions, mixed fraction”]

…well you’ve got sharing…

[TF pauses to think before listing off a number of concepts]

…. you’ve got collection, collections, area model, collection model, area model, you’ve got number line, number lines, fractions…

[TF’s tone changes, letting an a frustrated “oh” and then proceeds to list some more concepts with another frustrated “mmm”]

…oh then there’s like, mmm, fractions, decimals, percentages…

[TF pauses]

…then there’s like adding so adding fractions. Then there’s like mixed fractions, oh there’s counting fractions… I don’t know where that one is… I was reading it the other day… mmm…

[TF lets out a mmm sounding hum starting high and ending in a low, exasperated tone]

…start of foundation…

[40 second pause; TF occasionally lets out a “mmm” sound or clicks her pen]

[TF’s tone here is almost as if she’s correcting herself]

You can do it from the beginning… sharing is like, important to learn. Collections, sharing collections… you can do that there…

[TF notes “sharing collections” with an arrow between foundation and start of 1]

Area model…

[TF notes “area model” drawing an arrow from between 1 and 2]

… uh… number lines… fractions as numbers… mmm…

[TF taps her pen repeatedly in a steady rhythm]

I'm just trying to think back to when I taught grade 2's… because I've taught many year levels…

JD:

Yeah…

TF:

[TF winces and purses her lips slightly as she looks over her work; she proceeds to explain the concept to herself]

Because number lines has to do with, like, you would link it to measurement and using rulers and stuff. Rulers and measuring. Grade 2's can do that… but not as fractions though… oh, they could do halves… they could do that… potentially half…

[TF notes "number line 1/2" with an arrow from start of 2].

Rulers, that's how'd you'd introduce it…

[TF notes "rulers" with an arrow from previous note"].

Yeah… I reckon… here we'll go number line

[TF notes "number line" with an arrow from start of 3].

…and counting, counting fractions… oh, its…

[TF mutters to herself as if she's arguing with herself]

…just simple, simple… halves, thirds, what else do they do? quarters…

[TF notes "counting simple fractions 1/2, 1/3, 1/4" with an arrow from between 3 and 4 before letting out a long, high sounding "oh"].

Oh… I reckon that could be earlier… that could be earlier… you could do that earlier

[TF crosses out this arrow and draws an arrow from between 2 and 3; TF sighs; long pause; TF crosses out items from the list she wrote at the start of the activity and notes "%, +" with an arrow from 4; she notes "decimal links" with an arrow from between 4 and 5; she notes "adding fractions simple" with an arrow from 5; finally, she notes "mixed fractions" with an arrow pointing to 6].

Mm… I actually haven't worked, like, up here that much with fractions so I'm not too sure…

[TF points to and circles the space between 6 and end of primary and chuckles].

JD (24:55):

No that's fair enough…

TF:

Yeah… mmm… I reckon that could be earlier… even… you could, you could…

[TF again seems to be arguing with herself under her breath and crosses out “area model” arrow and redraws an arrow from start of 1].

Yeah…

JD:

Cool… happy with it?

TF:

I think so… go tell the department… [TF laughs]

JD:

[I laugh] Yeah, yeah… no, no, that’s not what I’m doing, that’s not what I’m here for…

TF:

Just be like, here, this is how you should teach it… [TF laughs]

JD:

And really what we’re looking at are your expectations and what you would expect roughly from each year level which is why I really liked how you kind of were like, “Oh it could go here but oh actually no, I think I could get that, I could get the students to learn that or the students could learn that a little bit earlier. So that’s fantastic… so could you explain it a little bit to me?

TF (26:00):

[TF clicks her pen quickly before explaining]

Um… so… I just thought of the main concepts with fractions and… I… oh, that needs to be collections, even area model you could do that in foundation

[TF draws a further extension of the area model line back to between foundation and 1].

Um… so kind of starting with the idea of sharing and equal groupings is probably one of the most important things… with collections. And then with the area model, its like same size, same shape. Um… then, yeah, so sharing collections, sharing… um, the area model, linking to measurement and the number line - level 2ish. Um… I know this isn’t… I just know because this is in the curriculum, counting by fractions, and I think its about there, 2 and a half, I reckon that could be done. Number 3, number lines moving into um… percentages, decimals and fractions and potentially adding fractions… Oh, that could be earlier maybe… oh, do they do it… no, that’s on the higher end of 4, I think, I’m not sure… and then mixed fractions. But I don’t know what else you could do.

JD:

Is there any other, um, concepts that you can think of that we would do?

TF (28:00):

[TF lets out a long “uhhhh” before questioning in a confident tone]

Uh… I'm missing stuff aren't I?

JD:

Uh, not so much, I'm just thinking of multiplication and division and subtraction…

TF:

[TF's tone is triumphant as she comes to this realisation]

Oh yes… oh yeah…

JD:

So where do you think they might fit?

TF:

[TF is confident and quick to place these concepts]

That's like up here…

[TF notes "x/÷" with an arrow pointing between 5 and 6 and adds "/-" next to adding fractions simple].

Multiplying, division, adding, subtracting… that just shows how much we put emphasis on addition…

JD:

But then addition links to lots of other concepts so…? Yeah, no, fair enough… cool. Anything else you want to say about that one?

TF:

[TF pauses to think before answering]

Uh… no…

JD:

Okay, pretty much sums it up?

TF:

Yah…. I think so, yeah…

JD:

No worries… would you approach this activity differently for a different mathematics concept?

TF:

[TF pauses briefly before responding in a persuasive tone]

Um… no I think this is a really important thing to do… and I tell you, if you go to different teachers, you'll have some very different things… You'll have some very, very different things. I think it's a really, really good exercise though. Because I don't think we do this enough and, I guess, where does the research come in as well to like verify what particular concepts kids can developmentally handle at different stages… so this is a really cool thing to do…

JD:

Yeah… and particularly as teachers, you know, you know your students, you know what they can achieve, you know what your expectation is of them. Yeah… absolutely. Obviously, you've explained it really well and I think you've got a lot on here which is fantastic. Um… so some researchers suggest that fractions can be taught as early as foundation and I'm assuming you agree with that as you've got down here that you've got sharing and collections. Could you elaborate on that?

TF (29:45):

[TF seems quick to respond but stops herself briefly before continuing]

I guess, like, halves… you know, if like, we had this bag of lollies or this block of chocolate, you know what, you could do area, that's what… yeah, move that over… [TF again seems to be reasoning with herself and proceeds to move the arrow pointing to "area model" from close to the "2" to close to the "1" section]

…to you can definitely do area, like the area model. Um, you know, we've got this cake or we've got this block of chocolate or bag of lollies and its just you and me, I want some, you want some, lets share. But it needs to be, like, am I going to get more than you? No, that's not fair. You've got half, I've got half, then you're bringing in that vocab very early on…. Yeah, yeah.

JD:

Awesome, great. So essentially that's the interview for today. I've just got a couple of concluding questions for you. Do you see yourself as a "typical" primary teacher and, if so, why or why not?

TF:

[TF pauses and then answers assuredly]

Um… I don't see myself as a typical primary school teacher. Um, I'm that person that wants to do things differently and I want, I'm always thinking about how can I do this differently, why are we doing it this way, do I have to do it that way… but at the same time, you can fall into doing the same thing again and again and again and just falling back to what you know… so that's, I think that can be a detriment because this kind of, as a teacher, doing this activity…

[TF points repeatedly to Artefact 2]

…and doing stuff like this, we don't think this way. We just go, "oh, what's on the curriculum. Oh yeah, let's just do that." So, yeah, I'd like to see myself as not a typical teacher, but I do fall into, you know, oh this is what we did last year so we'll just do it again, kind of thing, so yeah…

JD:

Um, well, I guess just extending on that, why do think that sometimes teachers fall into that?

TF:

Um… its familiarity. Its "it worked last year so its going to work again this year" which is the case, like, don't reinvent the wheel but sometimes you've got different kids in front of you and it might not work. And I guess, we as a profession, there's not enough of this kind of conversation. You know, only recently in the school that I'm at now, we're kind of starting to have this conversation but what tends to happen is that you get put into a year level, like year 4, and you might stay…. I'm quite lucky because I've changed, unlucky and lucky, first I was unlucky but now I'm lucky… you might be put into a year level and you'll stay in that year level for a couple of years and that's all you know. So, and if you're like a grad, you don't know what its like in grade 2, so, you know, you're not familiar with the content but your grades going to have kids that are from grade 2 so you only know what you know and you don't know outside of that and, you know, for teachers that have taught the same year levels only know that year level, and they'll just, you know, oh, we did this last year so we'll do it again and the curriculum is taught, is, like, seen as a, like, tick box thing…

[TF lowers her voice somewhat as if to avoid anyone hearing her]

…and not from a… um… its seen as a tick box thing rather than a guide. The curriculum is like a guide and we need to put this stuff in, like, where's the research into development, like, how kids develop concepts and like that continuum and as a teacher, we don't have enough of this…

[TF emphatically taps on Artefact 2 lying on the table]

…to go well, "I'm currently teaching grade 3s, and my contents, like, I know my grade 3 content really well but you might have a kind of idea about those ones and those ones but… um, yeah, we don't get enough of that… yeah.

JD:

No worries… do you think this interview has changed your thinking about teaching mathematics or setting expectations generally in any way?

TF:

Yeah… I think it's definitely highlighted… its definitely highlighted the need for this…

[TF again taps Artefact 2]

…yeah, for these continuums, because you might have a team of 4 teachers and they all have different expectations and they might have an idea of, "oh, you know, this is what I do." Classic example because we do the workshop model, so I've got the low group, next door has the mid group and the other person has the high group and you go in and we're all doing the same activity.

[TF's voice gets higher and more expressive as she comes to the end of the sentence: "and we're all doing the same activity"]

And that comes down to just what we know what we do. Oh, we're doing this so, oh, we do that activity but, we're all different groupings so what's, why is that happening?

[TF seems mildly frustrated]

Yeah…

JD:

Fantastic… is there anything that you'd like to add that perhaps we haven't covered?

TF:

[TF answers contemplatively]

Mmmm, no…

JD:

No… no worries… and just a final question, um, I know I got you for the first interview and then there was some situation changes but then you were able to come to the second one. Um, what made you want to come to an interview?

TF:

Um… because… so there was two things… number one, I felt real bad that I had bailed on you. [TF laughs]

And the next one, oh there's a few other ones… I'm currently studying at the moment, I'm doing psychotherapy and, you know, as part of that, and I know that you're studying and doing this sort of stuff, and if you don't have participants, it makes it really, really tricky and like, you know, that's why I came back. And also, you said you were really interested in some of the things that I was saying and I'm like, "Ooh, what are you interested about?"

[TF speaks expressively and laughs]

…so you like captured my curiosity, "Ooh, what are you talking about?"

[TF laughs]

JD:

No fantastic… Well, its been fantastic. Its, um, again, thank you for your time, thank you for noting all of this down, it's really, really valuable and just, thank you once again. Its been awesome.

TFs:

No worries… and good luck.

JD:

Thank you.

At the end of the interview:

TF and I briefly sat and discussed her questionnaire responses which seemed unique to the other interviewees in that she expressed both poor experiences and attitude toward mathematics but made some interesting comments about teaching. She seemed very excited at the end of the interview to do something similar to Artefact 2 in other areas of her teaching.

Interview ran for approx. 37mins

Appendix D: Artefact 1 Responses

Teacher A: Eric

LA TROBE UNIVERSITY

Interview Schedule

Question:

James had a bag of marbles.

There were 56 marbles in the bag.

He gave away 3/8 of them.

How many marbles were left in the bag?

Working Space:

$$\frac{3}{\cancel{8}_1} \times \frac{\cancel{56}^7}{1} = \frac{21}{1} = 21$$

Teacher B: Penny

Interview Schedule

Question:

James had a bag of marbles.

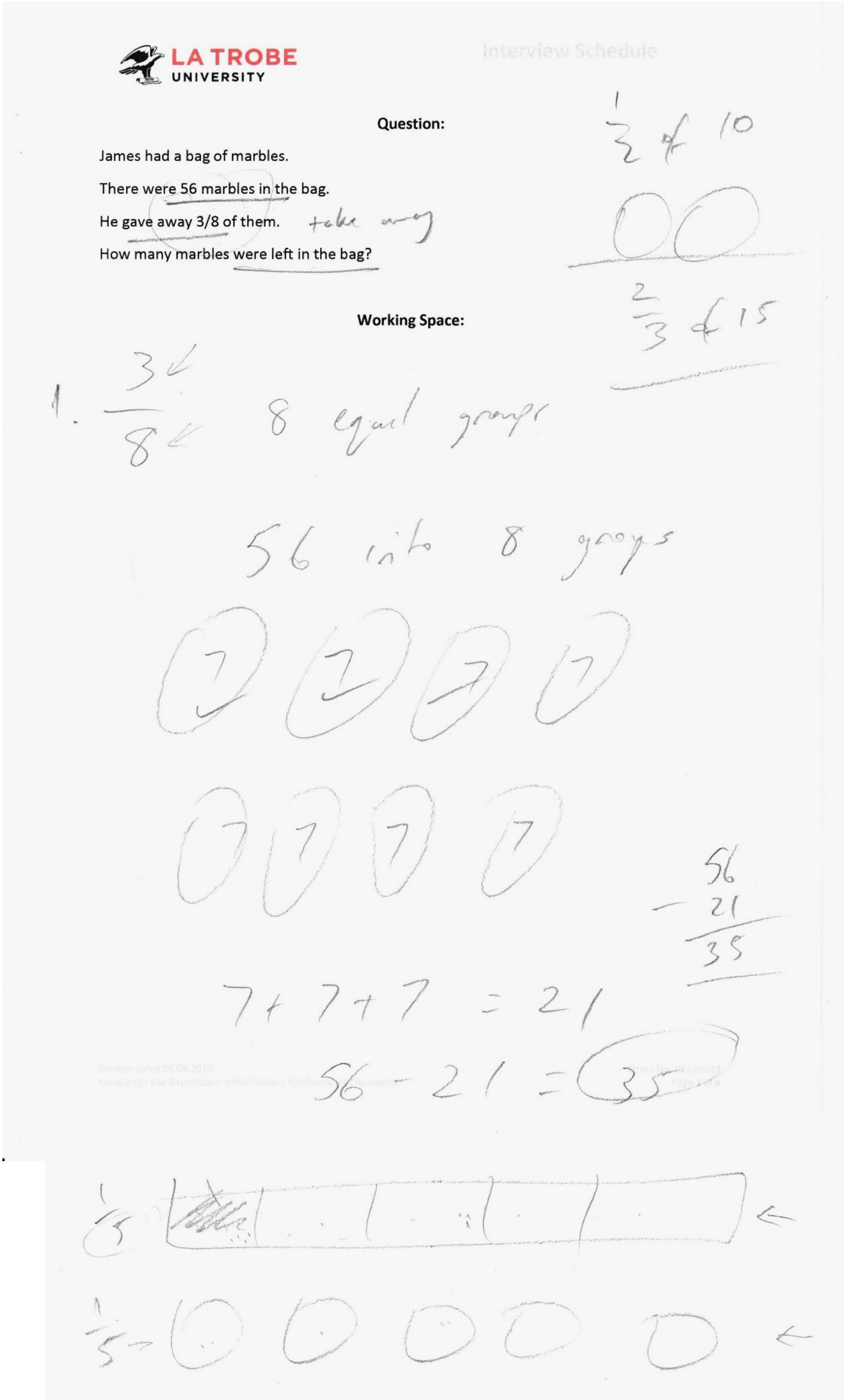
There were 56 marbles in the bag.

He gave away 3/8 of them.

How many marbles were left in the bag?

Working Space:

Teacher C: Terry



LA TROBE UNIVERSITY

Interview Schedule

Question:

James had a bag of marbles.

There were 56 marbles in the bag.

He gave away 3/8 of them. take away

How many marbles were left in the bag?

Working Space:

$\frac{1}{2}$ of 10

$\frac{2}{3}$ of 15

1. $\frac{3}{8}$ 8 equal groups

56 into 8 groups

7 7 7 7

7 7 7 7

7 + 7 + 7 = 21

56 − 21 = 35

$$\begin{array}{r} 56 \\ -\ 21 \\ \hline 35 \end{array}$$

$\frac{1}{5}$

$\frac{1}{5}$

Teacher D: Damon

LA TROBE UNIVERSITY

Interview Schedule

Question:

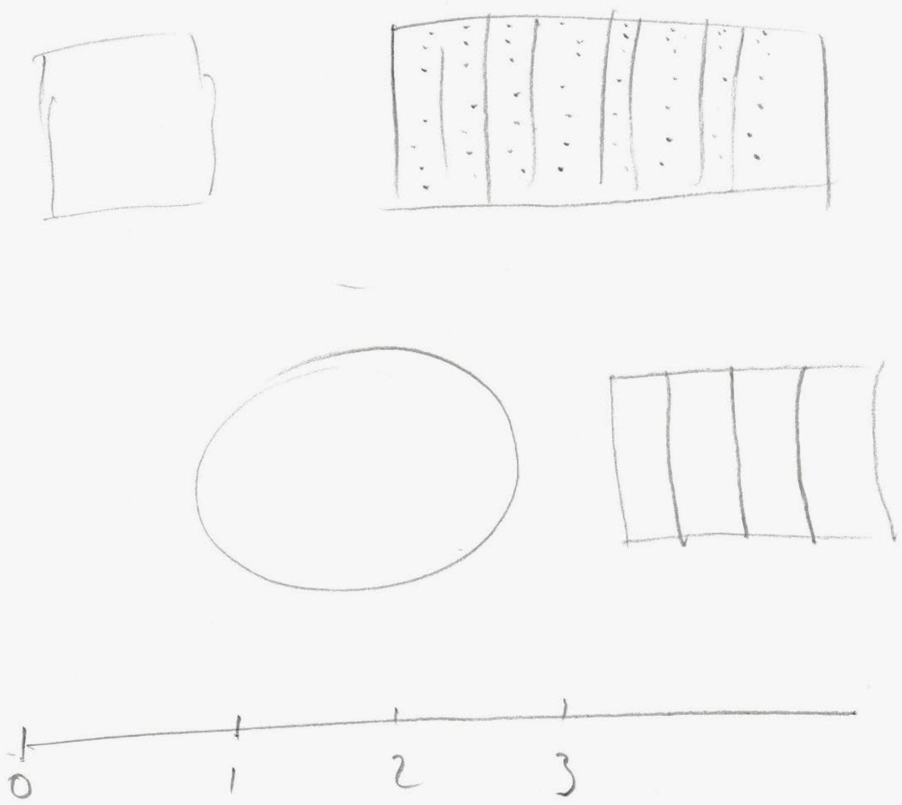
James had a bag of marbles.

There were 56 marbles in the bag.

He gave away 3/8 of them.

How many marbles were left in the bag? $\frac{3}{8}$

Working Space:



Teacher E: Annie

LA TROBE UNIVERSITY

Interview Schedule

Question:

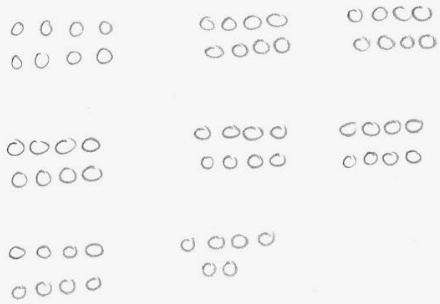
James had a bag of marbles.

There were 56 marbles in the bag.

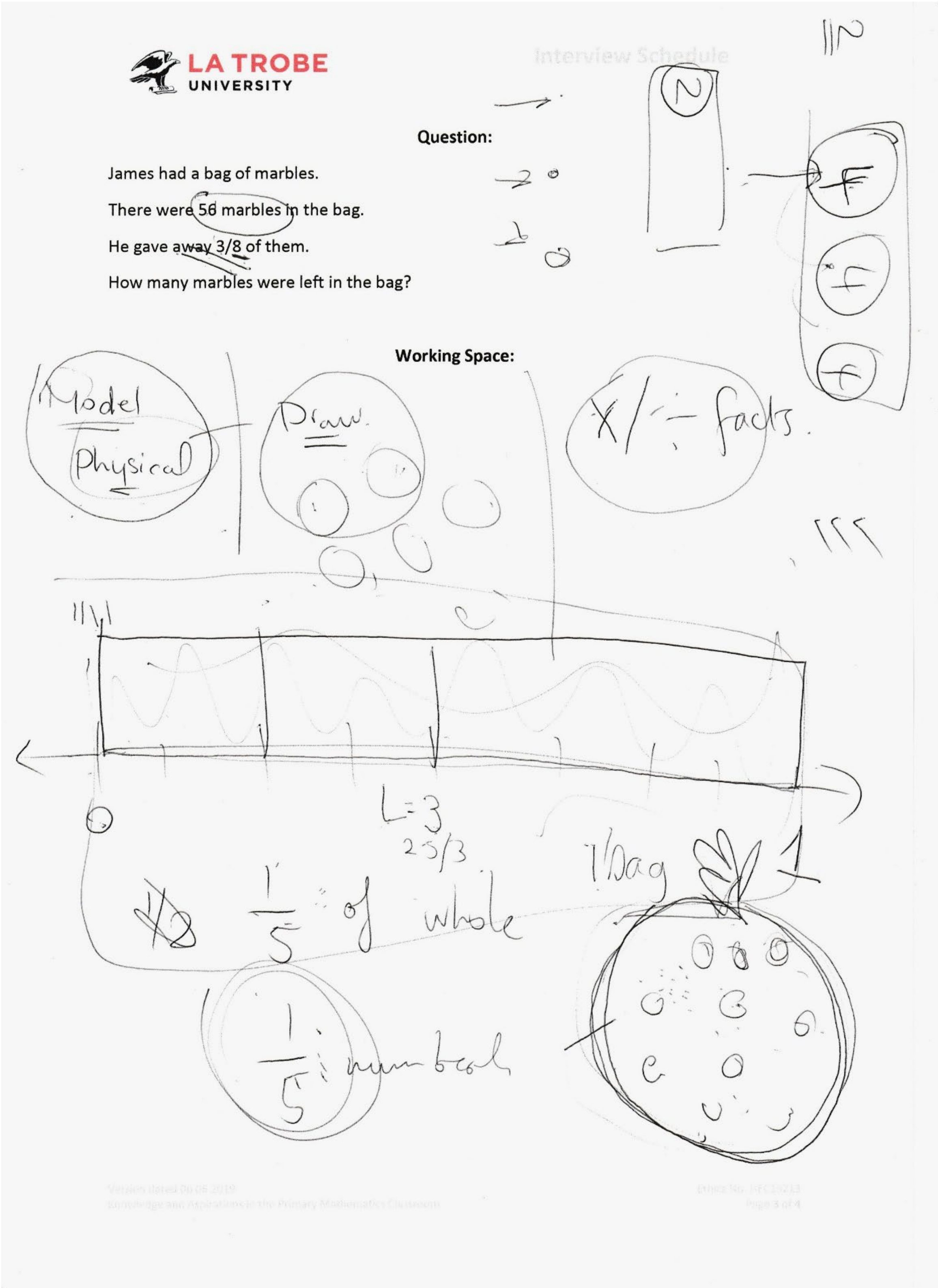
He gave away 3/8 of them.

How many marbles were left in the bag?

Working Space:



Teacher F: Cathy



LA TROBE UNIVERSITY

Interview Schedule

Question:

James had a bag of marbles.

There were 56 marbles in the bag.

He gave away 3/8 of them.

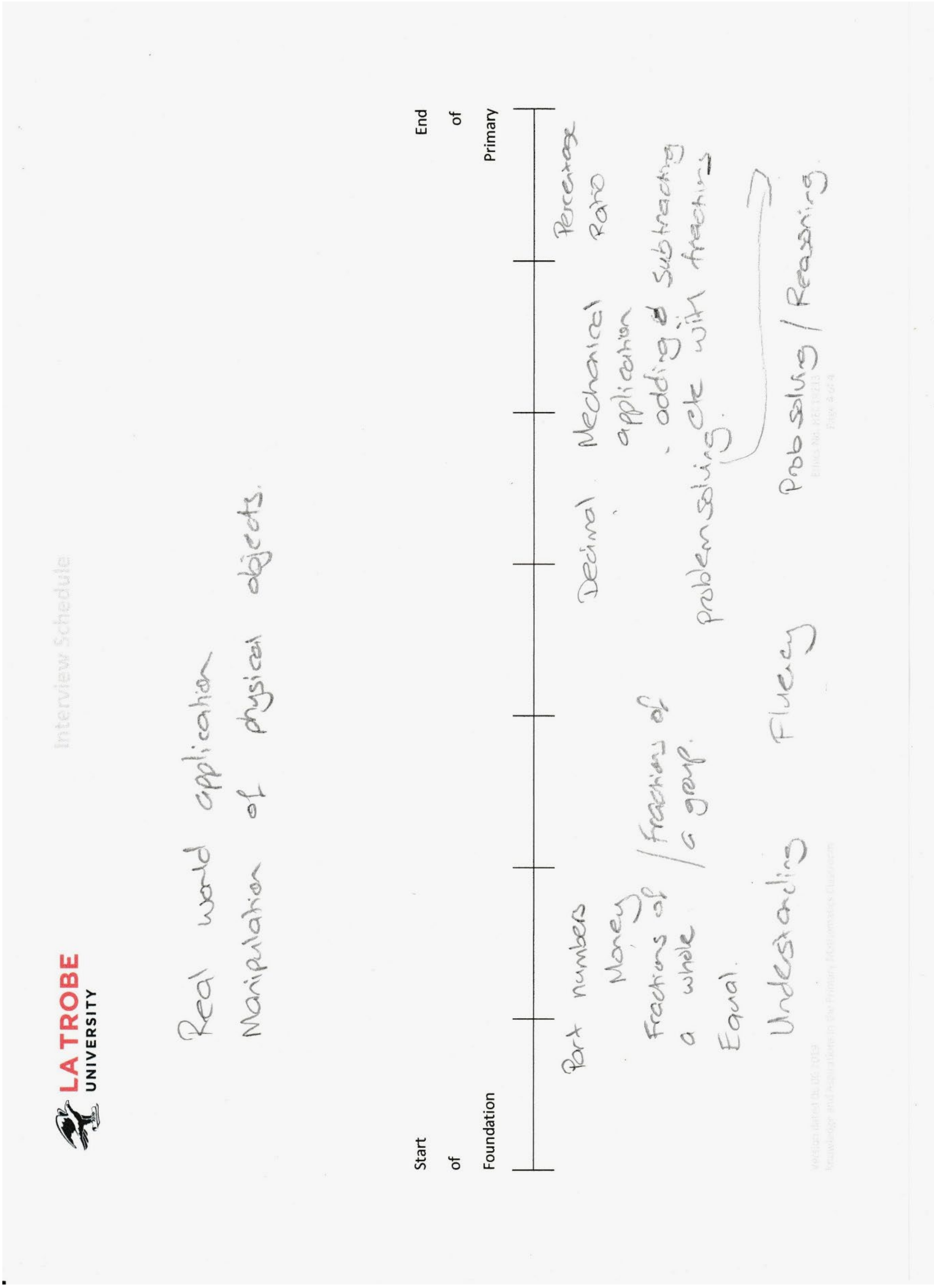
How many marbles were left in the bag?

Working Space:

Appendix E: Artefact 2 Responses

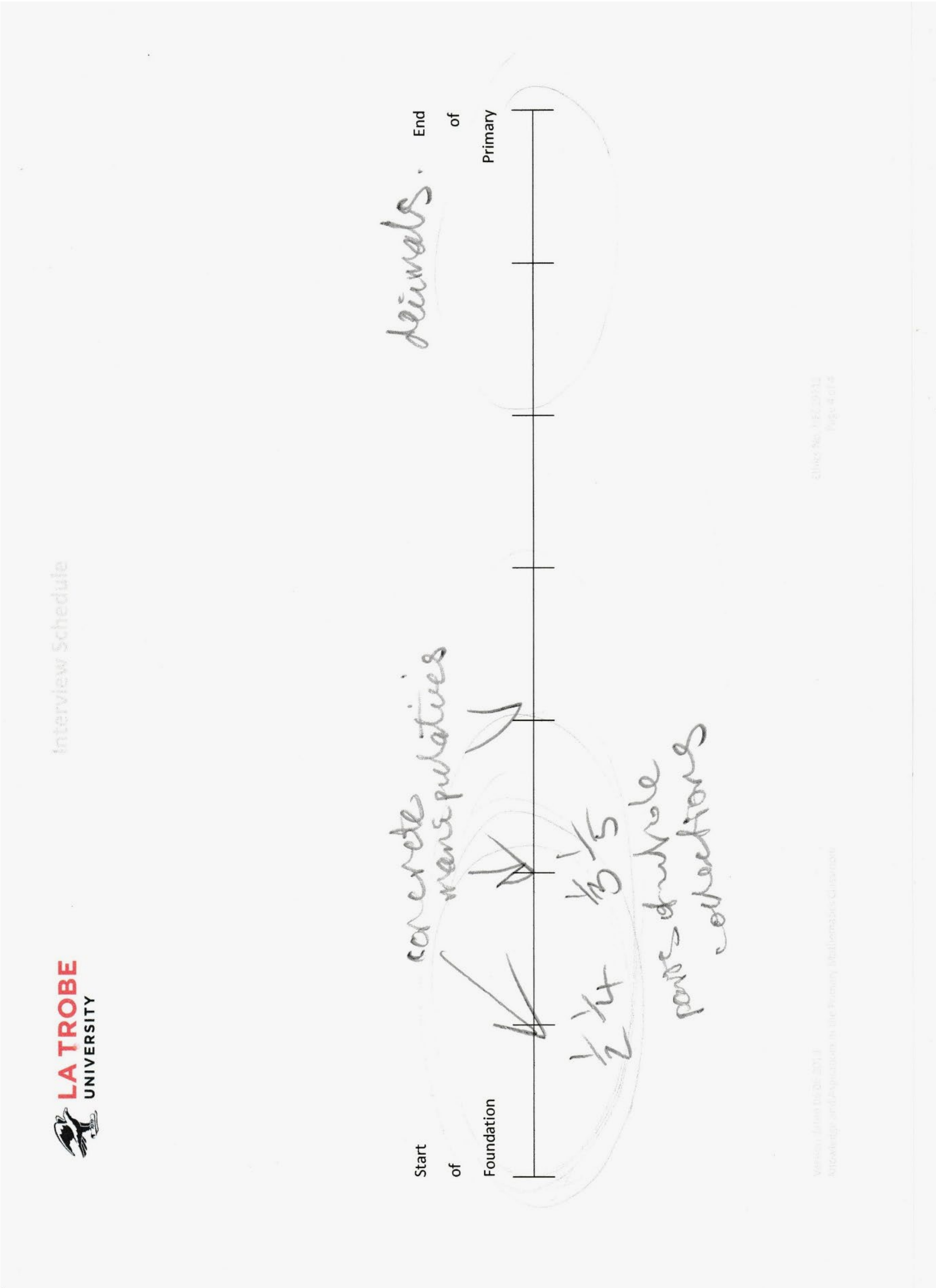
Teacher A: Eric

Teacher B: Penny

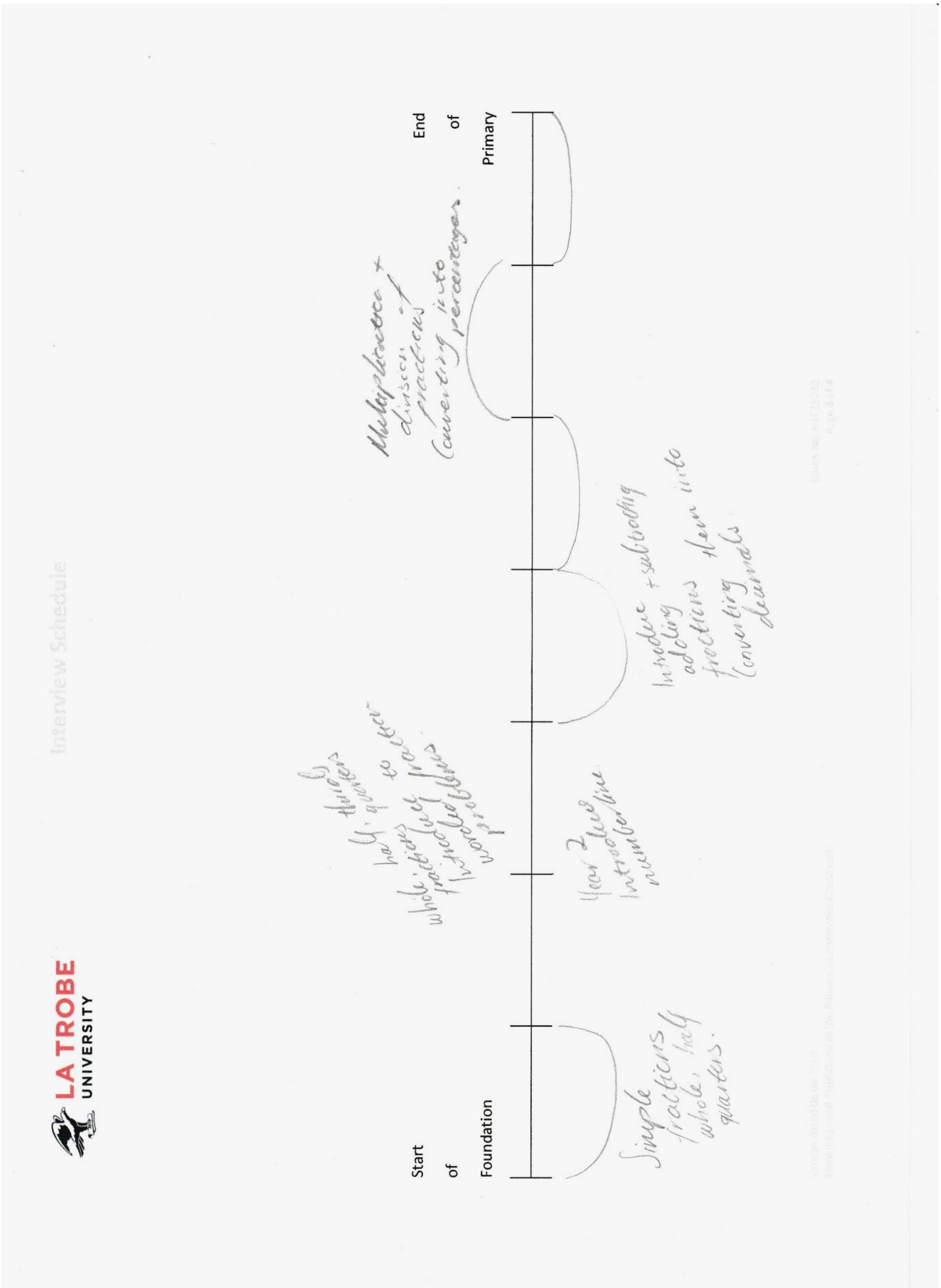


Teacher C: Terry

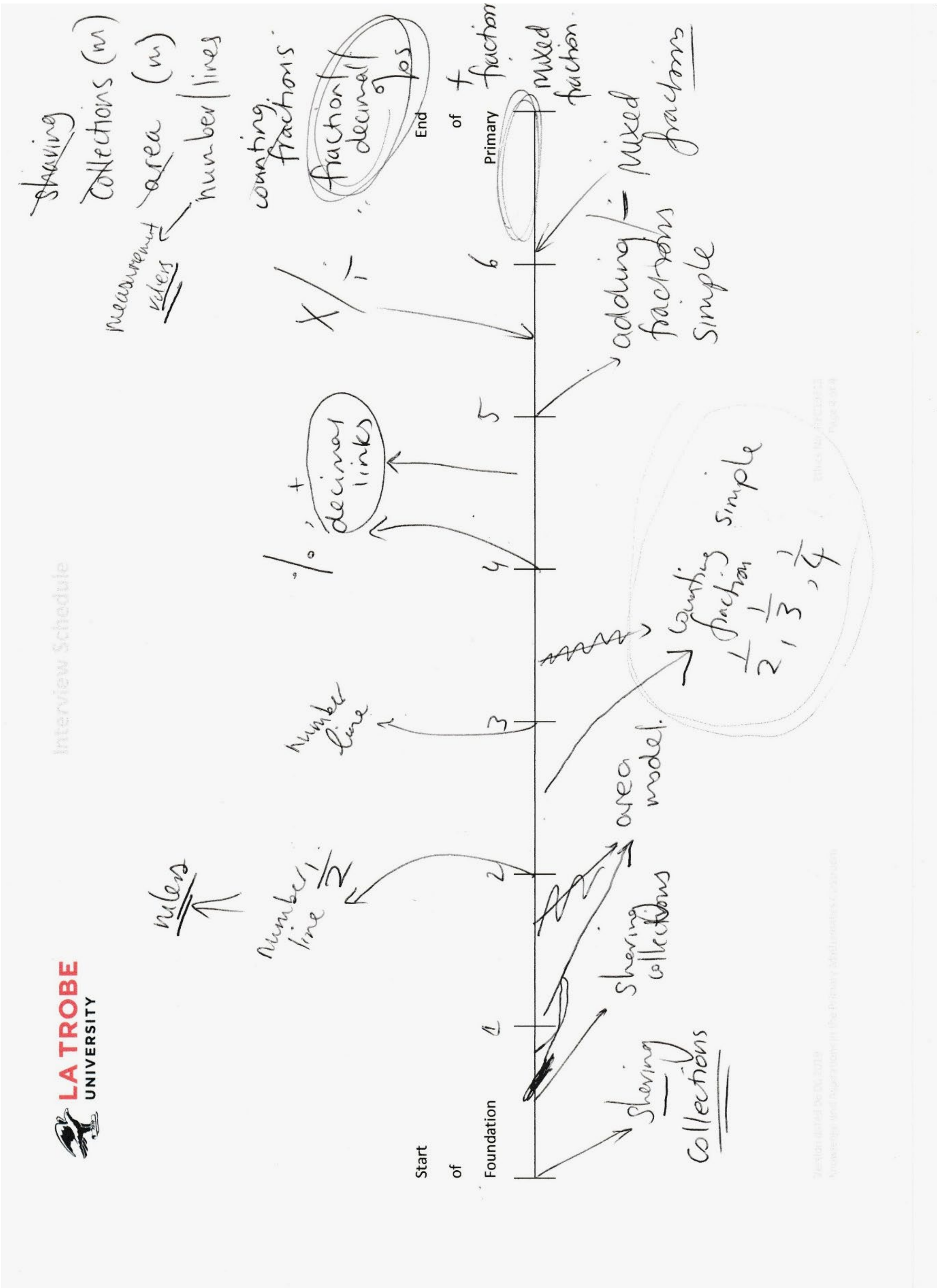
Teacher D: Damon



Teacher E: Annie



Teacher F: Cathy



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