FIRST YEAR AND BEYOND: BEGINNING PRIMARY SCHOOL TEACHERS AND TEACHING MATHEMATICS

a thesis
submitted in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy

by

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B. Ed. (Primary) (Honours) C. Sturt

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CERTIFICATE OF AUTHORSHIP

I hereby declare that this submission is my own work and to the best of my knowledge and belief, understand that it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at Charles Sturt University or any other educational institution, except where due acknowledgement is made in the thesis [or dissertation, as appropriate]. Any contribution made to the research by colleagues with whom I have worked at Charles Sturt University or elsewhere during my candidature is fully acknowledged. I agree that this thesis be accessible for the purpose of study and research in accordance with normal conditions established by the Executive Director, Library Services, Charles Sturt University or nominee, for the care, loan and reproduction of thesis, subject to confidentiality provisions as approved by the University.

Name                Judith Ann Geeves

Signature

Date
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NOTIFICATION OF ETHICS APPROVAL

This research project was approved and monitored by Charles Sturt University's Ethics in Human Research Committee.

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This thesis was professionally edited by Ms Kim Woodland. The professional editing of this thesis was limited to formatting, grammar and style, as per the Australian Standard for Editing Practice (ASEP) Standard D – Language and Illustrations, and did not alter or improve the substantive content or conceptual organisation of the thesis.
ABSTRACT

The most important single factor in determining the quality of students’ mathematical learning is what the teacher does in the classroom—their classroom practice. Therefore, supporting the development of beginning primary school teachers’ mathematical classroom practice is an important part of the wider national agenda to increase the mathematical outcomes for all Australian school students.

This study explores how various personal and school factors influence the development of mathematical classroom practice in beginning teachers over the first few years of their teaching careers. As such, it provides a greater understanding of this process, which, in turn, will assist those responsible for facilitating beginning teacher development to provide appropriate support at the appropriate time, based on the identified needs of the beginning teacher.

This is a mixed method, longitudinal study that is primarily concerned with investigating the social, or lived, reality of beginning primary school teachers in the first years of their teaching career. As such, a research design was formulated that incorporated the following data collection techniques: surveys, semi-structured interviews, mathematics testing and classroom observations. The data collected were then analysed and used to generate individual case stories of the development of beginning primary school teachers as teachers of mathematics.

This study identified links between beginning teacher confidence, school context and classroom practice and how schools can use these understandings to better support the mathematical development of beginning primary school teachers. It also identified that there needs to be a greater focus on the rigor of mathematical content in school and classroom programs, professional development, planning discussions, activity selection, lesson evaluations and student assessment in order for beginning teachers to develop as effective teachers of primary mathematics.
Chapter 1: Introduction

Study Overview

It is widely accepted, as it is based on strong research evidence, that the most important single factor in determining the quality of students’ mathematical learning is what the teacher does in the classroom—their classroom practice. Therefore, supporting the development of beginning primary school teachers’ mathematical classroom practice is an important part of the wider national agenda to increase the mathematical outcomes for all Australian school students.

However, in order to support the development of beginning primary school teachers’ mathematical classroom practice we first have to understand how classroom practice evolves and how this development process works.

This study explores how various personal and school factors influence the development of mathematical classroom practice in beginning teachers over the first few years of their teaching careers. As such, it provides a greater understanding of this process, which, in turn, will assist those responsible for facilitating beginning teacher development to provide appropriate support at the appropriate time, based on the identified needs of the beginning teacher.

The account of this study from its inception to the presentation of findings that meet the research objectives is detailed within this thesis. It is organised in seven chapters that are listed and described below.

Chapter 1: Introduction

This chapter provides a brief overview and background of the study, outlines the chapter structure of the thesis and identifies the first step of the research process by identifying the initial reasons for conducting the study and positioning the researcher within the study.
Chapter 2: The Literature Context

This chapter identifies the extant body of Australian and international, contemporary and seminal research and the literature context in which this study is set. Summarising and analysing this body of work identifies both areas of interest and gaps in the research literature that informed the formulation of the study’s research questions.

Chapter 3: The Research Design

This chapter presents and explains the mixed methods research design and outlines the methodological and analytical frameworks of the study. This includes identifying the timeline for the research; outlining the sample design and data collection tools used at each phase of the study; and explaining the three-stage process that underpinned the analysis of all data collected during the course of the study.

Chapter 4: The Pre-service Teacher

This chapter presents the results of the analysis of data collected via surveys administered to 200 final year pre-service primary school teachers in three universities located in the Australian Capital Territory and New South Wales. The quantitative data were reduced using descriptive statistics and inferential statistics generated using PCA and repeated ANOVAs. The qualitative data was reduced using Word Count, Keywords-In-Context and axial coding. Data statements were then generated for both sets of data and compared to each other and to the findings of extant research and literature. The findings that resulted from the integration of the quantitative and qualitative data statements were reported in three tables that include a demographic profile, a mathematical experience and expectation profile, and a table detailing emerging tensions between theory and practice.
Chapter 5: The Beginning Teacher

This chapter presents the results of the analysis of data collected via surveys administered to, and interviews conducted with, ten beginning primary school teachers teaching in the Australian Capital Territory.

The quantitative survey data were reduced using descriptive statistics and the qualitative data were reduced using data categories and continua to code responses. Data statements were then generated for both sets of data and compared to each other and to the findings of extant research and literature. The findings that resulted from the integration of the quantitative and qualitative survey data statements were reported in three tables that include an induction profile, a school context profile, and a table outlining areas of interest for practice.

The qualitative interview data were reduced using Key Focus Area coding and data statements were generated. Data statements were then compared to survey results and the findings of extant research and literature. The findings that resulted from the integration of the survey and interview data statements were reported in the following three beginning teacher profile categories: confidence, coherence, and consistency.

Chapter 6: Beginning Teacher Case Stories

This chapter presents the results of the analysis of data collected via the pre-service and beginning teacher surveys and the beginning teacher interviews and reorganised to build individual, longitudinal profiles of the ten existing beginning primary school teacher participants. From the comparison of the ten individual profiles, five participants were then selected as case story subjects. Two participants were selected as extreme case stories because they represented the two extremes of beginning teacher confidence.
Once their individual case stories were written and beginning teacher profiles created, a cross case comparative analysis was conducted and data statements generated. The remaining three participants were selected as extended case story participants. They were required to participate in an additional stage of data collection that involved completing a mathematical content assessment tool and having their mathematical teaching observed. Short interviews were also conducted at the end of the test and the lesson observation.

The data collected from the test and the lesson observations were reduced, analysed and data statements were generated. These data statements were compared to each other and the findings of extant research and literature to create integrated data statements. This data was then added to existing pre-service and beginning teacher survey and interview data to create individual case stories and beginning teacher profiles for all three participants. A cross case comparative analysis was then conducted and data statements generated. Finally, the data statements generated from the analysis of all case story participant data was compared and integrated and used to create the beginning teacher development continuum.

Chapter 7: Findings

This chapter integrates the analysis of all the study data collected and reported in Chapters 4 to 6 to both address the research questions and produce the findings of the study. In keeping with the mixed methods research design selected as the methodological framework of this study, a range of continua and visual representations were used to support the presentation of the study findings. This chapter also identified some limitations of the study and the implications these had for further research.
The Research Process

Teddlie and Tashakkori (2009) argue that the researcher’s “reasons for performing research are the authentic starting point” for documenting the research process (p. 111) as they underpin how a researcher conceptualises the research, which in turn influences the development of the research questions, which in turn informs how the research is conducted (see Box 1.1).

This idea of ‘starting with the researcher’ is similar to the concept of research reflexivity. As defined by Cohen, Manion, and Morrison (2008, p. 171):

Reflexivity recognises that researchers…bring their own biographies to the research situation and participants behave in particular ways in their presence. Reflexivity suggests that researchers should…disclose their own selves in the research, seeking to understand their…influence on the research…rather than trying to eliminate researcher effects…which is impossible, as researchers are part of the world that they are investigating.

As such, the first steps in providing the context of this study are to identify the reasons for doing the research in this content area, and as they are based on my own experience as a beginning teacher of primary mathematics, providing details of that experience as it will inform the rest of the study.
Reasons for Doing this Research

Teddlie and Tashakkori (2009, p. 113) identify that there are three main reasons for conducting research: personal reasons; reasons associated with advancing knowledge; and societal reasons. My motivation to conduct this research was a combination of aspects from all three categories.

Firstly, at the time I commenced this research I was a beginning primary school teacher and developing as a teacher of mathematics was my lived reality. As such, I wanted to satisfy my “own curiosity about a phenomenon of interest” (Teddlie & Tashakkori, 2009, p. 112).

Secondly, I had identified my own development as a beginning teacher of mathematics as an area of concern for my teaching and was having difficulty finding effective support in this area within my school context. As such, I wanted to “understand [the] complex phenomena” that was the process of beginning teachers’ mathematical development (Teddlie & Tashakkori, 2009, p. 112).

Finally, in trying to find answers to my own questions about my mathematical development I soon identified that many of my beginning teacher colleagues were also struggling with the same issues. Given that a teacher’s classroom practice is the single most important factor in determining student learning outcomes it was imperative that I, and my colleagues, got it right. As such, a desire to “improve society and its institutions” (Teddlie & Tashakkori, 2009, p. 112) was also driving my decision to conduct research in this content area.

Positioning the Researcher in the Research

In the context of this research, it was my experience as a beginning teacher that provided the “puzzle” (Richards & Morse, 2007, p. 127) that led to the research question and design and it was my identity as a primary school teacher that underpinned the researcher/participant relationships within the study.
As such, my experience must be explicitly involved in the study. However, care has been taken when including myself as data to minimise the risk that it becomes “self-indulgent” (Richards & Morse, 2007, p. 127). In the first instance, a short autobiography that details my journey from beginning teacher to PhD student is provided below.

**From Beginning Teacher to PhD Student and Back Again**

In late 2002, while still a student in my final year of an undergraduate primary teaching degree I agreed to participate in a PhD study on beginning teachers and was observed and interviewed in my classroom a number of times in my first 18 months as a teacher. My researcher was a full-time deputy principal at a rural primary school in New South Wales (NSW) and a part-time PhD student at the University of Tasmania. She provided me with the transcripts and copies of other raw data from my interviews and observations for use in building, and validating, this autobiographical profile of myself as a beginning teacher.

In January 2003 I began my career as a primary school teacher in the Australian Capital Territory (ACT). My first class was a Year 2 with 24 students aged between 6 and 8 years old who had an enormous range of learning needs and abilities. I had students with learning difficulties, Indigenous students and English as a Second Language (ESL) students who required individual learning plans. Up to a third of my class were withdrawn on a daily basis to receive specialist literacy learning intervention. At the other end of the learning spectrum I also had three students who were identified as being gifted and talented (G&T) and who were working academically at a Year 4 and above level in many aspects of the curriculum including mathematics.

My first observation and interview as a PhD participant occurred on 8 March 2003 when I was mid-way through my first term of teaching. At this time I described myself as “tentatively teaching” and amongst all the issues related to transition into the school and classroom
environment I was already identifying the programming, planning and teaching of mathematics as a particular issue of concern.

In my next observation and interview on 27 August 2003 as I was coming to the end of my first year of teaching, the researcher commented that I seemed more confident, relaxed and “natural” in my teaching than I had been at the beginning of the year. I agreed that my classroom practice had developed into a more integrated and seamless whole except for certain things I had to be “really conscious of…[like] …programming for maths” as I felt it had "gotten away from me" earlier in the year.

When reflecting on my first year of teaching I wanted to know what it was about my mathematics teaching that worried me and why I was more concerned about it than other curriculum areas. Initially I looked to factors of my school and education system contexts for both an explanation and a solution for my problem.

During my first year I received substantial in-school support to manage and meet the diverse literacy needs of my students. At regular times throughout the year the Learning Assistance (LA) and ESL teachers assessed my class using standardised reading assessments. As part of this process, the teachers showed me how to administer and diagnose these assessments and identify what skills and understandings I needed to focus on to consolidate and advance my students along the literacy continuum.

These specialist teachers also withdrew a third of my class for small group or individual intensive literacy instruction on a daily basis so it made sense for me to focus on literacy with the remainder of my class at those times. The effect of this was that I had dedicated literacy teaching blocks where I worked with a small number of students and these times were almost sacrosanct and were very rarely cancelled or double-booked by other school events.

These expert teachers were my literacy mentors—they helped me program, plan, resource, assess, diagnose and report on my
students and provided me with a level of professional dialogue and interaction that helped me to develop as a confident and skilled teacher of literacy. However, while I had as much of a range in student numeracy abilities and needs as I did in literacy, when it came to mathematics I found I was on my own.

There was no school-wide scope and sequence for teaching mathematics, no diagnostic test used, no mathematics curriculum coordinator and virtually no shared resources. In my first few weeks of teaching I actually bought my own basic resources, such as counters, blocks, dice, cards and games for my classroom.

Within the school there was no one staff member who was recognised as a ‘maths’ expert. When trying to find a mentor for mathematics, other teachers I approached would show me the textbook-based programs that they followed and talk about how they tried to adapt them to account for different ability levels. One resource I did have was a Year 2 Maths textbook that all the students in my class had purchased and which I used. The program also came with a teacher’s book that provided me with a program and lesson-by-lesson structure.

It was this experience as a beginning teacher that motivated me to commence this study as a part-time PhD student in my second year of teaching. Why had I come up against this wall of silence about mathematics when I had had such fantastic support in literacy? Similarly, why did I plan on my own for mathematics when I had shared the planning for the year’s integrated science, social science, arts and personal development units and participated in whole school and junior school sports and physical education (PE) programs?

In a document outlining my proposed research topic that I prepared for a meeting with my principal and one of the three school directors in the ACT in my second year of teaching I wrote:
As a beginning teacher in the ACT system I found that, while there was substantial resources, materials, system and school level support (Learning Assistance and ESL teachers, Reading Recovery specialists and Professional Development opportunities) in Literacy, there was not nearly as much readily available with a focus on numeracy.

This study…[will provide]…us with an opportunity to identify if this is a significant factor in determining classroom practice in beginning teachers and…is also a means for us to devise school and system wide policies and programs…[to effectively]…support new teachers’ successful transition into teaching and revitalise the way that mathematics is taught in the classroom. (PhD Scoping Paper, 18 May 2004)

By the time of my third and final PhD observation and interview on 17 September 2004—18 months into my teaching career—my PhD proposal was in the process of obtaining ethics approval from the university so I could commence data collection in 2005. In explaining my proposed study during this interview I identified that my decision to undertake a PhD so early in my career was ‘driven’ by the fact that I felt I had to do something to try and understand why mathematics was still such a huge issue for me and why I had been unable to get the answers I needed from within my local school or the wider system learning communities. I also felt that my experience wasn’t unique and that it was an issue for schools and education systems to consider in developing effective teachers of primary mathematics.

By the time I had my final PhD interview in Term 3 of my second year of teaching quite a bit had occurred in my development as a teacher of mathematics. As soon as it became known that I was undertaking a PhD related to mathematics I became the resident maths ‘expert’. I had just finished single-handedly writing the school’s most recent three-year Numeracy Plan that set the direction and priorities of maths curriculum from Kindergarten to Year 6. I was also the school’s maths curriculum and contact person which meant I received all resource catalogues and samples of maths resources to evaluate and pass on to staff as well as notifications about any upcoming professional development opportunities. So, at some point—almost while I wasn’t looking—I had ‘mathness’ thrust upon me. The net result of taking on these whole school responsibilities in conjunction with commencing my study was that I became immersed
in mathematics which had a positive effect on my development as a teacher of mathematics.

**Identifying the Research Content Area**

Wanting to understand my own experience as a beginning primary school teacher was not only the driving force in my decision to undertake this study, it also informed my initial focus when looking for a “researchable idea in a content area of interest” (Teddlie & Tashakkori, 2009, p. 116).

In the context of this study the broad content area of interest identified was **beginning primary school teachers’ development as effective teachers of mathematics**. The next step in the research process i.e., identifying the researchable idea within the content area, and the subsequent formulation of research objectives and research questions, are reported in the next chapter, **The Literature Context**.

**Conclusion**

This chapter provided a brief overview and background of this study and described the chapter structure of the thesis. It also documented the first step of the research process by identifying the researcher’s initial reasons for conducting the study and positioning these reasons within the study.

A brief account of the researcher’s own experience as a beginning primary school teacher in mathematics was also provided as this experience was instrumental in how this research was conceptualised and how the research objectives and questions were developed.

The process of identifying research objectives and developing the research questions based on a review of extant literature and research related to the identified research content area are described in the next chapter, **The Literature Context**.
Chapter 2: Literature Context

Introduction

The purpose of this chapter is to identify and describe the research and literature context in which this study is set, and the process that was taken by the researcher to establish the context, through conducting a literature review of the extant body of Australian, international, contemporary and seminal research related to beginning primary school teachers’ development as effective teachers of mathematics.

In keeping with the core characteristics of the mixed methods research design selected as the methodological framework of this study, the presentation of the synthesis of literature and research reviewed will reflect an “emphasis on continua” and a “reliance on visual representations (e.g., figures, diagrams)” (Teddlie & Tashakkori, 2012, p. 775).

Teddlie and Tashakkori (2009, p. 121) describe the literature review “as an integral part of the research process whereby an investigator develops research questions for a study”. They also identify that a literature review will “typically employ a funnel approach...[to]... refi[e] the information to the most relevant articles and sources” and that this process is “iterative” in that searching for and refining information is repeated throughout the study.

The organisation of this chapter reflects the repeated “funnelling” approach used to both narrow the research content area as the researcher “honetd in on ...[the]... specific researchable idea” (Teddlie & Tashakkori, 2009, p. 115) and identified the most relevant research sources and literature related to the “researchable idea” identified in the research content area. See Figure 2.1 for a visual representation of how the funnelling approach was used at this point in the study.
It begins with a review of literature that establishes the significance of the wider field of research within which this study is located relating to effective teaching and effective teachers of mathematics. The reviewed literature is then analysed and compared to identify both areas of interest and gaps in the research.

The identification of areas of interest and research gaps, in turn, informs the direction of the next level of review, which is the development of beginning teachers' mathematical classroom practice as it relates to effective teaching. A review and summary of the literature relating to this area of interest is then provided and further areas of interest and gaps in the literature are identified. This refinement process is continued until the area of interest is specific enough to inform the formulation of the study's research objectives and questions.
It is important to note that, as identified in the previous chapter, the researcher’s reasons for conducting this research are fundamental to how this study is conceptualised. As these reasons are fixed in the researcher’s own experience of developing as a beginning primary school teacher of mathematics, they are the first lens used to determine areas of interest and gaps in the literature selected as being ‘in scope’ for review.

**Effective Teachers and the Teaching of Primary School Mathematics**

In order to establish the educational significance of conducting research into the development of primary school teachers’ mathematical classroom practice, this literature review needed to accomplish three things. Firstly, the educational *bona fides*—the “So what?” of learning about effective teaching and effective teachers—had to be established. Secondly, what was known about what effective mathematics classroom practice is and what effective mathematics teachers do had to be identified. And thirdly, the “So, what’s next?” had to be identified as it would inform the next direction the review would take.

To address these areas, the relevant literature and research needed to be interrogated to identify:

1. What do effective mathematics teachers and teaching influence?
2. What is effective mathematical classroom practice? and
3. How do effective teachers become effective teachers of mathematics i.e., what influences the development of teacher classroom practice?

A diagram of the initial conceptualisation of the broad context in which this study is set (see Figure 2.2) was adapted from the graphical depiction of the research theory that guided the *Investigation of Effective Mathematics Teaching and Learning in Australian Secondary Schools* (DEST, 2004).
Developing a Numerate Population in Australia

In 2000, the Commonwealth Government of Australia’s paper titled *Numeracy, A Priority for All: Challenges for Australian Schools* (Department of Education, Training and Youth Affairs [DETYA], 2000, p. 1) identified numeracy (mathematics) education as a national priority for Australia.

Changing economic realities in the last 15 years...have seen the demand for unskilled labour fall markedly. This has prompted the recognition that high quality basic education reflected in the...workforce is vital for countries like Australia in maintaining national prosperity and social stability. The acquisition by all students of appropriate numeracy skills is now much more crucial than in the past.
With particular reference to primary school education—the education sector the report was targeted at—it also identified that:

In the early years of schooling the development of numeracy skills provides a crucial foundation for the later years to support and enhance future learning at school, in the workplace and in everyday life. (DETYA, 2000, p. 1)

**Linking Students’ Mathematical Achievement to Effective Teaching**

Having established primary school students’ mathematical outcome levels (their achievement) as a national priority for Australian schools, what do we need to do to ensure that students attain the “high standards of mathematical knowledge, skills and understanding...[that are]...essential for...[their]...successful participation in schooling, in work and in everyday life” (DETYA, 2000, Executive Summary, p. v.)? The simple answer to this question is to ensure that students learn mathematics in the classrooms of effective teachers.

There is a plethora of Australian and international research and literature that consistently demonstrates that “high quality teaching is the greatest in-school influence on student engagement and outcomes” across the curriculum in general (Centre for Education Statistics and Evaluation [CESE], 2013, p. 3), and in mathematics (Askew, Brown, Rhodes, Wiliam, & Johnson, 1997a, 1997b; Council of Australian Governments [COAG], 2008; Department of Education, Science & Training [DEST], 2004; DETYA, 2000; Education Queensland [EQ], Queensland Catholic Education Commission [QCEC] & Association of Independent Schools of Queensland [AISQ], 2004; Groves, Mousley, & Forgasz, 2006). Therefore, with particular reference to primary school mathematics, it is imperative that both pre-service primary school teacher education and in-service teacher professional development prepare teachers to become effective teachers of primary mathematics.
Identifying Effective Mathematics Teaching and Teachers

However, before we can develop programs that support teachers to become effective teachers of mathematics, we first need to understand what effective mathematics teaching is and what effective mathematics teachers do.

In response to the widely accepted understanding of the link between student outcomes and teacher practice, since the late 1990s “a significant amount” (Groves, Mousley, & Forgasz, 2006, p. 55) of mathematical research conducted in Australia has focused on primary school teachers’ “classroom activity, with the most common theme being…[the identification of]…characteristics of effective teachers”. When analysing, comparing and synthesising the findings of this significant body of work into the characteristics of effective teachers, it can be seen that there is, in Australia, a “general agreement” about a range of effective “teacher attributes and practices” based on the findings of both Australian and international studies (CESE, 2013, p. 6) into effective teaching (Groves, Mousley, & Forgasz, 2006).

One such study is the Effective Teachers of Numeracy (Askew et al., 1997a). The significance and veracity of this seminal study on effective mathematics teaching at the primary school level is widely acknowledged and it is extensively cited and referenced in contemporary Australian and international research related to the teaching of mathematics.

Indeed, in the Primary Numeracy: A Mapping, Review and Analysis of Australian Research in Numeracy Learning at the Primary School Level (2006) report, that reviewed and summarised 185 research projects and 726 publications related to primary school mathematics, Groves, Mousley, and Forgasz (2006, p. 55) noted that:

In examining a focus on the teacher, one should take note of the influence of the British Effective Teachers of Numeracy study (Askew et al., 1997).
Certainly, the 12 key findings (pp. 3-5) and associated framework for conceptualising the relationship between the beliefs, knowledge and practice of effective primary school mathematics teachers (p. 21) of the Effective Teachers in Numeracy study (Askew et al., 1997a) are widely summarised, adapted, analysed, and/or expanded on, and/or synthesised with, and in, other research findings and literature exploring the characteristics of effective teachers. Some examples of this are included in the studies listed below.

The National Numeracy Review Report (COAG, 2008) reported that the Effective Teachers of Numeracy study (Askew et al., 1997b, as cited in COAG, 2008, p. 29) found effective teachers were most likely to be those who:

- had ‘connectionist’ orientations (as opposed to ‘transmission’ or ‘discovery’ orientations);
- focused on students’ mathematical learning (rather than on provision of pleasant classroom experiences);
- provided a challenging curriculum (rather than a comforting experience); and
- held high expectations of initially low-attaining students.

The Primary Numeracy: A Mapping, Review and Analysis of Australian Research in Numeracy Learning at the Primary School Level reported that the Effective Teachers of Numeracy study (Askew et al., 1997a, as cited in Groves, Mousley, & Forgasz, 2006, p. 57) also identified quality teaching as being that where the teacher:

- instructs and demonstrates, explains and illustrates mathematics;
- sets work in contexts and links it to previous work;
- maximises opportunities to interact with children so that they can talk and be listened to;
- gives feedback that helps children to develop their mathematical knowledge, skills and understanding; and
- allows children to show what they know, explain their thinking and methods, and suggest alternative ways of tackling problems.

The Early Numeracy Research Project (Clarke, Cheeseman, Gervasoni, Gronn, Horne, McDonough, et al., 2002) identified 25 characteristics of effective early numeracy teachers, organised under 10 common themes.
Muir (2008, p. 80) synthesised the work of Askew et al. (1997a) and Clarke et al. (2002) to formulate six “principles of practice” for effective mathematics teachers. The principles are: making connections; challenging all pupils; teaching for conceptual understanding; fostering purposeful discussion; focusing on mathematics; and promoting positive attitudes.

Sullivan (2011, p. 24) synthesised “various lists of recommended practices” about effective teaching from education departments across Australia with the findings of Australian and international research for his six “key principles for effective teaching of mathematics”. These principles are: articulating goals; making connections; fostering engagement; differentiating challenges; structuring lessons; and promoting fluency and transfer.

Perry (2007, p. 271) interviewed Australian primary school teachers “nominated by their professional mathematics teachers’ associations as excellent teachers…[of]…mathematics” about inter alia the characteristics of effective mathematics teachers and effective mathematics lessons. From these interviews, Perry (2007, pp. 280-284) came up with a list of 19 characteristics that reflected the overall consistency between both the lists created independently by participants and their question responses when interviewed. These characteristics included: having a passion for mathematics; having a strong subject and syllabus knowledge of mathematics; knowing the students; having high expectations for student learning; and actively engaging students in mathematics learning.

**Teacher Factors that Influence Effective Classroom Practice**

In their review and synthesis of literature and research related to the teaching of primary mathematics, Groves, Mousley, and Forgasz (2006, p. 110) identified that for effective teaching to occur teachers need “sound mathematical and pedagogical content knowledge” and that appropriate “levels of confidence, and beliefs and attitudes towards mathematics, are also important” influences on a teacher’s capacity to teach mathematics effectively.
However, perhaps the most important legacy of the research and literature related to effective teaching and effective teachers is the widely accepted understanding that effective teaching is not about identifying and using a set of prescribed classroom practices. Indeed, while you could walk into two different classrooms and observe very similar classroom organisation, teaching practices and levels of student engagement, this does not necessarily result in similar net gains in mathematical achievement for students in those two classes.

Rather, what the Effective Teachers of Numeracy study (Askew et al., 1997a, as cited in Groves, Mousley, & Forgasz, 2006, p. 57) found was that:

While classroom practices were influential in children’s success, the teachers’ beliefs and understandings of the mathematical and pedagogical purposes behind those particular classroom practices seemed more important than the forms of practice themselves.

Furthermore, when looking more closely at the beliefs, understandings and classroom practice of effective teachers, it was identified that there existed both:

- a high level of congruence between the characteristics of effective teachers and teaching and the tenets of constructivism (Askew et al., 1997a; COAG, 2008, citing Beswick, 2007; EQ, QCEC, & AISQ, 2004; Muir, 2008); and
- a high level of internal consistency within and between the belief systems and knowledge bases of the effective teacher of primary mathematics (Askew et al., 1997).

In summary, effective teachers of primary mathematics maximise the mathematical outcomes of their students through the enactment of exemplary classroom practice that reflects a high level of commitment to, and understanding of, the tenets of constructivist learning theory. Underpinning the exemplary classroom practice of effective teachers are a coherent collection of beliefs and attitudes, and levels of mathematical confidence, knowledge and skill that enable them to realise their constructivist classroom ideals.
School Factors that Influence Effective Teaching Practice

In addition to teacher factors, the capacity of the teacher to teach is also “directly affected—amplified or muted—by conditions within the school” (DEST, 2004, Executive Summary, p. vii). In particular, the professional community within a school, including the provision of ongoing teacher professional development, are seen as being major influences on the effectiveness of teaching mathematics (Askew, et al., 1997a; CESE, 2013; COAG, 2008; DEST, 2004; DETYA, 2000; EQ, QCEC, & AISQ, 2004; Groves, Mousley, & Forgasz, 2006; Perry, 2007; Sullivan, 2011).

As with the teacher factors identified above, the school factors that influence the capacity of the teacher to teach will be examined in more detail later in the chapter within the specific context of beginning teacher development. However, it is interesting to note that, just as the Effective Teachers of Numeracy study (Askew et al., 1997a) identifies that highly effective teachers have a ‘coherent’ set of beliefs and understandings about mathematics and its teaching and learning, so too does the Investigation of Effective Mathematics Teaching and Learning in Australian Secondary Schools (DEST, 2004) identify the overall ‘coherence’ of a school’s mathematical program as a factor in effective school contexts.

Beginning Teachers’ Development as Teachers of Mathematics

It was at this point in the review process that a gap in the research content area of ‘effective teaching and effective teachers’ was identified. The gap identified was that none of the major research and literature reviewed so far had looked specifically at beginning teachers.

At the most basic level of developmental categorisation, teachers can be described as being either pre-service i.e., not yet qualified to teach, or in-service i.e., qualified practitioners. Beyond this simple dichotomy, a transitional third stage—the beginning teacher—is routinely inserted between the pre-service and experienced stage.
The process of identifying a beginning teacher stage of development that marks the transition from the pre-service stage to the experienced teacher stage is an acknowledgement that as a teacher:

It is not possible to learn, in the first few years of your teaching career, all you will need to know to be an effective teacher for the rest of your professional life. (Marland, 2007, p. 16)

At the same time, the current literature and research about pre-service teachers suggests that, as they make their transition into their teaching careers:

Pre-service teachers' beliefs, levels of self-confidence, and lack of suitable past experiences, act as constraints on their ability to support high-level mathematics learning…[and]…many pre-service teachers feel insufficiently prepared in mathematics content knowledge and pedagogical content knowledge. (Groves, Mousley, & Forgasz, 2006, p. 4)

As such, conducting research into the development of beginning teachers as effective teachers of mathematics (and the factors that support or impede it) is an important area of research.

Therefore, the next step in both establishing the literature and research context in which this study is set, and in identifying beginning teachers as a researchable idea within the effective teachers of primary school mathematics content area, was to look deeper into how beginning teachers developed their beliefs and knowledge about mathematics and its teaching and learning.

It is important at this stage in the review, prior to beginning the examination and discussion on beginning teachers’ development as teachers of mathematics, to provide a clear definition of the assumptions and nomenclature about the nature and acquisition of the teacher factors that influence classroom practice that will be used in this review to conceptualise this study.

It has already been identified in this review that there are a number of teacher factors that make up a teacher’s capacity to teach effective mathematics, and they have been generally categorised into two groups and referred to as teacher ‘beliefs’ and teacher ‘understandings’.
Up to this point, these terms have been used to name the two groups because they were those used in the final report of the *Effective Teachers of Numeracy* study (Askew et al., 1997a), which was identified as being influential to the current research and literature about effective mathematics teaching and teachers. These terms are also routinely used in other literature and research selected for review in this study (see, for example, Askew, et al., 1997a, 1997b; CESE, 2013; COAG, 2008; DEST, 2004; DETYA, 2000; EQ, QCEC, & AISQ, 2004; Ernest, 1989; Grootenboer, 2002, 2003; Groves, Mousley, & Forgasz, 2006; Macnab, 2003; Macnab & Payne, 2000, 2003; Perry, 2007).

However, as the focus of this review is being refined from looking at in-service teachers in general to looking at the development of beginning teachers in particular, it is necessary to select and precisely define the terms used when examining and discussing the experiences of this particular subset of teachers.

In its most basic form, the two categories used so far to describe the teacher factors that affect classroom practice development—beliefs and understandings—represent the affective and cognitive domains of the “thought structures of the teacher” (Ernest, 1989, p. 13). However, at both the ‘domain’ and ‘subdomain’ level, this process of separating, grouping, defining and naming the attributes of the individual domains is recognised as being troublesome as there is a “distinct connection” between the two domains and many of the facets within them are “interrelated” (Grootenboer, 2003, p. 8).

The inherent difficulty in compartmentalising these interrelated facets in often reflected in unclear, changing and/or the interchangeable use of multiple terms to describe what is stored in the minds of individual teachers (Grootenboer, 2003). Therefore, it is important that research studies, reports and other related literature are clear about the terms used and how they are defined.
For the purposes of this study, teacher ‘understandings’ and teacher ‘knowledge’ will be interchangeable and will refer to the teachers’ knowledge bases for teaching mathematics (Ainley & Luntley, 2009; Askew et al., 2007a; Ernest, 1989). This terminology is consistent with the use of these terms in the Effective Teachers of Numeracy study (Askew et al., 1997a, p. 21) from ‘understandings’ in the summary of findings to ‘knowledge’ when naming their “framework for beliefs, knowledge and practice”. It is also consistent with its general use in the work of others in this content area (see, for example, Ernest, 1989; Grootenboer, 2003; Groves, Mousley, & Forgasz, 2006; Macnab, 2003; Macnab & Payne, 2000, 2003; Shulman, 1987).

Similarly, for the purposes of this study, teacher ‘beliefs’ and ‘attitudes’ will represent the affective domain, where ‘beliefs’ are the result of the experiences that teachers have and ‘attitudes’ are the positive or negative feelings they have as a response to these experiences (Grootenboer, 2003).

While teacher attitudes are not specifically mentioned in the Effective Teachers of Numeracy study (Askew, et al., 2007a), they are prevalent in other research and literature related to the mathematical development of teachers in general and pre-service and beginning teachers in particular (Beswick, Watson, & Brown, 2001; Frid, Goos, & Sparrow, 2006; Klein, 2001; Macnab, 2003; Macnab & Payne, 2000, 2003; Sliva & Roddick, 2002; White, Way, Perry, & Southwell, 2006; Wilson, 2012a; Wilson & Thornton, 2006).

Central to the conceptualisation of this study (see Figure 2.3) is a constructivist understanding of learning whereby a teacher’s beliefs, attitudes and knowledge about mathematics are formed as a result of the cumulative effect of their own mathematical experiences that began when they were school students. The importance of experience in the formulation of beliefs, attitudes and knowledge is also widely accepted in the research into teacher development.
(Grootenboer, 2003; Groves, Mousley, & Forgasz, 2006; Haylock, 2001; Marland, 2007; Muir, 2008).

**Four Phases of Teacher Development**

In the context of this study, the examination and discussion of the development of beginning teachers' beliefs and understandings about mathematics will be organised using Marland's (2007) four-phase conceptualisation of the learning to teach process (see Figure 2.3).

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Individual's own experience of mathematics at school Individual's own everyday experience of mathematics</td>
</tr>
<tr>
<td>2.</td>
<td>Pre-service teachers experience new, primarily constructivist, understandings of mathematics Pre-service teachers experience how mathematics is taught in schools via practicum</td>
</tr>
<tr>
<td>3.</td>
<td>Beginning teachers experience initial 'reality shock' of teaching and focus on their own day-to-day survival Beginning teachers move from being teacher-focused to being student-focused as 'reality shock' dissipates</td>
</tr>
<tr>
<td>4.</td>
<td>Established teachers develop their ability to react effectively and immediately to what happens during lessons and in the classroom Established teachers constantly refine their practice through professional development to meet the changing demands of teaching</td>
</tr>
</tbody>
</table>

Teacher classroom practice will reflect the cumulative affect of all these layers of experience, but for beginning teachers in particular, their pre-formal and pre-service experiences (and any inconsistencies between them) will dominate their early practice until they accumulate a critical mass of in-service teaching experiences and incorporate them into their teaching belief systems and knowledge bases.

Conceptualisation diagram is based on the synthesis of Marland’s (2007) learning to teach phases and research and literature that identifies and defines various stages of teacher development (Berliner, 2004; Fuller & Bown, 1975; Gossman, 2008; Katz, 1972; Sparrow & Frid; 2006).
The phases Marland (2007, p. 2) identified are: the pre-formal phase, the pre-service phase, the beginning teacher phase, and the established teacher phase—and they were created specifically for a pre-service teacher audience. As such, they reflect an emphasis on the formulation of beginning teachers' beliefs, attitudes and understandings in the early stages of the teacher development process; an area that has been identified as being worthy of further study and research.

**Phase 1: The Pre-formal Phase**

Prior to beginning formal education studies, pre-service primary school teachers have already formed a set of beliefs, attitudes and knowledge about mathematics and its teaching and learning based on their own experiences as a school student and their everyday experiences of mathematics (Grootenboer, 2003; Haylock, 2001; Macnab & Payne, 2000, 2003; Marland, 2007).

Unfortunately, the nature of this pre-existing knowledge can often be problematic for pre-service teachers on a number of levels. As described by Marland (2007, p. 30):

...the pre-existing knowledge of pre-service teachers is knowledge that has been accumulated over a long period of time...it is well ingrained, largely implicit and exerts a powerful influence over the holder. Moreover, it is durable and not easy to change. At the same time...[this]...knowledge has not been consciously learnt. Rather it is the result of life experiences that are very personal, subjective and unique...[and]...it has not benefited from critical scrutiny or inputs from other sources such as research or a public knowledge base. It is therefore usually naïve and unsophisticated and is often not a reliable base for action.

The impact of this pre-existing knowledge on teacher development is twofold. In the first instance, this knowledge acts to ‘screen’ (Zulich, Bean, & Herrick, 1992, as cited in Marland, 2007, p. 21) or ‘filter’ (Kagan, 1992, as cited in Marland, 2007, p. 21) any new ideas encountered by pre-service teachers in their studies, especially when “those new ideas do not sit comfortably with the [pre-formal] educational views” of the pre-service teacher (Marland, 2007, p. 22).
Secondly, it acts “as a block to professional development” as teachers find it difficult to replace or modify these pre-existing beliefs and knowledge with “more acceptable beliefs and knowledge” about mathematics and its teaching and learning (Marland, 2007, p. 24).

This, in turn, has implications for the development of mathematical classroom practice in that, under the influence of these pre-existing beliefs, attitudes and understandings of mathematics, the initial inclination of the pre-service teacher is to “teach as they were taught” (Marland, 2007, p. 24), in a self-perpetuating cycle.

Grootenboer (2003, p. 4) identified the cyclic nature of this relationship between teachers’ pre-existing knowledge and the subsequent “impact upon their pedagogical practices” (see Figure 2.4). At the same time he noted that, while the cycle had been identified “with some concern” by a number of authors, and that there was “some consensus on the need for it to be broken, there was “less certainty about how it might be done” (p. 4). Concerns about the self-perpetuating legacy of the pre-formal phase of mathematical experiences on the development of the pre-service teacher are amplified by the fact that it plays out against a broader, contextual backdrop of mathematical negativity (Grootenboer, 2003; Haylock, 2001).
It is widely accepted, as it is based on strong research evidence, that many adults in Western societies suffer from mathematical anxiety (Grootenboer, 2003; Haylock, 2001) and that it is a significant issue for many primary school teachers and pre-service primary school teachers (Brady, 2007; Grootenboer, 2003, Haylock, 2001; Wilson, 2012). Haylock (2001, pp. 3-8) identified that mathematical anxiety manifests itself in pre-service primary school teachers as: feelings of anxiety and fear, stupidity and frustration; anxiety related to the expectations of others; anxiety related to teaching and learning styles; the image of mathematics as being difficult; and confusion about the language of mathematics.

As such, while many pre-service teachers may want to change their beliefs about mathematics, the high levels of mathematical anxiety (or low levels of confidence) formed as a result of their pre-formal mathematical experiences may stop them from enacting these changes as primary school teachers of mathematics.

**Phase 2: The Pre-service Phase**

The pre-service phase of learning to teach refers to the time an individual spends completing their formal teaching and education studies to qualify as a classroom teacher. During this time, the focus of the pre-service teacher is on acquiring the beliefs, attitudes and knowledge required to become an effective teacher across all curriculum areas, including mathematics (Marland, 2007).

However, as discussed above, research shows that many pre-service primary school teachers enter their pre-service teaching studies with strong sets of beliefs, attitudes and knowledge about mathematics and its teaching and learning that are not compatible with contemporary views of mathematics, or a constructivist, student-centred learning theory or approach to teaching (Biddulph, 1999; Grootenboer, 2003, Haylock, 2001; Macnab & Payne, 2000, 2003).
The research and literature related to pre-service primary school teachers’ beliefs and attitudes about mathematics shows that many pre-service teachers have a procedural, rule-based view of mathematics as a field of study rather than a connected, conceptual, problem-solving and creative view of mathematics (Ernest, 1989; Macnab & Payne, 2000, 2003; Marland, 2007). This view of mathematics is mirrored by the fact that, in most cases, teachers’ procedural (or computational) knowledge of mathematical content (“understanding the rules and routines of mathematics”) is stronger than their conceptual knowledge (the “understanding of mathematical relationships”) (Forrester & Chinnappan, 2011, p. 263).

Research has also shown that, when tested on the content level of mathematics they are expected to teach, many pre-service and beginning primary school teachers do not achieve very high results (Biddulph, 1999; Forrester & Chinnappan, 2011; Masters, 2009; Mewborn, 2001; Morris, 2001; Ryan & McCrae, 2006; Sullivan, Siemon, Virgona, & Lasso, 2002; White, Way, Perry, & Southwell, 2006). Pre-service primary school teachers at the beginning of their teaching studies are also more likely to have a ‘transmission’ or ‘discovery’ orientation towards teaching mathematics rather than the more powerful ‘connectionist’ orientation (Askew, et al., 1997a, 1997b; Ernest, 1989; Marland, 2007).

Therefore, teacher education programs responsible for the mathematical development and education of pre-service primary school teachers have a lot of ground to cover to support their students in developing the beliefs, attitudes and knowledge they need to be effective teachers of mathematics at the completion of their formal studies.

Considering both the short period of time that pre-service primary school teachers actually spend learning to teach in this phase and the limited amount of mathematics-specific subjects found in generalist teaching courses, research shows that pre-service teacher education programs do make significant and positive changes to the
mathematical beliefs, attitudes and knowledge of pre-service teachers during this time (Grootenboer, 2003; Macnab & Payne, 2000, 2003; Wilson; 2012).

In their study of pre-service primary school teachers, where 71% of all final year pre-service primary students in Scotland responded to their survey administered in 2000, Macnab and Payne (2003, p.64) reported that about two-thirds of respondents thought that their “understanding of, confidence in, liking for and enthusiasm for mathematics had changed for the better as a result of their course” (Macnab & Payne, 2003, p. 64). Similarly, in his investigations of the affective development of pre-service primary school teachers’ in mathematics, Grootenboer (2002, 2003) found that the negative responses they had to mathematics at the beginning of their studies “were significantly and positively changed” through the course of their studies (2003, p. 179).

It is also interesting to note the reported effect that the school-based practicum experience had on the development of pre-service primary school teachers’ mathematical beliefs, attitudes and knowledge in these two studies. In the Macnab and Payne (2003) study it was reported that, between the first year and final year pre-service student cohorts, pre-service teachers' view of mathematics changed from a “constructivist-oriented view of learning mathematics towards a more traditional transmission-oriented view”. It was as if they “had to ‘come down to earth’, and adapt their idealism to…their experiences of the realities of classroom teaching and learning (p. 65).

Grootenboer (2003, pp. 179-180) found that while approximately half of the participants in his study maintained their more positive attitude to mathematics throughout their practicum experience, the other half “reverted somewhat to the views and feelings they held prior to commencing their tertiary course in mathematics education”.

30
He also noted that:

The participants whose views remained relatively positive had a practicum experience that reinforced the affective views developed on the course. However, the participants whose views reverted towards their initial views had a practicum experience that was in many respects similar to their recollections of their own schooling in mathematics. (2003, pp.179-180)

As such, the quality of the practicum experience is a critically important component of pre-service teacher training, a view that is echoed in contemporary research and literature (CESE, 2012; Darling-Hammond, 2006; Grootenboer, 2003, 2005/6; Nyaumwe, 2004). This research and literature also notes that “weak links to theory” and the quality of supervision can affect the overall efficacy of the practicum experience for teacher development and that the practicum “must be tightly aligned with coursework and should be carefully supervised by effective teachers” (CESE, 2012, p. 13).

In summary, the review of the literature and research related specifically to the development of pre-service primary school teachers as teachers of mathematics found that:

- while teacher education courses ‘challenge’ the “durable and powerful”, “personal and highly subjective” theories that pre-service teachers have when they commence their formal study (Marland, 2007, pp. 27-28);
- the cognitive and affective dissonance this causes in the mathematical beliefs, attitudes and understandings of pre-service teachers is not always resolved appropriately at the completion of their study (Brady, 2007; Grootenboer, 2003; Haylock, 2007; Macnab, 2003; Macnab & Payne, 2000, 2003); and subsequently
- act as constraints on their ability to support high-level mathematics learning in the primary school classroom as beginning teachers (Groves, Mousley, & Forgasz, 2006; Macnab, 2003; Macnab & Payne, 2000, 2003).
Phase 3: The Beginning Teacher Phase

Once pre-service teachers make the transition to beginning teachers, their beliefs and attitudes about mathematics teaching and learning (formed initially as a result of their own experience of maths at school and then by their pre-service training experience) will be further challenged by their initial teaching experiences and be either reinforced and/or changed by them as a result (Frid & Sparrow, 2007; Sparrow & Frid, 2001, 2002, 2006).

As the continuum in Figure 2.5 shows, the early development of beginning teachers as they transition into their teaching careers follows a fairly predictable course. This course can be characterised by a shift in the focus of the teacher from meeting their own, normally short-term needs (being teacher-centred) to meeting the individual needs of students (being student-centred) (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Sparrow & Frid, 2001, 2002, 2006).

![Figure 2.5: Beginning Teacher Mathematical Development Continuum](image)

**Figure 2.5: Beginning Teacher Mathematical Development Continuum**

<table>
<thead>
<tr>
<th>Self</th>
<th>Teaching</th>
<th>Learning</th>
<th>Students</th>
</tr>
</thead>
</table>
| Self | Teachers focus primarily on themselves and/or their own needs.  
*Teacher's priority* = classroom control. |  |  |
| Teaching | Teachers focus on how and what they are teaching in the classroom.  
*Teacher's priority* = curriculum coverage. |  |  |
| Learning | Teachers focus on learning, or who they are teaching, as students start to gain equal importance as the teacher/teaching.  
*Teacher's priority* = pedagogical power to teach mixed ability classes. |  |  |
| Students | Teachers focus primarily on students as individual learners as opposed to a more homogenous collective.  
*Teacher's priority* = assessing and meeting the individual needs of students. |  |  |

Continuum is based on the seminal works of Katz (1972) and Fuller (1969), Fuller, Parsons, and Watkins (1974) and Fuller and Bown (1975) that underpin our understandings of the developmental stages of teachers as they transition into their teaching careers and the work of Sparrow and Frid (2006) who looked specifically at the mathematical development of beginning primary-school teachers in their first year of teaching.
At the very beginning of their teaching career, teachers experience a ‘reality shock’ when first given sole responsibility for managing the day-to-day operation of a classroom of students (Fuller & Bown, 1975; Katz, 1972; Sparrow & Frid, 2006). The focus of the teacher at this time is on quickly establishing themselves with others (parents, teachers and school leaders) as a ‘good’ teacher who can successfully control the classroom and produce a teaching program that reflects appropriate curriculum coverage (Sparrow & Frid, 2006).

To do this, beginning teachers initially teach in ways that are at odds with what they believe, or say they believe, about teaching mathematics (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006). Instead of using a constructivist, student-centred approach in the classroom, they use traditional and teacher-directed pedagogy. Lesson content is focused on teaching facts and procedures and then quickly moving on to the next lesson, textbook page or topic area. In this classroom, student participation is often limited to working independently from textbooks, worksheets or blackline masters (Sparrow & Frid, 2006).

As a result, an observer (the ‘other’) of their classroom would see a very traditional version of a ‘good’ teacher in action. The classroom would be a quiet, orderly space where all students were working busily and the teaching program would reflect that all syllabus topics would be covered over the year (Sparrow & Frid, 2006).

The use of these more traditional approaches to teaching also have the added bonus of minimising the time beginning teachers need to plan, prepare, deliver and assess the mathematics teaching program. This is an important factor for beginning teachers at a time when finding a healthy work-life balance is a significant challenge for them (Sparrow & Frid, 2006). In this scenario, the “durable and powerful” traditional and teacher-centred theories (Marland, 2007, pp. 27-28) about teaching mathematics that many beginning teachers are still ambivalent about after completing their formal study are initially reinforced by the first year experience.
Added to this is the understanding that the longer the beginning teachers rely on, and is validated for using, these traditional, teacher-centred approaches, the more likely they will become a permanent, and unchallenged, feature of their classroom practice (Sparrow & Frid, 2006).

The findings of extant national and international research and literature also suggest that these inconsistencies between traditional and constructivist beliefs are not always resolved quickly, appropriately or indeed at all in the first year of teaching (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Macnab, 2003; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006). Furthermore, how these inconsistencies are dealt with will, to a large degree, determine how quickly beginning teachers progress through the various stages of teacher development and how effective their classroom practice is at the ‘end’ of the process (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006).

Certainly at this point in their development, beginning primary school teachers seem to lack the “particular set of coherent beliefs and understandings” underpinning their mathematics teaching that the Effective Teachers of Numeracy study identified as being the thing that “distinguished highly effective teachers from other teachers” (Askew, et al., 2007a, p. 3).

However, ‘reality shock’ does not last forever and studies that extend past the first year of teaching show that the classroom practice of beginning teachers are more likely to reflect the constructivist beliefs and knowledge that are linked directly to their pre-service training and complementary professional behaviours beyond that of the basic classroom survival of first year (Brady, 2012; Frid & Sparrow, 2007; Grossman, Valencia, Evans, Thompson, Martin, & Place, 2000; Grudnoff & Tuck, 2002). Therefore, it is important that research into the development of mathematical classroom practice extends past the first year of teaching so we can better understand the entirety of
the journey that an individual makes from beginning to established teacher.

The need to document and investigate the development of beginning primary school teachers as effective teachers of mathematics beyond the first year of teaching has a number of implications for future research. As most educational research is generated by the tertiary sector, although research is conducted on beginning primary school teachers, the focus of the research recommendations is more often than not on how to improve pre-service mathematics teacher education to better equip students to make successful transitions into their teaching careers. This is unsurprising given that most researchers are also lecturers within the teacher education sector and/or work for university research centres and/or are post-graduate students within this sector. As such, not only is the effectiveness of teacher education courses their occupational priority, it is also the sphere where they have the most influence as opposed to the school sector where beginning teachers move on to.

Similarly, research conducted by tertiary sector researchers on beginning teachers often has fewer participants compared to research conducted on pre-service teachers (Brady, 2012; Frid & Sparrow, 2007; Macnab, 2003; Sparrow & Frid, 2001, 2002, 2006). Obviously, tertiary sector researchers have access to large cohorts of pre-service teachers who are geographically co-located with each other and the researcher. However, at the completion of their studies, continuing access to these participants can be problematic. Graduates move away and change contact details, they may be employed within a range of different education systems and sectors and be difficult to contact, some will not enter the teaching profession at all while others will not receive permanent teaching appointments straight away. Beginning teachers may also not be willing to participate in research on top of the demands of their new teaching careers.
As a result, researchers like Sparrow and Frid (2001, 2002, 2006) who tracked the mathematical development of four beginning primary school teachers in one study and then eight as part of a complementary study (2007), and Macnab (2003) who followed up his 2000 Scottish pre-service teacher national survey with a smaller survey of 25 second year beginning teachers, acknowledge that these smaller samples are “not fully representative” of the total populations of beginning teachers and “that their views and practices cannot be generalised to the larger group” (Frid & Sparrow, 2007).

However, what this smaller-scale research does is to contribute to the larger body of work about the development of beginning teachers as teachers of mathematics that allows for cross-study comparisons of findings, themes and issues to be made and used validly in the presentation of findings and discussions of results. Therefore, it is important that this type of research continues.

**Phase 4: The Established Teacher Phase**

In Marland’s (2007, p. 16) four-phase model of the learning to teach process, the established teacher phase is the years of a teacher’s career that occur after they are no longer considered to be a beginning teacher. Also according to Marland (2007), the focus of teachers in this phase of the learning to teach process is to “regularly update their professional knowledge and practices…[to]…retain their relevance and standing as credible professionals” (p. 17) in the face of “the ever present reality of change…in modern societies” (p. 16).

This link between the established teacher and an ongoing commitment to professional development is echoed in other research and literature related to effective teachers of mathematics. This research suggests that participation in this type of professional development increases both the mathematical subject and pedagogical knowledge of teachers (Askew et al., 2007a; CESE, 2013; COAG, 2008; DEST, 2004; EQ, QCEC, & AISQ, 2004; Gossman, 2008; Groves, Mousley, & Forgasz, 2006).
As well as being “much more likely...to have undertaken mathematics-specific continuing professional development over an extended period” of time (Askew et al., 2007a, p. 5), highly effective mathematics teachers are also more able to “respond effectively to what happens...minute by minute in the classroom” (Ainley & Luntley, 2009, p. 1). Ainley and Luntley (2009) define the ability of experienced teachers to pay attention to the “cognitive and affective aspects of pupil activity” during a lesson as “attention-based knowledge” (p. 2) and identify it as a third type of knowledge for teaching that effective teachers possess.

So, in addition to having high levels of both mathematical subject knowledge and pedagogical knowledge, effective teachers will also demonstrate high levels of knowledge about students’ cognitive and affective learning as it is happening and can respond immediately and appropriately (almost intuitively) to it (Ainley & Luntley, 2009; Askew et al., 2007a; Berliner, 2004; Gossman, 2008). But how do effective teachers acquire this attention-based knowledge? How do they become expert/experienced teachers?

When defining an experienced teacher, Ainley and Luntley (2009, p. 1) make clear the fact that they “mean those who have developed their expertise through experience...[and not by]...simply counting years in the classroom”. Clearly, years of service are no guarantee that a teacher will reach an expert level, especially if their beliefs and understandings about mathematics teaching and learning are still not closely aligned with those needed to enact recognised best teaching and mathematical practice.

However, time does play its part in reaching this level of teacher development. It takes a certain amount of experiences for a teacher to be “no longer surprised by what happens to them in their schools and classrooms” (Berliner, 2004, p. 14) and to have a bank of knowledge to draw on when having to adapt to an unplanned learning situation (Ainley & Luntley, 2009; Berliner, 2004; Gossman, 2008).
As identified by Berliner (2004, p. 14), “certainly experience alone will not make a teacher an expert, but it is likely that almost every expert pedagogue has had extensive classroom experience”.

Berliner (2004, p.14) also identified that five to seven years is a “reasonable answer to the question of how long it takes to acquire high levels of skill as a teacher”. In making this determination, Berliner (2004) draws on a few sources. Firstly, he cites anecdotal evidence from teachers in the United States that “informs us it takes 3-5 years” (p.14) until there is a “lack of surprise in…[the]…work environment…[that]…may be thought of as the achievement of competence in ones work”.

Berliner then refers to the findings of two 1995 PhD studies. The first study, by Lopez (1995, as cited in Berliner, 2004, p. 14) of Texas, examined standardised test data from 100,000 students of 6,000 teachers and found that “for beginning teachers the scores of their students were higher every year during the first seven years of their teaching”, and then stayed at roughly the same level for the next 17 years. The second study, by Turner (1995, as cited in Berliner, 2004, p. 14) of Australia, examined exemplary secondary school teachers and found that “non-exemplary experienced teachers claimed it took them 2.5 years to learn to teach…[while]…exemplary teachers thought it took them almost twice that long, 4.5 years”.

As such, it is also important that we investigate and identify both the personal teacher factors and school factors that support, or alternatively impede, teachers' development as highly effective teachers of primary mathematics and not merely experienced teachers.

**Teacher Factors and the Development of Beginning Teacher Classroom Practice**

The preceding discussion and investigation of the developmental journey that primary school teachers take when learning to teach mathematics has provided another level of context for this study and
identified further areas of interest and gaps in the research content area to help guide the direction of this study.

We know from the review of extant literature and research relating to effective teachers of mathematics that a teacher’s capacity to teach is determined primarily by their mathematical and teaching beliefs, attitudes, understandings and knowledge. We also know that in effective teachers of mathematics these beliefs and understandings are coherent both within and between the cognitive and affective domains, and are closely aligned to both the constructivist theory of learning and a connectionist approach to mathematics and its teaching.

Teachers’ beliefs and understandings are formulated as a result of the experiences they have had of mathematics and its teaching and learning—as a school student, a pre-service teacher, and as a beginning teacher becoming an established teacher. We also know that a teacher’s classroom practice will reflect the cumulative effect of all these layers of experience. However, for beginning teachers in particular, their pre-formal and pre-service experiences (and any inconsistencies between them) will dominate the development of their early practice until they accumulate a critical mass of in-service teaching experiences that they can incorporate appropriately into their teaching belief systems and knowledge bases.

This is an issue of some concern as research also shows that many pre-service primary school teachers begin their formal education studies with mathematical belief systems and knowledge bases that were formed as a result of negative and/or anachronistic mathematical experiences in the pre-formal phase of learning.

Because of the “durable and powerful” (Marland, 2007, p. 26) nature of beliefs and understandings formed prior to commencing study as a pre-service teacher, changing the mathematical belief systems and improving the mathematical knowledge bases of beginning teachers is often a long and slow process. Therefore, longitudinal research into the development of beginning teachers as effective teachers of
mathematics that focuses on tracking beliefs and attitudes and their
effect on classroom practice is an area worthy of further study.

One well-documented effect of the cognitive and affective
dissonance experienced by many beginning teachers on their
classroom practice is that it often manifests in observed
inconsistencies between what teachers say they believe and do
when teaching mathematics and what they actually do in the
classroom (Frid & Sparrow, 2007; Raymond, 1997; Sparrow & Frid,
2001, 2002, 2006). As such, it is important that research conducted
in this area does not rely solely on the self-reports of teachers but
also incorporates external measures of data validation such as
mathematical testing and direct observation of classroom practice.

**School Factors and the Development of Beginning Teacher
Classroom Practice**

As outlined earlier in this chapter, in addition to teacher factors, the
capacity of the teacher to teach is also “directly affected—amplified
or muted—by conditions within the school” (DEST, 2004, Executive
Summary, p. vii). This means that factors of school context can either
work with teachers to enable them to develop the belief systems and
knowledge bases required to become an effective teacher of
mathematics or they can constrain them.

In this study, the effect of school context on the development of
beginning teachers as effective teachers of mathematics has been
conceptualised as the relationship between three elements of school
context: the professional community within the school; the school’s
organisation of mathematics; and specific beginning teacher support
(see Figure 2.6).

The term professional community refers to the “collegial relationships
that exist between teachers within a school” (DEST, 2004, p. 16).
Schools with an “active, accountable, professional community” have
an important influence on developing teacher effectiveness and high
quality teaching (DEST, 2004, p. 16).
Similarly, the *Effective Teachers in Numeracy* study (Askew et al., 1997a, p. 100) identified that teachers without a connectionist orientation to teaching mathematics, who came to work at schools with a “clear connectionist philosophy” towards teaching mathematics, showed a change in their orientation over time. The study also identified that these schools provided opportunities for highly effective teachers of mathematics to work closely with other teachers when planning and evaluating mathematics teaching and working with them in the classroom (Askew et al., 1997a).
In light of the fact that we know that beginning teachers look initially to their more experienced colleagues for support and guidance on how to teach and be a ‘good’ teacher, having access to colleagues who model beliefs and pedagogy consistent with constructivism rather than more traditional approaches to teaching mathematics is important to their development as effective teachers of mathematics.

The school’s organisation of mathematics refers to other school-wide factors that can influence what is taught and how it is taught in classrooms. Factors can include setting specific times for teaching mathematics, streaming classes across year groups, the mandatory use of textbook-based commercial programs, or particular pedagogical practices, and the type and amount of resources available for use in the classroom (DEST, 2004).

Beginning teacher support refers to the range of experiences that a beginning teacher can have during the course of their professional ‘socialisation’ into the world of teaching. These experiences are usually designed to assist individuals to develop their identities as teachers in general but can focus on their identity as teachers of mathematics in particular (Atweh & Heirdsfield, 2003; Eisenschmidt & Poom-Valickis, 2003; Moss & White, 2003; Pietsch & Williamson, 2007, 2009; Wang, Odell, & Schwille, 2008).

The experiences can be formal or informal, structured or unstructured, planned or incidental, in-school or ex-school, individual or collaborative, imposed or self-initiated, pedagogy-focused or content-focused (Australian Association of Mathematics Teachers [AAMT], 1995; Beck, Kosnik, & Roswell, 2007; Ginns, Heirdsfield, Atweh, & Watters, 1997; Hudson & Beutel, 2007).

The use of induction and mentoring programs within schools and school districts is a common method of supporting beginning teachers in their transition into the teaching profession (DEST, 2006; Eisenschmidt & Poom-Valickis, 2003; Pietsch & Williamson, 2007). However, research shows that the mere existence of a support program for beginning teachers does not necessarily presuppose
that there will be universal access to it (DEST, 2006b; Pietsch & Williamson, 2007) or that it will be effective in meeting the individual needs of the beginning teacher (DEST, 2006b; Eisenschmidt & Poom-Valickis, 2003; Pietsch & Williamson, 2007). The competence, and confidence, level of the individual beginning teacher and the personalities of both the beginning teacher and the mentor may also be major factors in how induction and mentoring programs are structured and/or experienced.

Indeed, the earlier a beginning teacher acquires a clear concept of themselves as a teacher the quicker they will progress through the initial ‘survival’ stage of teacher development (Eisenschmidt & Poom-Valickis, 2003; Fuller, 1969; Katz, 1972). This rate of progress will affect the type and frequency of support that an individual needs from their induction and mentoring support programs.

If there is a mismatch between the needs of the individual beginning teacher and the support provided to them then the program will not be a worthwhile experience. Similarly, if there is a mismatch between the personalities involved in mentoring relationships where mentors are ‘assigned’ by the school, then the program will have limited success in providing support to the beginning teacher.

So, while each of these elements of school context has the potential to support teachers to develop as effective teachers of mathematics, national and international research has also shown that ‘program coherence’, a “measure of integration of the different elements in the school as an organisation” (DEST, 2004, p. 15) is an important factor in supporting teacher development as effective teachers of mathematics (DEST, 2004; Newmann, King, & Youngs, 2000; Newmann et al., 2001).

For beginning teachers in particular, having ongoing access to a range of quality professional development opportunities and experiences at their school is vital for their development as effective teachers of mathematics. These opportunities will form the next layer of experience that will enable them to develop the coherent belief
systems and knowledge bases required to become an effective teacher of mathematics.

**The Research Objectives of This Study**

We know from this review of international and Australian research into effective mathematics teaching that what teachers do in the classroom is the most important factor in determining the quality of student learning in mathematics. We also know that the development of effective classroom practice is influenced by both the teachers’ own beliefs and understandings about mathematics education and the school context in which they operate.

At the same time, however, research into beginning teachers has found that many pre-service primary school teachers, prior to beginning their teaching career, believe that the teaching of mathematics in particular is an area that is “difficult and worrying…in relation to other curricular areas” (Macnab & Payne, 2003) and one that they feel “poorly prepared” for after completing their pre-service training (Lang, 2002).

Given that many beginning primary school teachers begin their teaching careers with these unresolved tensions and anxieties about mathematics, it is vital that we understand what experiences change, or don’t change, these beliefs, attitudes and understandings in the initial years of teaching based on the first year experience and the school context in which it occurs and what affect this has on the subsequent development of classroom teaching practice.

In conducting research into this area it is important that it extends past the first year of teaching as the findings of the few longitudinal studies that do so indicate that it is often not until the second year of teaching that beginning teachers are more likely to display both pedagogical tools that are linked directly to their pre-service training (Grossman, Valencia, Evans, Thompson, Martin, & Place, 2000) and professional behaviours beyond that of the basic classroom survival of first year (Grudnoff & Tuck, 2002).
It is also important that this research incorporates direct observations of classroom practice and external measures of content knowledge; and focuses on known areas of inconsistency and tension within and between beginning teachers’ mathematical beliefs, attitudes, understandings and classroom practice.

As such, this study will record beginning primary school teachers’ beliefs, attitudes and understandings about mathematics teaching and learning from their final year of university into their first three years of their teaching careers, as well as identify a range of teacher and school factors that influence the development of beginning teachers’ classroom practice and their underlying beliefs of teaching and learning primary mathematics.

The Research Questions

To achieve the research objectives of this study, four specific research questions were formulated (see Box 2.1) to drive a longitudinal investigation into the development of beginning primary school teachers as effective teachers of mathematics as they transition into their teaching careers.

The first two questions were designed to collect data on teacher beliefs and attitudes about mathematics teaching and learning at two specific and significant points in their learning to teach journey: at the end of the pre-service phase, and the end of the initial survival stage of the beginning teacher phase. Once collected, this data could be analysed and add to our understandings of how teacher beliefs and understandings are affected by their initial teaching experiences and the role of the school context in the transition-related change process.
The third question is designed to look deeper into the “interplay and relationships between...[teacher]...beliefs, knowledge and classroom practices” (Askew et al., 1997, p. 22) and extend our understandings of how various teacher beliefs and types of knowledge affect classroom practices and the implications this has for the development of the teacher as an effective teacher of primary school mathematics.

The fourth question is designed to collect data on the types (and effects of) support that schools can provide to beginning teachers to ensure that they move through the initial ‘survival’ stage of the beginning teacher transition phase quickly, and are displaying the characteristics of effective teachers of mathematics as they move towards becoming established teachers.
Conclusion

The chapter identified and described the research and literature context in which this study is set, and the process that was taken by the researcher to establish this context, through the conduct of a literature review of the extant body of Australian, international, contemporary and seminal research related to beginning primary school teachers’ development as effective teachers of mathematics.

Once identified, the relevant research and literature were reviewed and then summarised, compared, analysed and synthesised to identify both areas of interest and gaps in the research area. This, in turn, informed the formulation of the study’s research objectives and research questions.

The process of creating the mixed methods research design and describing the methodological and analytical frameworks that were used to answer the research questions and achieve the research objectives are described in the next chapter, The Research Design.
Chapter 3: The Research Design

Introduction

This purpose of this chapter is to present and explain the development of the mixed methods research design used in this study. It will also describe the methodological and analytical frameworks of the research design. This description will include identifying the timeline and stages of the research; outlining the sample design and data collection tools used at each stage of the study; and explaining the three-step process that underpinned the analysis of all data collected during the course of the study.

The Mixed Methods Research Design

This is a mixed method, longitudinal study that is primarily concerned with investigating the social, or lived, reality of beginning primary school teachers in the first years of their teaching career. The research design (as shown in Figure 3.1) satisfies the assumptions and conventions of the mixed methods research paradigm and demonstrates an understanding of, and commitment to, the principles of internal and external research validity and the broader ethical considerations of social research (Bailey, 2007; Gilbert, 2008; Onwuegbuzie & Johnson, 2006; Onwuegbuzie & Leech, 2006; Punch, 1999; Richards & Morse, 2007; Teddlie & Tashakkori, 2009).

The Rationale for Using a Mixed Methods Research Design

When developing a research design, Cohen, Manion, & Morrison (2008) advise that “‘fitness for purpose’ must be the [researcher’s] guiding principle” (p. 3) when selecting the research paradigm and associated methods, processes, timelines and tools to be used in the study. Only then can the researcher be confident that the data collected and analysed during the course of the study will address the issues identified in the original research objectives and/or questions (Johnson & Onwuegbuzie, 2009; Johnson, Onwuegbuzie, & Turner, 2009; Teddlie & Tashakkori, 2006).
Figure 3.1: The Research Design

Methodological Framework

Sample
- Preservice Teachers
  - n₁=200
  - Final year primary education students from 3 universities
  - Simple random sampling

Data Collection Tools
- 8-question survey:
  - Likert scales
  - Object ranking
  - 4-point value scales
  - Open response

Data Type
- QUAN + qual

Beginning Teachers
- n₂=10 (nested in n₁ sample)
  - Fulltime teachers in primary schools
  - Convenience and criterion non-random sampling

Stage 1 – Data Reduction and Display
- Quantitative and qualitative data is reduced
  - Descriptive statistics, exploratory factor analysis, coding, categorising, labelling
  - Displayed (tables, graphs, theme boxes, matrices, sociograms, narrative profiles)

Stage 2 – Data Comparison
- Data from different sources within the study are constantly compared across and within temporal, method and case boundaries, and are also compared to data reported in extant research and literature to identify, verify and describe themes and findings.

Stage 3 – Data Integration
- All data is integrated into a coherent whole that addresses the research question/s.

Research Questions

1. Can we use these understandings of the links between teacher beliefs, attitudes and practice to construct a model that allows a range of educational stakeholders to provide more targeted and effective support for beginning primary teachers to develop as effective teachers of mathematics?

2. To what extent is a beginning primary school teacher's classroom practice an artefact of their beliefs and attitudes formed as a result of their experiences as:
   - a school student;
   - a preservice teacher;
   - a beginning teacher;
   - a teacher within a particular school context;
   - part of developing an individual teacher identity?

3. How do factors of school context and the first year experience reinforce and/or change beginning primary school teachers' pre-existing beliefs and attitudes about teaching and learning mathematics?

4. How do individuals' experiences of mathematics as a school student and as a preservice teacher influence their beliefs and attitudes about mathematical teaching and learning on the eve of their transition into the primary school classroom?
In the context of this study, this meant developing a research design that would allow valid data, collected from the same participants over a number of years, to be used to create descriptive and reliable profiles and narratives about beginning primary school teachers and their mathematical journeys.

At the beginning of this study, prospective participants would be final year university students. However, to be eligible to continue in the study after they finished their pre-service education, participants would not only have to be willing, they would also have to be employed full-time as a teacher and be contactable and easily accessible by the researcher at a point in their lives where many would be moving away from their university location.

Even if they did meet all these requirements and continued in the study, there was no guarantee that participant eligibility and/or willingness, or indeed easy access to the participant, would remain constant over the entire research timeline. Therefore, to ensure that a statistically viable sample was available to participate in the latter stages of the research study it was imperative that there was a large sample size at the initial stage of the research. The implications of the extremes in sample size generated by the longitudinal nature of the study were best countered by applying a mixed methods research design.

By incorporating both quantitative and qualitative data collection tools in this study, this research design satisfied the principles of internal and external research validity, and, in turn, the “extent to which the researcher could generalize their findings” at the conclusion of the research (Onwuegbuzie & Collins, 2007, p. 281).

The Methodological Framework

The methodological framework of the research design (as shown in Box 3.1) was comprised of the following three research components: the longitudinal stages of the research; the sample design; and the data collection tools employed in the study. Detailed explanations of
each of these components and how they contributed to the overall validity of this research are provided below.

The Longitudinal Stages of the Research

Stage 1: Pre-service Teacher Survey (2005)

The initial stage of data collection was the administration of an 8-question survey to 200 pre-service teachers in their final year of study at three Australian universities. Using a survey meant that participants could respond to the questions anonymously and in isolation from the researcher, their peers and their lecturers who may have influenced and/or inhibited their responses. Data could also be collected from a large sample of participants in a short amount of time by a lone researcher.

Broadly speaking, the purpose of the Student Teacher Survey (Appendix C) was to collect data on the beliefs, perceptions and attitudes of final year pre-service primary teachers about mathematics teaching and learning prior to the commencement of their teaching careers. Participants were asked to rate, rank and respond to statements and questions using a variety of scales with one open-response question being asked at the end of the survey.

Of the 200 participants who completed the initial survey, 101 were prepared to complete another survey in 12 months' time and provided their names and current contact details to the researcher.

Stage 2: Beginning Teacher Survey and Interview (2006/2007)

The next stage of data collection was the administration of a second survey to, and then later participation in an interview with, beginning teachers working on either a permanent full-time or long-term contract basis in 2006. This target group was selected as they were responsible for planning, implementing and assessing a full year primary mathematics program and were also immersed in a single school culture during that period.
Participants who completed the initial survey in 2005 and provided their names and contact details to the researcher at that time were contacted in 2006 to determine their willingness and eligibility to complete the second survey. From the initial pool of 101 potential participants, some were unable to be contacted as their contact details were no longer current, some did not reply to emails sent or phone messages left and others did not meet the work status requirements. As a result, surveys were sent to 30 potential participants; 10 of these participants returned completed surveys to the researcher and agreed to participate in an interview to be conducted in the following year.

In the Teacher Survey (see Appendix D), participants were asked to provide general demographic information about their school and identify factors of system-wide and school level organisation, programs and professional development that made up their first year experience. They were then required to reflect on their experience of teaching mathematics in the primary classroom as a first year teacher to see what, if any, effect this had on their pre-service understandings about teaching mathematics.

As with the initial survey, this survey provided baseline descriptive data from which a general profile of the first year experience could be developed for comparison with the findings of other national and international research. It also provided further information for use in building the in-depth individual teacher profiles used in the latter stages of the research and in identifying areas for discussion in the next stage of the data collection process.

In the semi-structured beginning teacher interviews, participants were re-asked questions from the initial survey and were then asked to compare and comment on the similarities and differences of their current responses to those they made as pre-service teachers. They were then shown their surveys and asked to clarify information, comment on the researcher’s interpretation of the survey data, and discuss the themes that were emerging from the data analysis.
Finally, participants were asked to reflect on their overall experience as beginning teachers and their ongoing development as teachers of mathematics and to identify what support beginning teachers need to assist them in this development.

As such, the purpose of the interviews was to: collect new data; check the researcher’s initial analysis of the existing data; generate participant meanings about the data and the research objectives; and identify new interpretations of the data not considered by the researcher.

Interviews were held at the participants’ schools and took between 30 to 60 minutes to complete. They were audio-taped to preserve the primary source of data for ongoing data analysis and to allow the researcher to participate naturally in the face-to-face interaction (Cohen, Manion, & Morrison, 2008; Hammersley & Atkinson, 1997).


As part of the final stage of the research design, five participants were selected to be individual case study subjects. Of these five participants, three were willing to be involved in additional data collection to produce extended individual case stories.

Prior to accepting the opportunity to continue with the research project, participants were advised that they would be required to complete a Year 6 commercial maths test, allow the researcher to observe their mathematics teaching, and participate in further interviews and discussions relating to the analysis of the data.

The purpose of administering a mathematics test to participants at this stage of the study was to collect further data on teachers’ conceptual understanding of primary mathematics. While the issue of conceptual understanding of mathematics had featured in the data collected from participants via the surveys and interviews, the test provided live, first-hand data that was generated from an alternative source.
In addition to completing the mathematics test, participants’ mathematics teaching was also observed by the researcher to develop the individual in-depth case studies. Each participant was asked to allow the researcher access to observe two mathematics lessons in a sequence of lessons covering the same mathematical content area. In addition to having their teaching observed, participants were also asked to provide an interview opportunity post-observation to discuss what had been observed with the researcher.

In the context of this study, the classroom observations provide a ‘reality check’ of the data already collected from participants about their mathematical classroom practice; sometimes “what people do may differ from what they say they do” (Cohen, Manion, & Morrison, 2008, p. 396). Observations also allowed the researcher, as an external agent, to “look afresh at everyday behaviour” that the participants may have either “taken for granted, expected or gone unnoticed” (Cohen, Manion, & Morrison, 2008, p. 396) and therefore not been collected as part of the existing data generated through participant accounts.

The data collected from the mathematics test and classroom observations were then used in conjunction with the individual participants’ survey and interview data to build a profile of their development as teachers of primary mathematics over the first three years of their teaching careers.

**The Sample Design**

The sample design of a study details the decisions that underpin the ‘who’ and the ‘how’ (sample scheme) and the ‘how many’ (sample size) aspects of the recruitment and selection of research participants and has major implications for the “extent to which researchers can generalize their findings” at the conclusion of their research (Onwuegbuzie & Collins, 2007, p. 281).

Over the course of this study, three different non-random sample schemes were employed: purposive convenience sampling;
purposive convenience and criterion sampling; and purposive convenience extreme and opportunistic sampling. More details about the selection of these sample schemes are reported below.

**Stage 1: Purposive Convenience Sampling**

A purposive (or non-random) convenience sampling scheme was used to identify and recruit the 200 pre-service primary school teachers who completed the initial survey and who subsequently became the participant pool for the next stages of the study. The decision to use purposive convenience sampling for this survey was based on the following considerations:

- the difficulties associated with conducting simple, random sampling;
- the appropriateness of using known contacts and geographic factors to select the sites where the survey was to be administered; and
- the recommended minimum sample sizes required to establish the statistical and/or theoretical reliability of findings based on the types of data analysis methods employed.

In 2005—the year this survey was administered—around 6,500 students (Ministerial Council on Education, Employment, Training & Youth Affairs [MCEETYA], 2005) were expected to graduate from primary school teacher education courses offered by 35 universities across Australia (Louden, Rohl, Gore, McIntosh, Greaves, Wright, Siemon, & House, 2005).

Using simple, random sampling—for a researcher to be 95% confident that a sample drawn from a population of this size ($N=6,500$) was truly representative of that population—the size of the sample would need to be between 300 and 360 ($n=300-360$) (de Vaus, 2002; Cohen, Manion, & Morrison, 2008; Johnson & Christensen, 2008).
To obtain that sample the researcher would most likely use a self-completion postal survey as it allows a survey of a large population to be conducted relatively cheaply (de Vaus, 2002; Cohen, Manion, & Morrison, 2008; Gilbert, 2008; Johnson & Christensen, 2008). However, as self-completion postal surveys have a low response rate of around 20% (de Vaus, 2002; Gilbert, 2008), the researcher would have to cover the printing and postage costs of a minimum of 1,500 surveys, plus consent forms and information sheets, to achieve the required sample size. Having printed the surveys, consent forms and information sheets and packaged them with self-addressed, reply-paid envelopes for the responses to be returned, the researcher would then have to distribute the packages to 1,500 potential participants via their universities.

As the population is spread across 35 universities (5,000 students ÷ 35 universities = 143 final year students at each university offering a primary school teacher education course), the researcher would have to approach at least 10 universities in the first instance to gain the appropriate sample size (1,500 ÷ 150 [143 students rounded up] = 10 universities). This would involve contacting each university and gaining permission to conduct research at their site, which may or may not involve going through a formal process with the university’s ethics committee, and then locating a suitable contact person within each site who would be willing to distribute the survey packages to the appropriate students. As part of an unfunded PhD study being conducted by a lone, part-time researcher, it was not feasible for this to occur in terms of either the time required or the printing and postage costs involved in applying a random sampling method in the administration of this survey.

Having determined that a random sampling scheme was not practical in the context of this study, a purposive convenience sampling scheme was designed. The scheme designed allowed the researcher to retain significant control over the data collection process, maximise the response rate to the survey, and minimise the number of university sites to be approached.
At the same time, it would still allow the researcher to obtain a sample considered to be representative of pre-service primary school teachers, was large enough to ensure the validity of the statistical tests that were to be performed on the survey data collected, and was reasonable and practical for use as a pool from which to draw research participants for the subsequent stages of the study.

Stage 2: Purposive Convenience and Criterion Sampling

A purposive convenience and criterion sampling scheme was used to identify and recruit the 10 beginning primary school teachers from the participant pool established at the time of administering the initial pre-service teacher survey. The sampling scheme was:

- purposive in that participants were not selected randomly from the total population of first year beginning primary school teachers in Australia;
- convenience-based in that participation was voluntary within the identified potential participant pool; and
- criterion-based in that potential participants who were willing to participate in the study also had to meet work status and geographic prerequisites to be eligible to participate.

The target group for the second stage of the study was teachers who had completed the pre-service teacher survey and were working on either a permanent full-time or long-term contract basis in primary schools in the ACT. It was important that participants had completed the pre-service teacher survey as it allowed questions from this survey to be re-asked and for responses over time to be compared. This helped to determine how participants’ recollections of past experiences and their understandings and beliefs change in light of their new experiences.

It was also important that participants be employed on either a permanent full-time or long-term contract basis in the first year of their transition into teaching. This meant that they had been responsible for planning, implementing and assessing full year
mathematics programs in primary school classroom settings whilst being immersed in a single school culture.

The decision to include work location as an eligibility criterion was made for both practical and theoretical reasons. As the researcher was living and working in the ACT, it was more manageable to conduct multiple, individual face-to-face interviews with teachers in different schools if they were limited to the ACT area. However, it also meant that participants had a higher degree of system-level homogeneity as they were required to work with the same mandated curriculum documents and, particularly for public school teachers, had access to the same system-wide induction programs and professional development opportunities.

It was also important that participants were willing to continue their participation in the study as they had to be prepared to complete a second survey and participate in a face-to-face, individual interview with the researcher.

Of the 101 self-nominated potential participants from the pre-service teacher survey, 30 would be sent the beginning teacher survey and a total of 10 individuals would complete and return the survey to the researcher and go on to participate in a face-to-face interview. Through the purposeful recruitment and selection of these participants, the researcher was confident that participants had been fully informed about the research and that the survey and interview data collection combination would provide high quality data for the study.

Stage 3: Purposive Convenience, Extreme and Opportunistic Sampling

Purposive convenience, extreme and opportunistic sampling schemes were used to identify the five case stories from the participant pool of 10 beginning primary school teachers established at the time of administering the beginning teacher survey and conducting the beginning teacher interviews.
The sampling scheme was purposive in that participants were not selected randomly from the total population of beginning primary school teachers in Australia. It was extreme in that two of the five cases were selected as they were located at the extreme ends of the teacher confidence scale used in the Beginning Teacher Development Model (BTDM), were of interest in their own right, and were used as a basis for cross case comparison and analysis.

The sample was also convenience-based in that the individuals were conveniently available and willing to participate in the study and/or had already provided the data used in developing their case story. And finally, it was opportunistic in that the participants who were willing to participate in the supplementary data collection stage had “specific characteristics” within their cases that capitalised on “developing events occurring during data collection” (Onwuegbuzie & Collins, 2007, p. 286).

Sample Profiles

The general profile of the survey samples at the first two stages of the study have been constructed from information obtained from a variety of sources during the course of the study.

Stage 1: Pre-service Teacher Sample Profile

The profile of the pre-service teacher participants of this study is summarised in Box 3.2.

Of the approximately 6,500 pre-service primary school teachers expected to graduate from teacher education courses in Australia in 2005, almost 5,700 of them (90%) would be graduating from four-year Bachelor undergraduate degrees (MCEETYA, 2005). An examination of the Bachelor degree course structures found in the 2002 Australian Catholic University, University of Canberra and Charles Sturt University Handbooks show that, over the course of their four years of study, the respondents (who commenced their studies in 2002) were required to:
• complete a minimum of three subjects specifically related to mathematics/numeracy education; and
• participate in between 95 to 120 days of school-based professional experience which would include some teaching of mathematics.

**Box 3.2: Demographic Profile of Survey Sample**

Respondents to this survey were:
• pre-service primary school teachers in the final year of a 4-year undergraduate teacher education degree in an Australian university;
• predominantly female; and
• mostly aged between 22-25 years old.

**During the course of their studies they had:**
• successfully completed a minimum of three subjects specifically related to mathematics/numeracy education; and
• taught some mathematics in the primary school context through their participation in between 95-120 days of school-based professional experience.

The Bachelor degree course structures of the three universities selected as recruitment sites for the survey respondents are consistent with a national study (Louden et al., 2005, p. 6) that found that the “average minimum number of explicitly named numeracy units to be taken [by pre-service primary school teachers] over four years was two” and the total amount of school experience to be completed was between 95 and 110 days.

Of the 200 completed surveys received, 85% (170) of the respondents were female and 15% (30) were male. This result is consistent with other major Australian studies of final year pre-service teachers (Department of Education, Science and Training [DEST], 2006a) and beginning teachers (Australian Education Union [AEU], 2008; DEST, 2006b; Louden et al., 2005) where there is a ratio of 75-80% female to 20-25% male participants.
This result also confirms the generally held understanding, both nationally and internationally, of the highly feminised nature of the primary school sector teaching workforce.

In addition to reporting the overrepresentation of females as primary school education students and beginning teachers, major Australian studies of final year pre-service teachers (DEST, 2006a) and beginning teachers (AEU, 2008; DEST, 2006b) also identify that the average beginning primary school teacher in Australia is aged between 22 to 25 years old. While this information was not collected via the survey, this demographic characteristic was confirmed by the Course/Maths Coordinators (Arnold, personal communication, June, 2005; Smith, personal communication, June, 2005; Trimingham-Jack, personal communication, June, 2005) as being consistent with the final year student cohorts who would be completing the surveys and a representative of the ACT Department of Education’s Human Resources section who confirmed that most beginning primary school teachers in ACT public schools were aged between 22 and 23 years (Earle, personal communication, March 18, 2009).

The decision not to include a question about respondents’ age in the survey was taken in light of the fact that ‘age’ was not going to be used as an Independent Variable (IV) in the data analysis process. This is consistent with other studies that either report on ‘age’ as a demographic descriptor only (AEU, 2008; DEST 2006a, 2006b) or, even when the data is collected, do not report on it at all (Louden et al., 2005) as it does not have any direct effect on the responses to the Dependent Variables (DV) under study.

In light of the demographic profile of the survey sample, which was constructed from information obtained from a variety of sources, the researcher is confident that the selection of respondents from final year students enrolled in four-year Bachelor degree courses at these three universities was appropriate in that they are representative of the total population of final year pre-service primary school teachers in Australia.
Stage 2: Beginning Teacher Sample Profile

The profile of the beginning teacher participants (as shown in Box 3.3) has been constructed from information obtained from the survey administered and the interviews conducted in this second stage of the study.

<table>
<thead>
<tr>
<th>Box 3.3: Beginning Teacher Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants in the second stage of this study were:</td>
</tr>
<tr>
<td>• all female (n=10);</td>
</tr>
<tr>
<td>• aged between 23-30 (n=5) or 35-45 (n=5) years old;</td>
</tr>
<tr>
<td>• all employed on a full-time basis as primary school teachers in the ACT (n=10) and mostly in public schools (n=9); and</td>
</tr>
<tr>
<td>• teaching a range of K-6 classes</td>
</tr>
<tr>
<td>Junior School (K-2): (n=6)</td>
</tr>
<tr>
<td>Middle/Senior School (3-6): (n=4)</td>
</tr>
</tbody>
</table>

From this point on, all participants involved in the study were female. While this is not unusual considering the highly feminised nature of the primary school sector teaching workforce, it is important to note that male participants were not deliberately excluded from this study. While 15% of the participants who completed the pre-service teacher survey were male (30 from a total pool of 200), only 11 male participants registered interest in participating in the beginning teacher survey by providing their name and contact details to the researcher. Of these 11 participants, only two could be contacted 12 months later and, while they were sent a second survey, neither of these participants returned a completed survey to the researcher.

While all 10 participants were teaching at schools in the ACT, nine were teaching at schools in the public sector (their employer being the ACT Department of Education and Training [ACT DET]) and one was teaching at an independent school. However, as teachers working in ACT schools, all participants were working with the same mandated curriculum document—*Every Chance to Learn: Curriculum Framework for ACT Schools Preschool to Year 10*—in relation to teaching mathematics.
It is also important to note that, while permission to conduct research had been granted by the local Catholic Education Office, no completed surveys were received from teachers at Catholic schools in the ACT.

Participants also had to nominate the year level of the class they were teaching. These responses were grouped into the common sub-schools used in ACT primary schools for planning and other organisational purposes: junior, middle, and senior. The middle and senior sub-schools are reported as a combined group to reflect the common delineation between the ‘infants’ section i.e., the (K-2) junior school, and the ‘primary’ section i.e., the (3-6) middle/senior school, of Australian and ACT primary schools.

As reported in Box 3.3, six participants taught in the junior school and four taught in the middle/senior school. One participant taught in a variety of classes across the K-6 range in their first year out as they provided Release from Face-to-Face (RFF) teaching for other class teachers. This included providing extended RFF for the school’s executive staff, who had a greater ‘off-class’ entitlement than Level 1 classroom teachers. Thus, while not on one class full-time, the participant was still responsible for planning, teaching, assessing and reporting on some aspects of maths for students in some classes. This participant was then given a full-time class in the same school in their second year of teaching. As they had been responsible for planning, implementing and assessing full year primary mathematics programs and had also been immersed in a single school culture during their transition into teaching they were considered to be ‘in-scope’ for the purposes of this study.

Overall, this sample of participants demonstrates a high degree of homogeneity based on a range of demographic and contextual factors. This characteristic in turn became a major consideration in determining whether or not the sample size was appropriate in the context of this study.
Stage 3: Beginning Teacher Case Story Sample Profile

The profile of the beginning teacher case story participants (as shown in Box 3.4) was refined from the beginning teacher sample in the second stage of the study.

Box 3.4: Beginning Teacher Case Story Sample

Participants in the third stage of this study were:
- all female \( n=5 \);
- aged between 23-30 \( n=2 \) or 35-45 \( n=3 \) years old; and
- all employed on a full-time basis as primary school teachers in ACT public schools \( n=5 \).

Sample Size

The next question for the researcher was whether or not the sample sizes at each stage of the research were appropriate in the context of this study?

Stage 1: Pre-service Teacher Sample Size

As reported above as part of the sample scheme discussion for the first stage of this study, for a researcher to be 95% confident that a random sample is truly representative of a total population of 6,500 final year pre-service teachers across Australia, the minimum sample size recommended is 300. However, due to the purposive convenience sampling scheme used in this initial stage of the study and the way in which the survey was administered, the PhD supervision team felt that a strong case for representativeness based on this smaller sample size could be made.

The other issue regarding sample size relates to the “statistical power”, or reliability, of the tests conducted on the data (Onwuegbuzie & Collins, 2007, p. 288). According to Onwuegbuzie, Jiao, and Bostick (2004, as cited in Onwuegbuzie & Collins, 2007, p. 288), “many of the sample size guidelines provided...for both correlational and causal-comparative designs, if followed, would lead
to statistical tests with inadequate power as they are not based on power analyses”.

In order to avoid conducting statistical tests with inadequate power, Onwuegbuzie and Collins (2007, p. 288) suggest that researchers should adopt the minimum sample size recommended by Onwuegbuzie et al. (2004, as cited in Onwuegbuzie & Collins, 2007, p. 288), as they “represent sizes for detecting moderate effect sizes with .80 statistical power at the 5% level of significance” (see Box 3.5). As such, the sample size \( n=200 \) for this survey allows for powerful statistical testing to be conducted on the data to investigate the strength and nature of the relationships between variables.

<table>
<thead>
<tr>
<th>Box 3.5: Sample Size Recommendations (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum Sample Size Recommendations for Most Common Quantitative and Qualitative Research Designs</strong></td>
</tr>
<tr>
<td>Research Design</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Correlational</td>
</tr>
<tr>
<td>Causal-Comparative</td>
</tr>
</tbody>
</table>

Source: Table adapted from Table 3 in Onwuegbuzie & Collins, 2007, p. 288.

**Stage 2: Beginning Teacher Sample Size**

As the data collected from the beginning teacher survey is used primarily to support and inform the interviews, the sample size conventions relating to interviews as a data collection method were those applied to this stage of the study.

In order to generalise findings made as a result of analysing interview data to a larger population, Onwuegbuzie and Collins (2007) suggest that researchers adopt the minimum sample size of 12 participants recommended by Guest, Bunce, and Johnson (2006, as cited in Onwuegbuzie & Collins, 2007, p. 288). However, as reported in Box
3.6, after reviewing the findings of the source article for this recommendation (Guest, Bunce, & Johnson, 2006) and applying them to the context of this study, the researcher and PhD supervision team felt that a strong case for representativeness based on this smaller sample size could be made.

Guest, Bunce, and Johnson (2006) used the results of a research project they conducted with 60 participants over two countries to investigate how many of the 60 interviews they conducted actually had to be analysed before data saturation was achieved. At the end of their project they looked at the final codes and themes identified during the data analysis process of all 60 interviews and then compared them to the codes and themes they had identified after each ‘round’ of six interviews. They concluded that:

- when a relatively homogenous and ‘expert’ sample are interviewed individually but consistently (i.e., asked the same questions) about a relatively narrow topic; then
- while full data “saturation occurred within the...[analysis of the]...first twelve interviews”;

<table>
<thead>
<tr>
<th>Data Collection Method</th>
<th>Minimum Sample Size Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview</td>
<td>12 participants¹</td>
</tr>
</tbody>
</table>

¹ The Guest, Bunce, and Johnson (2006) source article for this recommendation clarifies that the ‘metathemes’ identified after analysing all 60 interviews had all been identified, with ‘meaningful interpretations’ after analysing the first 6 interviews they conducted.

This occurred in a study context where:
- they had a reasonably homogenous sample;
- the interviews were quite structured; and
- the sample participants had a high degree of experience with the object under study.

Guest, Bunce, and Johnson (2006) used the results of a research project they conducted with 60 participants over two countries to investigate how many of the 60 interviews they conducted actually had to be analysed before data saturation was achieved. At the end of their project they looked at the final codes and themes identified during the data analysis process of all 60 interviews and then compared them to the codes and themes they had identified after each ‘round’ of six interviews. They concluded that:

- when a relatively homogenous and ‘expert’ sample are interviewed individually but consistently (i.e., asked the same questions) about a relatively narrow topic; then
- while full data “saturation occurred within the...[analysis of the]...first twelve interviews”;

<table>
<thead>
<tr>
<th>Data Collection Method</th>
<th>Minimum Sample Size Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview</td>
<td>12 participants¹</td>
</tr>
</tbody>
</table>

¹ The Guest, Bunce, and Johnson (2006) source article for this recommendation clarifies that the ‘metathemes’ identified after analysing all 60 interviews had all been identified, with ‘meaningful interpretations’ after analysing the first 6 interviews they conducted.

This occurred in a study context where:
- they had a reasonably homogenous sample;
- the interviews were quite structured; and
- the sample participants had a high degree of experience with the object under study.
• both the “metathemes” and the underlying elements that allowed them to be interpreted meaningfully “were present as early as six interviews” (p. 59); and that
• “in terms of the range of commonly expressed themes...very little appears to have been missed in the early stages of analysis” (p. 73).

In the context of the overall purposive convenience and criterion sampling design of this study (where the participants had a high degree of homogeneity, expert knowledge and experience of the study topic and context, were interviewed individually and were asked the same questions by a researcher who also had a high degree of expert knowledge and experience of the study topic and context) the sample size of n=10 was deemed large enough to ensure that high quality data would be collected and reliable analysis performed.

Stage 3: Beginning Teacher Case Story Sample Size

In order to generalise findings from case story data analysis to a larger population (see Box 3.7), Onwuegbuzie and Collins (2007) suggest that researchers adopt the minimum case study research method sample size of three to five participants recommended by Creswell (2002, as cited in Onwuegbuzie & Collins, 2007, p. 288) and three or more participants per subgroup in a nested sampling design (Onwuegbuzie & Collins, 2007, p. 289).

<table>
<thead>
<tr>
<th>Box 3.7: Sample Size Recommendations (3)</th>
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<tbody>
<tr>
<td><strong>Minimum Sample Size Recommendations for Most Common Quantitative and Qualitative Research Designs</strong></td>
</tr>
<tr>
<td>Research Design</td>
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<tr>
<td>Case Study</td>
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<tr>
<td>Sampling Design</td>
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<tr>
<td>Nested Sampling Design</td>
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Source: Table adapted from Table 3 in Onwuegbuzie & Collins, 2007, p. 288.
As such, the case story sample size of \( n=5 \):

- where all five participants are nested within a larger sample of \( n=10 \);
- which in turn is nested within the initial sample size of \( n=200 \);
- where two participant cases are extremes on one variable; and
- the other three participant cases share a specific characteristic that is of interest to the study.

ensured that high quality data would be collected and organised in the case stories and reliable analysis performed on that data.

**Data Collection Tools**

Combinations of four different tools were used to collect the data for this study: surveys, interviews, observations, and a test. These combinations were chosen based on what Johnson and Christensen (2012, p. 195) call the “fundamental principle” of mixed research which states that data collection tools should “mix in a way that provides complementary strengths and nonoverlapping weaknesses” in order to collect high-quality research data. Details about the data collection tools are reported below.

**Pre-service Teacher Survey Construction**

The survey instrument administered to pre-service primary school teachers collected data related to the respondents’ own experience of maths at school, how they felt and what they believed about teaching maths in general and in comparison with other curriculum areas, and how they imagined their classroom practice would reflect their philosophy of teaching and learning mathematics.

The questions and items used in the survey were based strongly on those used by Macnab and Payne (2003) in a national study of pre-service primary school teachers in Scotland. After discussions with the PhD supervision team it was decided that, with amendments to the wording of items to reflect Australian curriculum terminology and
to the response types to support the proposed interrogation of the data during the data analysis process, it was appropriate to draw strongly from this study within the context of this study for a number of reasons. The Macnab and Payne study (2003) had a proven ‘provenance’ in that it:

- surveyed 70% of all final year pre-service primary school teachers in Scotland in 2000 \((n=568)\) and had a strong claim that the sample was representative of the total population of pre-service primary school teachers in that country;
- *inter alia* required respondents to provide information related to the three main areas identified as being of interest in this study on the eve of their transition into teaching;
- was designed and conducted by highly qualified university academics/teacher educators involved in the education of pre-service primary school teachers in mathematics; and as such
- used items related to primary school mathematical content, pedagogy, classroom organisation, resources and student learning that reflected current international and Australian thought, theory and knowledge about mathematics education; and
- had a high response rate indicating that it was easy to administer, that there was a high level of respondent engagement with the instrument, and that the items were appropriate and meaningful as it was seemingly easy for respondents to understand and complete.

The pre-service teacher survey (see Appendix C for sample) was comprised of eight questions that asked respondents to provide information about their gender, their own experience of mathematics at school, their pre-service training experience of mathematics, and their expectations of their school-based experiences of teaching mathematics. Throughout the survey, respondents were required to respond to a variety of items in four different ways: using semantic differential 7-point bipolar rating scales; object ranking; 4-point rating scales; and an open-ended, exploratory free-response question.
More detailed information about the individual survey questions and response type, rate and coding for analysis is provided in Chapter 4 that reports the results of survey data analysis.

**Beginning Teacher Survey Construction**

The survey instrument administered to beginning primary school teachers collected data related to the participants’ participation in transition-based professional development activities, the school context and how mathematics teaching is organised and resourced at the school-level, how participants felt and what they believed about teaching maths, and what they would like to change about their classroom practice in light of their first year experience. The data collected also had to adequately describe and define the experience of early career primary school teachers and then be compared with other data collected across the different stages of the study in order to identify the implications it had on their development as teachers of mathematics.

This survey was constructed using a combination of questions taken from the pre-service teacher survey and modified items taken from a DEST (2004) study that investigated effective mathematics teaching and learning in Australian secondary schools. After discussions with the PhD supervision team it was decided that it was appropriate to re-ask questions from the pre-service teacher survey as it would demonstrate change over time in participant responses and provide powerful opportunities for participants to reflect on their own development as teachers of mathematics.

It was also decided that it was appropriate to use items and questions from the DEST (2004) study that were modified to reflect the primary school context as it had a proven ‘provenance’ in that it:

- was a national, Australian study of mathematics teachers;
- *inter alia* required participants to provide information related to the professional development, school context and classroom issues identified as being of interest in this study; and
used items and terminology related to school context, mathematical content, pedagogy, classroom organisation, resources and student learning that reflected the Australian context as well as accepted current thought, theory and knowledge about mathematics education.

The beginning teacher survey (see Appendix D for sample) was comprised of 23 questions organised into four sections: background information; professional development; school context; and mathematical teaching practices. Throughout the survey participants were required to respond to a variety of items using 2-point (yes/no) or 4-point rating scales and free-response either as comment boxes attached to rating scale questions or as separate open-ended, exploratory free-response questions.

The decision to use a 4-point rating scale without a “middle” alternative (such as “neutral”, “about the same”, “no difference”) was consistent with the pre-service teacher survey and was based on the understanding that “omitting the middle alternative...does not appreciably affect the overall pattern of results” but it does force the respondents to “lean one way or the other” (Johnson & Christensen, 2008, p. 181).

Comment boxes linked to various questions and items were also included to allow participants to provide fuller descriptions of, and/or additional information about, their first year experience and school context not covered by checking the appropriate response.

Two open-ended, free-response questions were used at the end of the survey again as it was consistent with the pre-service teacher survey and also gave participants an opportunity to use their own words to “illuminate some aspect[s] of” their developing classroom practice and to identify new themes and issues of importance to this study that had not been previously identified by the researcher (Teddle & Tashakkori, 2009, p. 235).
Beginning Teacher Interview Development

The format of the semi-structured beginning teacher interviews was developed using a combination of questions taken from the pre-service teacher survey, and issues and themes raised as a result of the analysis and interpretation of data from both the pre-service and beginning teacher surveys. The use of semi-structured interviews helped establish overall data validity at this stage of the study by providing a focus for the data collected, while at the same time allowing for a greater participant role in the data generation and analysis process (Cohen, Manion, & Morrison, 2008; Richards & Morse, 2007; Tashakkori & Teddlie, 2003; Teddlie & Tashakkori, 2009; Yin, 2003).

In the first instance, asking participants the same questions meant that enough data were collected about each topic and/or theme from within the sample for robust data comparison and analysis to be conducted (Tashakkori & Teddlie, 2003; Teddlie & Tashakkori, 2009). Some questions from the previous surveys were re-asked and responded to using exactly the same language, response types and categories so that the data could be directly compared across the pre-service and beginning teacher samples as a whole and also to record how each individual participant’s responses changed over time.

Within the pre-determined focus of the interviews however, there was also enough scope for the researcher to “word questions spontaneously” and “build a conversation” with the participants (Patton, 2002, p. 343) in “such a way as to invite detailed, complex answers” (Richards & Morse, 2007, p. 114). This flexibility facilitated participant-identified themes, issues and meanings to emerge from the data.

Allowing participants to have ongoing involvement in the data analysis process is a powerful way of ensuring data validity through respondent validation.
This validation process ensures that data in this study is generated by both the researcher and the participants and not solely generated by the researcher and tested by the participants (Bailey, 2007; Cohen, Manion, & Morrison, 2008; Gilbert, 2008; Richards & Morse, 2007).

In general, the purpose of the interviews was for participants to:

- re-answer questions from both the pre-service and beginning teacher surveys, compare their current and previous responses and comment on the results of that comparison;
- clarify information provided in the surveys, comment on the researcher’s interpretation of the survey data and discuss the themes that were emerging from the data analysis process; and
- reflect on their ongoing development as teachers of mathematics and identify what support beginning teachers need to assist them in this process and what aspects of teaching mathematics they found most challenging.

To ensure that the core set of questions and the “same basic lines of inquiry are pursued with each person interviewed” (Patton, 2002, p. 343), an interview guide was developed (see Appendix E for sample). The interview guide was organised into four sections: introduction; reorientation to the research study; questions; and conclusion.

The introductory phase of the interview gave the researcher an opportunity to thank the participant in advance for taking part in the interview while stressing the importance of their role in the study. In the reorientation phase of the interview the researcher used the information sheet (see Appendix A for sample) as a prompt to revisit the research objectives and the issues of informed consent, voluntary participation, participant anonymity, and data use and security.

The next phase of the interview involved the actual data collection. The interview questions were organised into five major focus areas:
school experiences of maths; teaching mathematics compared to other curriculum subjects; the school context; teaching mathematics; and reflections on practice. However, except for the two questions asked exactly the same way as originally presented to participants in the pre-service teacher survey, “the flow of the interview, rather than the order of the guide, determin[ed] when and how a question [was] asked” (Bailey, 2007, p. 100).

The concluding phase of the interview again gave the researcher an opportunity to thank the participants while advising them of the requirements and timeframe for the next stage of the study (building in-depth case stories of beginning teachers) and giving an approximate time as to when they would be contacted to determine their willingness and eligibility to participate further in the study.

More detailed information about the individual interview questions and focus areas are provided in Chapter 5 of this study which reports the results of survey data analysis.

**The Mathematical Test Instrument**

The decision to include a mathematical test as part of the final data collection stage of this study was taken in light of a number of inconsistencies identified both within and between the self-reports of participants about their beliefs and attitudes and their classroom practice that were often related to their level of mathematical content knowledge. Therefore, it was important that the instrument used at this stage of the study collected data that, while related to the participants’ mathematical content knowledge (their ability to do and understand mathematics) and their classroom practice (their ability to teach mathematics), was not generated solely from participant self-reports.

The mathematical test instrument administered in this study was the International Competitions and Assessments for Schools (ICAS) Mathematics 2006 Paper D. ICAS (see Appendix F), formerly known as the Australasian Schools Competition, is the main product of
Educational Assessment Australia (EAA), which is a subsidiary of the University of New South Wales (UNSW). As reported on EAA’s website <http://www.eaa.unsw.edu.au/etc/eaa>, “over 1.7 million students from across Australia, NZ and the Pacific Region participate in the annual ICAS program”. ACT public schools invite students to enter these competitions, on a user-pays basis, and administer the assessments at school on behalf of EAA for those students who choose to enter.

Paper D was selected for use as it was the Australian Year 6 equivalent paper and thus would contain the level of mathematical content that the participants, as primary school teachers, could be reasonably expected to know and teach. As such, the PhD supervision team and the researcher felt it was an appropriate and credible instrument to test the mathematical content knowledge of participants in the context of this study.

When scheduling a time to administer the mathematical test, the researcher made sure that participants were available to be interviewed directly after the testing had finished. This allowed the participant and the researcher to mark the test and discuss both the test results and the process of taking the test from the perspective of the participant.

The ICAS Mathematics 2006 Paper D was comprised of 40 items: 35 multiple choice and 5 free-response questions that covered the mathematical content strands of number, measurement, space, and chance and data. Participants completed the test under the same conditions required of students, thus they had one hour to complete the test, had to record their answers on a separate answer sheet, and were allowed to use a ruler and spare paper during the test. Participants were not allowed to use a calculator nor were they allowed to discuss the test items with the researcher who was acting as an invigilator while participants were completing the test. More detailed information about individual test items are provided in Chapter 6 of this study that reports the results of the test.
Observations of Beginning Teachers’ Classroom Practice

In developing the classroom observation data collection instrument, the researcher had to take into consideration a number of researcher and participant-based factors relating to access and voluntary participation.

At the time of data collection, the lone researcher was employed full-time while studying part-time. Classroom observations needed to be conducted within a three-week period in Term 2 while the researcher had access to limited study leave. Of the three participants who were willing to participate in the final stage of this study, two agreed to have two mathematics lessons observed within this period and one agreed to have one mathematics lesson observed. As a result, a three-part plan of lesson observation, interview and document collection was developed to maximise the amount, and validity, of data collected as part of the classroom observation process.

During the observation, the researcher recorded information based on a “lesson observation schedule” (Rhodes, Swain, Coben, & Brown, 2006, p. 1), developed to capture information related to the identified focus areas of curriculum, pedagogy, resources, and the role of the teacher and students in the learning experience. More detailed information about the lesson observation schedule is provided in the Lesson Observation Schedule section below.

When scheduling the lesson observation, as with the administration of the mathematical test, the researcher made sure that participants were available to be interviewed directly after the lesson had finished. This gave the researcher an opportunity to gather more information about observed events and allowed the participant to orient the single lessons observed within their larger teaching program.

Similarly, at the post-observation interview, participants were asked to provide the researcher with copies of any documents that related to the observed lesson. This included worksheets and/or textbook
pages provided to students in the lesson, identification of textbook-based maths programs or teaching texts used, and/or copies of the teaching program documents that contained the lesson.

**Lesson Observation Schedule**

The lesson observation schedule used in this study was modified from one used by Rhodes, Swain, Coben, and Brown (2006) in a research project looking at effective teaching practices in adult numeracy classrooms. After discussions with the PhD supervision team, it was decided that it was appropriate to modify this existing lesson observation schedule as it identified factors of lesson structure, mathematical pedagogy, classroom organisation, resources, and the teacher and student role in the learning process that reflected current thought, theory and knowledge about constructivist mathematics education.

The lesson observation schedule was organised into three main sections: overview; lesson episode; and conclusion.

In the overview section of the schedule, a quick sketch of the classroom was made, the lesson start and finish times were recorded, and the mathematical content being taught in the lesson was identified.

In the lesson episode section of the schedule, the researcher was able to break the lesson down into its various sub-parts, or episodes, time them, and record key information such as:

- structure (introduction, main teaching, conclusion);
- organisation (whole class, group, pairs, individual);
- activity (conceptual, procedural, problem solving);
- teacher role (introducing, answering questions, giving instructions, questioning students, supporting individuals);
- student role (listening, discussing, answering questions, asking questions, explaining to others, working alone, working with others, off-task); and
• materials used (worksheets, textbooks, workbooks, games, IWB, calculator, hands-on, computer, whiteboards).

The concluding section of the schedule was used as part of the post-observation interview and is where the researcher recorded participant reflections of the lesson and the participant’s responses to researcher-generated questions regarding:

• the main objective of the lesson;
• where it fit in to the wider teaching program; and
• why the participant chose the particular activities, organisation and/or resources used in the lesson.

At the end of the final post-observation interview for each participant, the researcher took the opportunity to thank the participants for their participation in the study over the three-year data collection period.

**Ethical Procedures and the Data Collection Process**

This study is a piece of social research in that it “involves collecting data from people and about people” (Punch, 1999, p. 21). In these circumstances, it is imperative that research is conducted ethically so that participants are protected and that the data collected from them is given freely without fear of misuse, ridicule or censure (Bailey, 2007; Cohen, Manion, & Morrison, 2008; Gilbert, 2008; Hammersley & Atkinson, 1997; Punch, 1999; Richards & Morse, 2007). As such, a number of measures were incorporated into the design of the research project to address ethical procedures dealing with site and participant access, informed consent, voluntary participation, and participant and data anonymity.

Firstly, as the researcher was a PhD student at a university, the proposed research design, methodology, survey instruments, information sheet and consent form were approved by the university’s Ethics in Human Research Committee prior to the commencement of data collection.
Once ethics approval was granted in writing from the researcher’s university, application was then made to the universities from which access was sought for the initial pool of participants in their final year of pre-service primary teacher training. Once permission to administer the initial survey was granted, the researcher negotiated an opportunity to do so with the appropriate member of staff at the university.

It was at this stage that all participants were provided with detailed information about the study. An information sheet (see Appendix A) was distributed to all potential participants to present the research as a transparent and open process. Issues addressed in the information sheet included voluntary participation, informed consent, privacy and confidentiality, withdrawal from the project at any time, recording and storage of research materials and data, the contact details of the university’s Ethics in Human Research Committee, and procedures for registering a complaint with that body.

At the same time as receiving the information sheet, participants were also required to sign a written consent form to participate in the study (see Appendix B). Each consent form was uniquely numbered and accompanied by a survey with a corresponding number. This allowed for the researcher to track participants’ responses over time. Participants were advised that their signed consent forms would be stored separately to their completed surveys to preserve privacy and that, if they did not complete the second survey, the number would be removed from their consent form so no matching of participant name to an individual survey could occur.

After completing the initial survey, participants willing to participate in the next stage of the study—a second survey—were asked to provide their name and contact details to the researcher so they could be contacted in 12 months’ time. Prior to re-contacting participants at the end of their first year of teaching in 2006, the researcher completed an Application to Conduct Research in ACT Public Schools form and submitted it to the ACT Department of
Education and Training. This application was approved in writing and gave permission for the researcher to contact teachers and principals to negotiate access to schools to collect data in the next stages of the research design.

Central to the design of this study was the understanding that individual participants would self-determine the level of their involvement in the research. This was important as different stages of the research had different procedures for data collection and for preserving participant and data anonymity and confidentiality (Bailey, 2007; Cohen, Manion, & Morrison, 2008; Gilbert, 2008; Hammersley & Atkinson, 1997; Punch, 1999; Richards & Morse, 2007).

These different procedures were communicated clearly to the participants prior to the commencement of each stage of the research and the following general guidelines relating to participant and data anonymity and confidentiality were incorporated into this study:

- completed consent forms were stored securely by the researcher and were stored separately to research data collected;
- completed initial surveys where participants did not continue in the study were de-identified (unique number identifier removed) and therefore responses were anonymous (these surveys were stored securely by the researcher and used only for the purpose outlined in the study);
- completed surveys where participants did continue in the study were matched by unique number identifier only and were stored separately from consent forms so only the researcher could match responses to an individual participant;
- all individual interviews were audio-taped, then converted to a digital format and stored on a CD with a USB backup (audio and digital data were stored securely by the researcher and used only for the purpose outlined in the study);
• any documents collected as part of building up case stories were de-identified by removing school, teacher and student names and using pseudonyms to identify them with a specific participant; and
• pseudonyms were used to identify individual participants so their responses remain confidential and were used only for the purposes outlined in the study.

Data Analysis Framework

Within the field of educational research, just as there are various approaches to data collection, there are also various approaches to data analysis. The process of data analysis used in this study satisfies both the assumptions and conventions of the mixed methods research paradigm and the overall research design (Bailey, 2007; Cohen, Manion, & Morrison, 2008; Gilbert, 2008; Hammersley & Atkinson, 1997; Miles & Huberman, 1994; Onwuegbuzie & Teddlie, 2003; Punch, 1999; Richards & Morse, 2007).

The process used starts with the researcher taking a wide angle lens to gather data, and then, by sifting, sorting, reviewing and reflecting on them, the salient features of the situation emerge...[and are]...then used as the agenda for subsequent focusing” (Cohen, Manion, & Morrison, 2008, p. 462). The process of “funnelling from the wide to the narrow” (Cohen, Manion, & Morrison, 2008, p. 462), that reduces the raw data into themes and categories using a repeated and interdependent cycle of data collection and analysis, was a feature of this study.

It meant that the theories identified as the study continued were continually tested and refined in order to identify patterns, similarities, differences and relationships within and between the data (Burns, 2000; Cohen, Manion, & Morrison, 2008; Gilbert, 2008; Hammersley & Atkinson, 1997; Miles & Huberman, 1994; Onwuegbuzie & Teddlie, 2003; Punch, 1999; Yin, 2003).
The data analysis process used in this study has three stages: data reduction and display; data comparison; and data integration used in a repeated cycle to constantly refine the analysis of the data collected in order to make robust and meaningful inferences about the object, phenomenon or event being studied (Miles & Huberman, 1994; Onwuegbuzie & Teddlie, 2003; Punch, 1999).

The key ideas and findings that emerged as a result of the iterative and cumulative data analysis process employed in this study are reported using Data Statements. Data Statements are meant to be purposive signposts for data interpretation and sense making and are deliberately framed in an assertive and non-ambiguous manner to ensure that there is clarity in the evaluative judgments being made by the researcher. Data Statements are displayed within bordered text boxes and provide a visual representation of key data points identified as a result of the data analysis process.

The analysis of data collected at each stage of the study was used as a focus for collecting and analysing the data in the next stage of the study. This data was then assembled and organised into profiles of beginning teachers at critical points of their transition into the teaching profession and developing their identities as teachers of mathematics. These profiles, themes and categories then became the framework for writing up the data analysis and presenting the research findings in the following chapters. As such, more detailed information about the data analysis process related specifically to each stage of this study is provided in Chapters 4, 5 and 6 as part of reporting the results of data analysis.
Conclusion

This chapter presented and explained the development of the mixed methods research design used in this study. It also described the methodological framework and analytical frameworks of the research design. The description of the methodology included identifying the timeline and stages of the research; outlining the sample design and data collection tools used at each stage of the study; and reporting the procedures followed during the data collection process that ensured the research was conducted in an ethical manner that protected participants so that the data collected from them was given freely without fear of misuse, ridicule or censure.

The description of the analytical framework explained the three-step process of data reduction and display, data comparison and data integration that underpinned the analysis of all data collected during the course of the study. More detailed explanations of how the analytical framework was applied to the data collected at each stage of this study are provided in the next three chapters: The Pre-service Teacher, The Beginning Teacher, and Beginning Teacher Case Stories.
Chapter 4: The Pre-service Teacher

Introduction

The first data of this study was collected via the administration of a survey (see Appendix C for sample) to 200 pre-service primary school teachers prior to the commencement of their teaching careers. The purpose of this initial survey was to collect data that, when analysed, would:

- establish that the sample surveyed was representative of pre-service primary school teachers through comparison with samples reported in other national and international research;
- identify and define from a sound statistical base sub-groups within the sample and major themes within the data to be used as initial filters and lenses when examining subsequent data collected as part of the study;
- explore the relationships between the sample and the themes to provide a more detailed picture of the links between experience and the formation of beliefs, attitudes and understandings of pre-service primary school teachers; and
- provide the first layer of information to be used in building the in-depth individual teacher case stories in the latter stages of the research.

As such, this survey was the primary source of data used to address the first research question of this study and established baseline data for the other three research questions (see Box 4.1).

The Data Analysis Process

As discussed in The Research Design (Chapter 3), the data analysis process used in this study has three stages: data reduction and display; data comparison; and data integration used in a repeated cycle to constantly refine the analysis of the data collected in order to make robust and meaningful inferences about the object,
phenomenon or event being studied (Miles & Huberman, 1994; Onwuegbuzie & Teddlie, 2003; Punch, 1999).

**Box 4.1: The Research Questions**

**Research Question 1**
How does an individual's experience of mathematics as a school student and as a pre-service teacher influence their beliefs and attitudes about mathematical teaching and learning on the eve of their transition into the primary school classroom?

**Research Question 2**
How do factors of school context and the first year experience reinforce and/or change beginning primary school teachers’ pre-existing beliefs and attitudes about teaching and learning mathematics?

**Research Question 3**
To what extent is a beginning primary school teacher’s classroom practice an artefact of their beliefs and attitudes formed as a result of their experiences as:
- a school student;
- a pre-service teacher;
- a beginning teacher;
- a teacher within a particular school context; and
- part of developing an individual teacher identity?

**Research Question 4**
Can we use these understandings of the links between teacher beliefs, attitudes and practice to construct a model that allows schools to provide more targeted and effective support for beginning primary school teachers to develop as effective teachers of mathematics?

*Note: bold font used to highlight specific parts of questions where survey data will be used in formulating answers.*

In the context of this survey, as shown in Box 4.2, the quantitative and qualitative data analysis processes were conducted separately in the first instance to reflect the different ways of reducing, displaying and comparing different types of data and then integrated to form a cohesive picture of the total data collected via the survey instrument.
Quantitative Data Analysis

Preparing Data for Analysis: Initial Coding and Data Entry

The analysis of the quantitative data collected via the pre-service teacher survey was conducted using the statistical software program PASW Statistics 17.0 (formerly known as SPSS 17.0). Prior to entering data into this program each survey question and/or item was given a descriptive code and each possible response to that survey question and/or item was allocated a numerical code starting at ‘1’ where ‘1’ was the most positive response.

This process included reverse coding 5 items in Question 6 to ensure that the directionality of the responses was consistent with all other...
items when making comparisons within the data. More detailed information about the reverse coding of these items will be provided in the following reporting of the data analysis.

Once the initial coding system was devised, the data was entered into PASW by the researcher. The descriptive codes for the survey questions and/or items were used to enter them as variables and then a record was created for each of the 200 respondents using the unique numerical identifier on each survey. Each individual response to each variable was then entered into the data source ready for analysis.

**Data Analysis Process**

In the first instance, the data collected from each question was reduced and displayed using descriptive statistics such as frequency tables and calculating group means and examined to see if patterns within the data were emerging. The data displays were then compared to the data displays of other survey questions and to the findings of national and international research and literature to identify similarities and differences within the data.

As a result of this initial round of data reduction and comparison, the researcher and their PhD supervision team felt that there was an opportunity for a more robust interrogation of the data to identify and define the nature and strength of the relationships within and between these data. This involved reducing the data further by collapsing the IVs relating to school experience of mathematics and pre-service experience of mathematics into near-equal, dichotomous groups and using Principal Component Analysis (PCA) to reduce the remaining 23 survey items into smaller groups to be used as Dependent Variables (DVs).

Once the data reduction was complete and the new IVs and DVs created, a series of ANOVAs was conducted to measure the relationships between the IVs and DVs. The results of the ANOVAs were then analysed and compared to the extant literature and
research. More detailed information about the use of PCA and ANOVAs in the context of this survey will be provided in the following reporting of the data analysis.

**Reporting the Data Analysis Results**

**Descriptive Statistics and Analysis**

*School Experience of Mathematics*

Respondents were asked to record their own experience of mathematics at school on three semantic differential 7-point bipolar rating scales. Semantic differentials are “useful when you want to ‘profile’ or describe the multiple characteristics associated with attitudinal objects” (Johnson & Christensen, 2008, p.183).

In the context of this question, the ‘attitudinal object’ is the respondents’ recollection of their own experience of mathematics at school and the ‘multiple characteristics’ of their experience:

- whether or not they thought mathematics was enjoyable (their attitude towards maths);
- whether or not they thought they were ‘good’ at mathematics (their ability as a student of maths); and
- whether or not they found the mathematics they learnt at school relevant to their everyday lives (their engagement with maths as a field of human endeavour).

The 7-point rating scales were presented to respondents as a number line continuum with four equally spaced, marked and numbered intervals. The intervals that anchored the scales were also labelled with the bipolar contrasting descriptors of ‘Fun’ and ‘Boring’, ‘Easy’ and ‘Difficult’ and ‘Relevant to my life’ and ‘Irrelevant to my life’.

Where respondents placed a mark directly on one of the four marked intervals on the scale their response was scored with the appropriate number value: ‘1’, ‘2’, ‘3’ or ‘4’. Where respondents placed a mark
anywhere on the continuum between two marked intervals on the scale, a ‘.5’ value was added to the value of the lower interval to score the response. For example, if a respondent placed an ‘x’ on the scale between the first and the second marked intervals their response was scored as ‘1.5’. This gave seven possible response values of ‘1’, ‘1.5’, ‘2’, ‘2.5’, ‘3’, ‘3.5’ or ‘4’ where ‘1’ was the most positive response, ‘4’ was the most negative response and ‘2.5’ was the neutral, mid-point of the scale.

As shown by the mean scores listed in Table 4.1, on average, respondents found the mathematics they did at school to be more boring than fun, more difficult than easy to do, and were neutral as to whether it was relevant or not to their lives. When looking at the minimum and maximum values of the scales (as shaded in Table 4.1) more respondents recorded extreme negative experiences (score = 4.0) of their enjoyment of and ability to do school mathematics than those at the positive end (score = 1.0) of the continuum.

<table>
<thead>
<tr>
<th>Score</th>
<th>Enjoyment</th>
<th>Ability</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
</tr>
<tr>
<td>1.0</td>
<td>6</td>
<td>3.0</td>
<td>6</td>
</tr>
<tr>
<td>1.5</td>
<td>19</td>
<td>9.5</td>
<td>12</td>
</tr>
<tr>
<td>2.0</td>
<td>50</td>
<td>25.0</td>
<td>49</td>
</tr>
<tr>
<td>2.5</td>
<td>26</td>
<td>13.0</td>
<td>38</td>
</tr>
<tr>
<td>3.0</td>
<td>59</td>
<td>29.5</td>
<td>68</td>
</tr>
<tr>
<td>3.5</td>
<td>14</td>
<td>7.0</td>
<td>12</td>
</tr>
<tr>
<td>4.0</td>
<td>26</td>
<td>13.0</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

Therefore the following data statement can be reported:

**Data Statement 4.1**
On the eve of their transition into teaching, pre-service primary school teachers are more likely to remember the mathematics they did at school as being:
- more boring than fun;
- more difficult than easy to do; and
- neither relevant nor irrelevant to their lives.
This result is generally consistent with other national and international research that “present a common theme of negativity when reporting on the…[mathematical]…school experiences of pre-service primary school teachers” (Grootenboer, 2003, p. 27). While it is important to note that based solely on the mean scores of these responses, this “theme of negativity” was not overwhelming in the context of this survey sample, however it did raise negative school experiences of mathematics as being an area of further interest for the researcher.

*Teaching Mathematics Compared to Other Curriculum Areas*

Respondents were asked to rank, using the numbers 1 to 6, the core curriculum subjects of Society and Environment, Science and Technology, The Arts, PDHPE (Personal Development, Health and Physical Education), English and Mathematics according to how enjoyable they were to teach and then how easy they were to teach.

Using ranking as a response type can be problematic as respondents can find it a “difficult task” to complete (Johnson & Christensen, 2008, p. 183) and this was certainly reflected in the high non-response rate for this question. However, forcing respondents to compare the standard curriculum areas in this way yielded important data as to where mathematics was placed by respondents when considering the other ‘players’ in the crowded primary school classroom curriculum.

There was a 20% nil (question left blank), incorrect (ranking all subjects but using the same ranking more than once), or incomplete (only ranking two or three subjects) response rate to this question. These responses were treated as out-of-scope and were not used as part of the sample size for this question. Of the in-scope responses, as shown in Table 4.2, 71% of participants ranked mathematics in the bottom half of subjects based on both how easy it was to teach and how enjoyable it was to teach.
This result was consistent with other studies of pre-service teachers on the eve of their entry into the teaching profession (Lang, 2002; Macnab & Payne, 2003) and with the view that mathematics is generally “not recognised as an easy subject to learn or teach” (Council of Australian Governments [COAG], 2008, p. 1).

Therefore the following data statement can be reported:

**Data Statement 4.2**
At the end of their studies pre-service primary school teachers are more likely to think that:
- mathematics will be one of the hardest and least enjoyable curriculum subjects to teach.

**Attitudes and Beliefs Related to the Teaching and Learning of Mathematics**

The next four questions of the survey contained 23 items related to primary school mathematical content, pedagogy, classroom organisation, resources and student learning that reflected current international and Australian thought, theory and knowledge about mathematics education. Respondents were asked to respond to the items using 4-point rating scales in order to provide information about their attitudes and beliefs related to the teaching and learning of primary school mathematics on the eve of their transition into teaching.
The decision to use a 4-point rating scale without a ‘middle’ alternative (such as ‘neutral’, ‘about the same’, ‘no difference’) was based on the understanding that “omitting the middle alternative...does not appreciably affect the overall pattern of results” but it does force the respondents to “lean one way or the other” (Johnson & Christensen, 2008, p. 181).

**Aspects of Mathematical Learning: 8 Items**

In the first instance, respondents were asked to rate eight aspects of mathematical learning using one of the following response categories: ‘Very important’, ‘Important’, ‘Not very important’ and ‘Not at all important’. As the ‘Not at all important’ rating was not used by any respondents for any of the eight aspects it does not appear in the report of responses in Table 4.3. The aspects themselves were taken from the Macnab and Payne (2003) study and were presented to respondents in two separate groups that reflect Ernest’s model (1989, as cited in Grootenboer, 2003, p. 12; and as cited in Brady, 2007, p. 150) of conceptualising teachers’ beliefs about the nature of mathematics.

The aspects in the first group, as presented in this survey, are closely aligned to the traditional, and prevailing, teachers’ view of mathematics as a pre-existing set of methods, facts, rules and procedures (Brady, 2007; Ernest, 1989; Grootenboer, 2003). The aspects in the second group are described by Macnab and Payne (2003, Findings section, p. 8) as “higher level mathematical abilities” and are more closely aligned with the view of mathematics as a dynamic and expanding field of human endeavour (Brady, 2007; Ernest, 1989; Grootenboer, 2003).

As shown in Table 4.3, the majority of respondents identified all eight aspects of student mathematical learning as being either very important or important with learning methods of problem-solving receiving the highest number of ‘very important’ ratings (82%) for any one individual aspect.
Table 4.3: The Importance of Various Aspects of Students’ Mathematical Learning

<table>
<thead>
<tr>
<th>The learning of:</th>
<th>Very important</th>
<th>Important</th>
<th>Sub-total %</th>
<th>Not very important</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>methods of problem-solving</td>
<td>82%</td>
<td>17%</td>
<td>99%</td>
<td>1%</td>
<td>100%</td>
</tr>
<tr>
<td>mental methods of calculation</td>
<td>65%</td>
<td>33%</td>
<td>98%</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>mathematical facts (e.g., multiplication tables)</td>
<td>60%</td>
<td>35%</td>
<td>95%</td>
<td>5%</td>
<td>100%</td>
</tr>
<tr>
<td>standard written procedures for carrying out calculations</td>
<td>29%</td>
<td>61%</td>
<td>90%</td>
<td>10%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The ability to:</th>
<th>Very important</th>
<th>Important</th>
<th>Sub-total %</th>
<th>Not very important</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>improvise mathematical approaches to solving problems</td>
<td>55%</td>
<td>42%</td>
<td>97%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>apply known mathematics in unfamiliar contexts</td>
<td>55%</td>
<td>42%</td>
<td>97%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>undertake open-ended mathematical investigations</td>
<td>56%</td>
<td>40%</td>
<td>96%</td>
<td>4%</td>
<td>100%</td>
</tr>
<tr>
<td>explain mathematics to others</td>
<td>41%</td>
<td>50%</td>
<td>91%</td>
<td>9%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: The survey instrument included a fourth response option of 'Not at all important' but as no respondents checked it for any of the items it has not been reported in this Table.

Confidence in Developing Students’ Mathematically: 4 Items

Respondents were then asked to rate their confidence in developing students’ higher level mathematical abilities using the response categories ‘Very confident’, ‘Confident’, ‘Not very confident’ and ‘Not at all confident’. As shown in Table 4.4, while the majority of respondents were confident in their ability to assist students develop these four important aspects of their mathematical learning, a significant number of respondents (between 26% and 36% on any one item in this group) were not very confident in their ability to do so.
### Table 4.4: Confidence in Developing Students’ Mathematical Abilities

<table>
<thead>
<tr>
<th>The ability to:</th>
<th>Very confident</th>
<th>Confident</th>
<th>Sub-total %</th>
<th>Not very confident</th>
<th>Not at all confident</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>explain mathematics to others</td>
<td>12%</td>
<td>62%</td>
<td><strong>74%</strong></td>
<td>24%</td>
<td>2%</td>
<td><strong>26%</strong></td>
<td>100%</td>
</tr>
<tr>
<td>undertake open-ended mathematical investigations</td>
<td>10%</td>
<td>58%</td>
<td><strong>68%</strong></td>
<td>31%</td>
<td>1%</td>
<td><strong>32%</strong></td>
<td>100%</td>
</tr>
<tr>
<td>apply known mathematics in unfamiliar contexts</td>
<td>5%</td>
<td>59%</td>
<td><strong>64%</strong></td>
<td>35%</td>
<td>1%</td>
<td><strong>36%</strong></td>
<td>100%</td>
</tr>
<tr>
<td>improvise mathematical approaches to solving problems</td>
<td>7%</td>
<td>57%</td>
<td><strong>64%</strong></td>
<td>34%</td>
<td>2%</td>
<td><strong>36%</strong></td>
<td>100%</td>
</tr>
</tbody>
</table>

**Attitudes towards Mathematics: 6 Items**

Respondents then used the following descriptors—‘Strongly agree’, ‘Agree’, ‘Disagree’, ‘Strongly disagree’—to record their responses to six statements about possible attitudes towards mathematics. Of the six statements, five were reverse-worded (or reverse-scored) to “encourage participants to read each item...more carefully” (Johnson & Christensen, 2008, p. 186). Reverse-worded items are usually employed as a technique to prevent the occurrence of a response set within a survey (Johnson & Christensen, 2008, p. 186).

A response set is “the tendency to respond in a specific direction regardless of... [the]...content” of an item (Johnson & Christensen, 2008, p. 186) and, most commonly, will be due to either acquiescence (“the tendency to...agree rather than to disagree on a whole series of items”) or social desirability (“the tendency to provide answers that are socially desirable”) (Johnson & Christensen, 2008, p.186). In the context of this survey, respondents had already been ‘forced to lean’ in one direction or the other in all the questions. There was no marked or labelled mid-point on the school experience rating scales, they were asked to rank order the curriculum areas (acknowledged as a difficult task) and then there was the deliberate omission of a middle alternative in the 4-point rating scales.
As such, there was a real concern that agreeing would become the default position especially when an item was somewhat controversial, in that it may involve a conflict between what a respondent thought and what they thought was ‘socially desirable’ i.e., what they were supposed to think at the end of their pre-service studies. However, when making comparisons within the data it was important to ensure that the directionality of the responses to these five items were consistent with all other items, i.e., that ‘1’ was the most positive response score. To do this, the five items were reverse-scored and have been re-worded to reflect these changes (see Box 4.3 for details).

As shown in Table 4.5, the highest overall respondent agreement rates were with the following items: that mathematics was training in logical thinking (84%); and that most students understand it (80%).

<table>
<thead>
<tr>
<th>Original Item</th>
<th>Re-worded Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning mathematics is hard work for most students</td>
<td>Learning mathematics is not hard work for most students</td>
</tr>
<tr>
<td>Most students cannot be expected to like mathematics</td>
<td>Most students can be expected to like mathematics</td>
</tr>
<tr>
<td>To be good at maths you have to like it</td>
<td>You don’t have to like maths to be good at it</td>
</tr>
<tr>
<td>Only a few students are capable of understanding early algebraic ideas</td>
<td>Most students are capable of understanding early algebraic ideas</td>
</tr>
<tr>
<td>Most students do not understand mathematics</td>
<td>Most students understand mathematics</td>
</tr>
</tbody>
</table>

However, while 80% of respondents agreed that most students understood mathematics in general, they were less likely (73%) to agree that most students would have the capacity to understand more complex concepts associated with pre-algebra.

Opinions within the sample become less clear-cut with the items that dealt with the affective domain and mathematics. Only 64% of respondents agreed that you can be good at maths without necessarily liking it and only 61% of respondents expected most students to like mathematics.
The respondents were then divided evenly (50%) as to whether or not they thought that learning mathematics was hard work for most students.

**Table 4.5: Attitudes Towards Mathematics**

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Sub-total %</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths is training in logical thinking</td>
<td>9%</td>
<td>75%</td>
<td>84%</td>
<td>15%</td>
<td>1%</td>
<td>16%</td>
<td>100%</td>
</tr>
<tr>
<td>Most students understand mathematics*</td>
<td>8%</td>
<td>72%</td>
<td>80%</td>
<td>18%</td>
<td>2%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>Most students are capable of understanding early algebraic ideas*</td>
<td>9%</td>
<td>64%</td>
<td>73%</td>
<td>24%</td>
<td>3%</td>
<td>27%</td>
<td>100%</td>
</tr>
<tr>
<td>You don’t have to like maths to be good at it*</td>
<td>8%</td>
<td>56%</td>
<td>64%</td>
<td>30%</td>
<td>6%</td>
<td>36%</td>
<td>100%</td>
</tr>
<tr>
<td>Most students can be expected to like mathematics*</td>
<td>8%</td>
<td>53%</td>
<td>61%</td>
<td>32%</td>
<td>7%</td>
<td>39%</td>
<td>100%</td>
</tr>
<tr>
<td>Learning mathematics is not hard work for most students*</td>
<td>2%</td>
<td>48%</td>
<td>50%</td>
<td>46%</td>
<td>4%</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Note: Items marked with an asterisk (*) have been re-worded to reflect the reverse-coding process used for data analysis. Please refer to Box 4.3 or Appendix C in this report to see original item wording.*

**Impediments to Student Learning: 5 Items**

Finally, respondents were presented with a list of five factors relating to school and classroom organisation and asked whether or not they felt that these factors could impede students’ mathematical learning. As with the previous items, respondents used the descriptors—‘Strongly agree’, ‘Agree’, ‘Disagree’, and ‘Strongly disagree’—to record their responses.

As shown in Table 4.6, while the majority of respondents identified quite strongly that all five factors could potentially impede the learning of students, those factors that were resource-related—type and availability of learning materials (88%) and textbooks and other written resources (70%)—had the lowest overall agreement rates.
Table 4.6: School and Classroom Impediments to Student Learning in Mathematics

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Sub-total %</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required style of teaching</td>
<td>35%</td>
<td>59%</td>
<td>94%</td>
<td>6%</td>
<td>0%</td>
<td>6%</td>
<td>100%</td>
</tr>
<tr>
<td>Time devoted per day to mathematics</td>
<td>24%</td>
<td>68%</td>
<td>92%</td>
<td>8%</td>
<td>0%</td>
<td>8%</td>
<td>100%</td>
</tr>
<tr>
<td>Type of classroom organisation</td>
<td>31%</td>
<td>60%</td>
<td>91%</td>
<td>9%</td>
<td>0%</td>
<td>9%</td>
<td>100%</td>
</tr>
<tr>
<td>Availability and nature of other learning materials</td>
<td>36%</td>
<td>52%</td>
<td>88%</td>
<td>12%</td>
<td>0%</td>
<td>12%</td>
<td>100%</td>
</tr>
<tr>
<td>Textbooks and other written resources</td>
<td>12%</td>
<td>58%</td>
<td>70%</td>
<td>29%</td>
<td>1%</td>
<td>30%</td>
<td>100%</td>
</tr>
</tbody>
</table>

In order to make the following data statement with respect to the 23 items related to respondents’ attitudes and beliefs about teaching and learning mathematics, the following categories were assigned the following percentage cut-off points:

- ‘Very sure’ – 90%
- ‘Sure’ – 75%
- ‘Fairly sure’ – 60%
- ‘Not sure’ – 50%

Using these cut-off points, the following data statements can be reported:

**Data Statement 4.3**
At the end of their studies pre-service primary school teachers were very sure that:

- learning methods of problem-solving, mental methods of calculation, mathematical facts (e.g., multiplication tables) and standard written procedures for carrying out calculations were all important aspects of mathematical learning;
- being able to improvise mathematical approaches to solving problems, apply known mathematics in unfamiliar contexts, undertake open-ended mathematical investigations and explain mathematics to others were also very important aspects of mathematical learning; and
- teaching style, time devoted each day to maths and classroom organisation could impede student learning in mathematics.
Looking Deeper into the Data: Going Beyond Descriptive Statistics

The initial analysis of the survey data using descriptive statistics provided information from which a profile of the pre-service primary schoolteacher on the eve of their transition into teaching could be created. However, the descriptive statistics do not establish whether or not there are deeper relationships between the three sections of the survey.

If a respondent indicated that they had had a negative experience of mathematics at school, did this mean they were more likely to respond a certain way when asked questions about their attitudes and beliefs about teaching and learning mathematics than someone who did not report having a negative school experience? Would a respondent who thought mathematics was going to be one of the hardest or least enjoyable curriculum subjects to teach respond

### Data Statement 4.4
At the end of their studies pre-service primary school teachers were sure that:
- they had the capacity to assist students in developing their ability to explain mathematics to others;
- the type and availability of learning materials could impede student learning in mathematics; and
- mathematics was an exercise in logical thinking and that most students can understand it.

### Data Statement 4.5
At the end of their studies pre-service primary school teachers were fairly sure that:
- they had the capacity to assist students in developing their ability to improvise mathematical approaches to solving problems, apply known mathematics in unfamiliar contexts and undertake open-ended mathematical investigations;
- most students could understand more complex mathematical concepts;
- while most students could be expected to enjoy mathematics they could still be good at maths even if they didn’t like it; and
- textbooks and other written resources could impede student learning in mathematics.

### Data Statement 4.6
At the end of their studies pre-service primary school teachers were not sure:
- whether or not learning mathematics would be hard work for most students.
differently to some attitudinal items than a respondent who did not think the same way?

To see if there were differences between groups within the survey sample a second cycle of data reduction was undertaken to:

- create statistically and theoretically viable IVs related to ‘school experience of maths’ and ‘pre-service expectation of teaching maths’; and
- create five statistically viable DVs from the original 23 attitudinal items using Principal Component Analysis (PCA).

These variables were then used to conduct a series of Analysis of Variance (ANOVA) tests to determine whether or not significant differences between groups did occur within the survey data collected. This second cycle of data reduction was necessary as a “general rule” of data analysis is to “get the best solution with the fewest variables” (Tabachnick & Fidell, 2001, p. 11). The number of variables used in analyses is an important consideration for researchers as having “too many variables relative to sample size” can decrease the extent to which the findings of data analysis can be generalised to the wider population (Tabachnick & Fidell, 2001, p. 11).

The Independent Variables (IVs)

Prior to further analysis using ANOVAs, the variables related to ‘school experience of maths’ and ‘pre-service expectation of teaching maths’ were converted into “dichotomous or two-level variables” so they could be “appropriately analysed” using correlation methods (Tabachnick & Fidell, 2001, p. 6). These converted variables to be used as IVs in the next cycle of data analysis are reported in Box 4.4. Care was also taken to ensure that the categories within each dichotomous variable were roughly equal in size as “uneven splits between the categories...[can]...present problems” during analysis (Tabachnick & Fidell, 2001, p. 6).
Once the categories were formed they were examined to see if they could be justified in light of the extant literature and research relating to pre-service and beginning teachers and mathematics education.

For both the ‘school experience of maths’ and ‘pre-service expectation of maths’ variables, the two categories within each variable can be defined as either ‘negative’ or ‘not negative’. The concept of using negativity as a category in relation to pre-service primary school teachers school experience of maths and their understanding about what maths was going to be like to teach has already been established in the initial analysis of the data collected from this survey (see School Experience of Mathematics and Teaching Mathematics Compared to Other Curriculum Areas sections of this report).

It was also established that these results were generally consistent with other national and international research (COAG, 2008; Grootenboer, 2003; Lang, 2002; Macnab & Payne, 2003) that:

- “present a common theme of negativity when reporting on the …[mathematical]…school experiences of pre-service primary school teachers” (Grootenboer, 2003, p. 27); and
• acknowledge that mathematics is “not recognised as an easy subject to learn or teach” (COAG, 2008, p. 1).

When converting the 'pre-service expectation of maths' variables the issue of missing data had to be resolved. As previously reported, there was a 20% non-response rate to this survey question. When confronted with missing data within completed surveys the researcher must decide whether to continue analysis without the data or replace the missing data using one of a number of valid statistical procedures (Tabachnick & Fidell, 2001).

In making the decision to continue the analysis without replacing the data, the randomness of the missing data was investigated using a series of cross tabulations. These cross tabulations showed that the respondents who did not complete this question correctly, or at all, were not overrepresented in either of the two categories in any of the 'school experience of maths' variables.

Using Principal Component Analysis (PCA) to Identify the Dependent Variables (DVs)

Once the dichotomous IVs had been created, the remaining 23 survey items relating to aspects of mathematical learning, teacher confidence, attitudes towards mathematics and potential impediments to students' mathematical learning, were reduced using Principal Component Analysis (PCA), which is a “standard tool in modern data analysis” (Schlens, 2009, Introduction, p. 1). PCA is a technique that reduces data by using the correlations among variables to identify the underlying structure of the data set and create a smaller set of components or super-variables from it (DeCoster, 1998; Schlens, 2009; Statistical Analysis Software [SAS], n.d.; Tabachnick & Fidell, 2001).

In the context of this survey, while the 23 items had been organised into four questions when presented to respondents, they had not been tested previously to determine statistically what sets of items “hang together” (DeCoster, 1998, p. 2) to “reveal the sometimes
hidden, simplified structures that often underlie” a data set (Schlens, 2009, Introduction, p. 1). The application of PCA to these 23 survey items ultimately identified 16 items that could be reliably grouped into five uncorrelated components or super-variables. These super-variables were then used as the Dependant Variables (DVs) in the subsequent analyses that investigated the type and nature of relationships that existed within the survey data.

Determining the Number of Components Using PCA

When PCA is performed on data it extracts the same number of components as there are items and ranks them depending on how much of the total variance they account for. The first component extracted in PCA “can be expected to account for a fairly large amount of the variance...[while]...each succeeding component will account for progressively smaller amounts of variance” (SAS, n.d., p. 21).

The next task for the researcher is to determine how many of the extracted components are “meaningful” and should be retained for interpretation (SAS, n.d., p. 22). In the context of this study, the following three criteria were applied to the PCA to make this determination:

- the eigenvalues-greater-than-one rule (also known as the Kaiser criterion);
- the proportion of variance accounted for by components (with individual variance levels set at of 5% and a cumulative total target of 60%); and
- the interpretability criteria (using four rules to interpret the components and verify that they make sense in terms of the objects under study).

In PASW the default setting for retaining components is the “commonly used” Kaiser criterion, or the eigenvalues-greater-than-one rule (Cliff, 1988, p. 276). The initial PCA performed on the data from the 23 survey items extracted eight components with
eigenvalues greater than 1 that accounted for 63.45% of the total explained variance. However, as the Kaiser criterion can overestimate the number of reliable components in PCA (Cliff, 1988; Zwick & Velicer, 1984), other criteria were also applied to the components to determine their overall suitability (Cliff, 1988; SAS, n.d.; Tabachnick & Fidell, 2001; Zwick & Velicer, 1984).

A check of the proportion of variance accounted for by the components showed that, while the cumulative total of the eight components met the 60% target set by the researcher, components 6, 7 and 8 all accounted for less than 5% of the total explained variance. As such, they were unlikely to be retained for interpretation but, prior to making that determination a further examination of how the 23 items were loading onto the components was conducted. As a result of this examination, seven items were removed from the PCA process based on their measure of communality and pattern of component loading.

Removing Items during PCA

A total of seven items (variables), as shown in Box 4.5, were removed from the PCA process after the initial PCA was performed. Ideally, variables should conform to a “simple structure factor pattern” where, if they load onto more than one component, they should have a “relatively high factor loading on only one component and...[lower] loadings on any other components” (SAS, n.d., p. 27).

The first test of the loading pattern of a variable is its communality. Communality is the “percent of variance in an observed variable that is accounted for by the retained components” (SAS, n.d., p. 13). If a variable has a large communality it means that it is “loading heavily on at least one of the retained components” (SAS, n.d., p. 13) and meets the first condition of the simple structure factor pattern.
Of the 23 survey items, three had a communality of less than .5 (where the maximum value is 1.0) and were removed from the second PCA on the basis that they did not load heavily onto any of the original retained components. A further four items were then removed based on their factor patterns as displayed on the component matrix for the initial PCA. Three of these items were removed because they were loading equally onto four different components and had no single, significant factor loading of greater than .5. The fourth item was removed because the one significant factor loading it did display (8.04) was loading onto Component 6 which was unlikely to be retained for interpretation as it accounted for less than 5% of the total explained variance.

Further Tests Applied During PCA

Following the removal of the seven items, PCA was undertaken on the remaining 16 items using the Oblimin with Kaiser Normalization rotation method (rotation converged in 5 iterations). As shown in Table 4.7, the PCA now identified five components that:
• had eigenvalues greater than 1;
• individually accounted for more than 5% of the total explained variance; and
• together accounted for 60.19% of the total explained variance.

An examination of the component correlation matrix (see Table 4.8) also confirmed that the analysis was “good”, as most residuals were small (less than .05) meaning that the five components were uncorrelated (Tabachnick & Fidell, 2001, p. 622).

Table 4.7: Total Variance Explained in Principal Component Analysis (PCA)

<table>
<thead>
<tr>
<th>Component</th>
<th>Total (eigenvalue)</th>
<th>Percentage of Variance</th>
<th>Cumulative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.556</td>
<td>15.97</td>
<td>15.97</td>
</tr>
<tr>
<td>2</td>
<td>2.257</td>
<td>14.11</td>
<td>30.08</td>
</tr>
<tr>
<td>3</td>
<td>2.072</td>
<td>12.95</td>
<td>43.03</td>
</tr>
<tr>
<td>4</td>
<td>1.500</td>
<td>9.37</td>
<td>52.40</td>
</tr>
<tr>
<td>5</td>
<td>1.246</td>
<td>7.79</td>
<td>60.19</td>
</tr>
</tbody>
</table>

Having satisfied both the eigenvalues-greater-than-one and proportion of total variance criteria, the components were then examined using criteria related to the “interpretability” of components (Hair, Anderson, Tatham & Black, 1998; SAS, n.d.; Tabachnick & Fidell, 2001). Applying these criteria to the PCA allow the researcher to “interpret the substantive meaning of the retained components and verify that this interpretation makes sense in terms of what is known about the constructs under investigation” (SAS, n.d., p. 26).

In the first instance the rotated structure matrix generated by the PCA (see Table 4.9) was examined to assess the significance levels and loading pattern of the variables across the components.

Table 4.8: PCA Component Correlation Matrix

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-0.048</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.053</td>
<td>-0.12</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.087</td>
<td>-0.13</td>
<td>-0.36</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.013</td>
<td>-0.38</td>
<td>-0.29</td>
<td>0.031</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Table 4.9: PCA Structure Matrix

<table>
<thead>
<tr>
<th>Variable</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
<th>Component 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.778</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.772</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>.707</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.705</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>-.822</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>-.752</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>-.745</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>-.719</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>.808</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>.714</td>
<td>-.208</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>.661</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>.244</td>
<td>.626</td>
<td></td>
<td>.866</td>
<td>-2.75</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.855</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>.203</td>
<td></td>
<td></td>
<td></td>
<td>.750</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.699</td>
</tr>
</tbody>
</table>

Note: Extraction Method: Principal Component Analysis Rotation Method: Oblimin with Kaiser Normalization

For a factor loading to be considered of practical significance in a sample size of 200 it needs to be at .40 or above (Hair et al., p. 112) and in general, a factor loading of .55 is considered to be “good”, .63 is “very good”, and .71 and above is “excellent” (Comrey & Lee, 1992, as cited in Tabachnick & Fidell, 2001, p. 625).

For a loading pattern to demonstrate “simple structure”, variables should load significantly onto only one component and any other component loadings should be very small (SAS, n.d.). For the purposes of this study, a very small factor loading has been defined as being less than .32 based on the recommendation that variables with factor loadings of less than .32 not be included when interpreting components (Tabachnick & Fidell, 2001, p. 625).

As shown in Table 4.9, all 16 variables loaded significantly (in excess of .60) onto only one component. These factor loadings exceeded the .40 recommendation for a sample of this size. Of the three variables that also loaded onto other components (variables 10, 12 and 15), none of these factor loadings exceeded .32 and would not be included in the subsequent interpretation of these components.
Having established the veracity of the 16 variables, the next step in applying the interpretability criteria to the PCA was to look at the make-up of the components themselves. Ideally, it is recommended that components contain at least three variables with significant factor loadings in order to be considered well defined (SAS, n.d.; Tabachnick & Fidell, 2001). As shown in Table 4.9, the first three components each contained four variables with significant factor loadings and met the more-than-three-significant-variables standard.

As the last two components contain only two variables with significant factor loadings, further tests were conducted on the variables in PAWS using the Pearson product-moment correlation coefficient. These tests were conducted as components that contain two variables with significant factor loadings may still be “reliable” if the two variables correlate highly with each other while being “relatively uncorrelated” with the rest of the variables (Tabachnick & Fidell, 2001, p. 622).

The results of these tests established that the variable pairs in the last two components were highly correlated to each other (correlations were significant at the 0.01 level) and not with the other component variables. These results, coupled with the excellent/very good factor loadings for the variables (.866/.885; and .750/.699) underpinned the decision to retain these components for further interpretation.

Interpreting the PCA

The final step in applying the interpretability criteria to the PCA is interpreting and naming the components based on the concepts measured by the loading variables. This process involved ensuring that all variables loading on a given component shared the same conceptual meaning and that all variables loading on different components measured different concepts (Hair et al., 1998; SAS, n.d.; Tabachnick & Fidell, 2001).
Once these checks were completed, the researcher named the components based on their understanding of the initial analysis of the survey data and the existing body of research and literature that provided the context for this study. These named components, with survey items and factor loadings, are reported in Table 4.10.
Table 4.10: Five PCA Components with Item Variables and Factor Loadings

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Item Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component 1</td>
<td>IMPORTANCE OF HIGHER ORDER MATHEMATICAL ABILITIES TO STUDENT LEARNING</td>
<td>undertake open-ended mathematical investigations (.778)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>improvise mathematical approaches to solving problems (.772)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>apply known mathematics in unfamiliar contexts (.707)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>explain mathematics to others (.705)</td>
</tr>
<tr>
<td>Component 2</td>
<td>TEACHER (LACK OF) CONFIDENCE IN THEIR CAPACITY TO DEVELOP STUDENTS’ HIGHER ORDER MATHEMATICAL ABILITIES</td>
<td>improvise mathematical approaches to solving problems (-.822)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>undertake open-ended mathematical investigations (-.752)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>apply known mathematics in unfamiliar contexts (-.745)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>explain mathematics to others (-.719)</td>
</tr>
<tr>
<td>Component 3</td>
<td>ATTITUDES ABOUT STUDENTS AS LEARNERS OF MATHEMATICS</td>
<td>learning mathematics is not hard work for most students (.808)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>most students understand mathematics (.714)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>most students are capable of understanding early algebraic ideas (.661)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>most students can be expected to like mathematics (.626)</td>
</tr>
<tr>
<td>Component 4</td>
<td>POTENTIAL IMPEDIMENTS TO STUDENT LEARNING</td>
<td>classroom organisation (8.66)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>type and availability of learning materials (.855)</td>
</tr>
<tr>
<td>Component 5</td>
<td>IMPORTANCE OF KNOWING SET MATHEMATICAL METHODS, FACTS, RULES AND PROCEDURES TO STUDENTS’ LEARNING</td>
<td>mental methods of calculation (.750)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mathematical facts (e.g., multiplication tables) (.699)</td>
</tr>
</tbody>
</table>

Note: The qualifying negative (lack of) has been included in the naming of Component 2 to reflect the direction of the variable factor loadings.
The Dependent Variables (DV)

It was this process of identifying, interpreting and naming the PCA components that provided the Dependent Variables (DV), as reported in Box 4.6, to be used in the next cycle of data analysis.

Box 4.6: Dependent Variables

‘importance of higher order mathematical abilities to student learning’

‘teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities’

‘attitudes about students as learners of mathematics’

‘potential impediments to student learning’

‘importance of knowing set mathematical methods, facts, rules and procedures to students learning’

Using Analysis of Variance (ANOVA) to Look Deeper into the Data

Multiple ANOVAs were conducted to test whether or not the type of school experience or pre-service expectation of maths respondents (classified as being either ‘negative’ or ‘not negative’ in the IVs) had significantly influenced their attitudes and beliefs about mathematical teaching and learning on the eve of their transition into the teaching profession (as measured by the responses made to the DVs created from the PCA).

These multiple ANOVAs were conducted in PASW and results are reported below. In the context of this study, while 0.05 is the generally accepted alpha level for statistical significance, i.e., \( p \leq 0.05 \), a post hoc Bonferroni adjustment to the significance alpha level was applied to the ANOVA results to control for the increased risk of Type I error that is a feature of conducting multiple ANOVAs (Hair et al., 1998; Tabachnick & Fidell, 2001). The Bonferroni adjustment was calculated at 0.01 which was then used as the
critical alpha level when determining statistical significance in the results, i.e., \( p \leq 0.01 \) ("Bonferroni adjustment", n.d.).

**Reporting the ANOVA Results**

The first analysis of variance (ANOVA) tested the effect of respondents’ enjoyment of mathematics at school on their attitudes and beliefs about mathematical teaching and learning as defined through the DVs.

**Table 4.11: Results ANOVA ‘school experience of maths’—Enjoyment**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>Sig. of F*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Between Groups</td>
<td>Within Groups</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities</td>
<td>Between Groups</td>
<td>.91</td>
<td>1</td>
<td>.906</td>
<td>4.181</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>41.39</td>
<td>191</td>
<td></td>
<td>.217</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>42.30</td>
<td>192</td>
<td></td>
<td></td>
</tr>
<tr>
<td>attitudes about students as learners of mathematics</td>
<td>Between Groups</td>
<td>.79</td>
<td>1</td>
<td>.792</td>
<td>4.223</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>34.69</td>
<td>185</td>
<td></td>
<td>.187</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35.48</td>
<td>186</td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of higher order mathematical abilities to student learning</td>
<td>Between Groups</td>
<td>.19</td>
<td>1</td>
<td>.191</td>
<td>.994</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>37.61</td>
<td>196</td>
<td></td>
<td>.192</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>37.80</td>
<td>197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>potential impediments to student learning</td>
<td>Between Groups</td>
<td>.34</td>
<td>1</td>
<td>.342</td>
<td>1.182</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>56.43</td>
<td>195</td>
<td></td>
<td>.289</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>56.77</td>
<td>196</td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of knowing set mathematical methods, facts, rules and procedures to students learning</td>
<td>Between Groups</td>
<td>.81</td>
<td>1</td>
<td>.811</td>
<td>2.619</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>61.02</td>
<td>197</td>
<td></td>
<td>.310</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>61.83</td>
<td>198</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Bonferroni adjusted significance alpha \( p \leq 0.01\) applied to results – ** indicates significance.

The results show that, while the DVs related to teacher confidence and attitudes about students show significance at the \( p \leq 0.05\) level, when the Bonferroni adjusted significance level is applied, \( p \leq 0.01\), the analysis is not significant for any of the DVs \( [F(1,191)=4.18, p=.042; F(1,185)=4.22, p=.041; F(1,196)=.99, p=.320; F(1,195)=1.18, p=.278; F(1,197)=2.62, p=.107] \).
The second analysis of variance (ANOVA) tested the effect of respondents’ experience of mathematics at school as being easy/difficult on their attitudes and beliefs about mathematical teaching and learning as defined through the DVs.

Table 4.12: Results ANOVA ‘school experience of maths’—Ease/Difficulty

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>Sig. of F</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities</td>
<td>Between Groups</td>
<td>1.36</td>
<td>1</td>
<td>1.356</td>
<td>.01</td>
<td>0.36 moderate</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>40.94</td>
<td>191</td>
<td>.214</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>42.30</td>
<td>192</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>attitudes about students as learners of mathematics</td>
<td>Between Groups</td>
<td>.46</td>
<td>1</td>
<td>.461</td>
<td>.120</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>35.02</td>
<td>185</td>
<td>.189</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35.48</td>
<td>186</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of higher order mathematical abilities to student learning</td>
<td>Between Groups</td>
<td>.15</td>
<td>1</td>
<td>.152</td>
<td>.374</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>37.65</td>
<td>196</td>
<td>.192</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>37.80</td>
<td>197</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>potential impediments to student learning</td>
<td>Between Groups</td>
<td>.001</td>
<td>1</td>
<td>.001</td>
<td>.960</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>56.773</td>
<td>195</td>
<td>.291</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>56.774</td>
<td>196</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of knowing set mathematical methods, facts, rules and procedures to students learning</td>
<td>Between Groups</td>
<td>.64</td>
<td>1</td>
<td>.638</td>
<td>.154</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>61.20</td>
<td>197</td>
<td>.311</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>61.83</td>
<td>198</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results show that, while the DV related to teacher confidence showed significance at the \( p=\leq0.05 \) level, when the Bonferroni adjusted significance level is applied, \( p=\leq0.01 \), the only variable with a significance level at the adjusted level was teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities.

The third analysis of variance (ANOVA) tested the effect of respondents’ experience of the relevance of the mathematics they studied at school to their everyday lives on their attitudes and beliefs about mathematical teaching and learning as defined through the DVs.
Table 4.13: Results ANOVA ‘school experience of maths’—Relevance

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>Sig. of F</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities</td>
<td>Between Groups</td>
<td>1</td>
<td>1.27</td>
<td>1.271</td>
<td>.01</td>
<td>0.34 moderate</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>191</td>
<td>41.03</td>
<td>.215</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>192</td>
<td>42.30</td>
<td>.164</td>
<td></td>
<td></td>
</tr>
<tr>
<td>attitudes about students as learners of mathematics</td>
<td>Between Groups</td>
<td>1</td>
<td>.35</td>
<td>.348</td>
<td>.177</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>185</td>
<td>35.13</td>
<td>.190</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>186</td>
<td>35.48</td>
<td>.177</td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of higher order mathematical abilities to student learning</td>
<td>Between Groups</td>
<td>1</td>
<td>.06</td>
<td>.063</td>
<td>.329</td>
<td>.567</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>196</td>
<td>37.74</td>
<td>.193</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>197</td>
<td>37.80</td>
<td>.193</td>
<td></td>
<td></td>
</tr>
<tr>
<td>potential impediments to student learning</td>
<td>Between Groups</td>
<td>1</td>
<td>.15</td>
<td>.148</td>
<td>.510</td>
<td>.476</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>195</td>
<td>56.63</td>
<td>.290</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>196</td>
<td>56.77</td>
<td>.290</td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of knowing set mathematical methods, facts, rules and procedures to students learning</td>
<td>Between Groups</td>
<td>1</td>
<td>.001</td>
<td>.001</td>
<td>.002</td>
<td>.966</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>197</td>
<td>61.834</td>
<td>.314</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>198</td>
<td>61.834</td>
<td>.314</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

One of the dependent variables produced a significance level at $p=0.01$, namely, *teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities.*
The fourth analysis of variance (ANOVA) tested the effect of respondents’ expectation of how enjoyable mathematics was going to be to teach on their attitudes and beliefs about mathematical teaching and learning as defined through the DVs.

Table 4.14: Results ANOVA ‘pre-service expectation of maths’—Enjoyable

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>SS0</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>Sig. of F</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>teacher (lack of)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>confidence in their</td>
<td>Between Groups</td>
<td>1.45</td>
<td>1</td>
<td>1.450</td>
<td>6.938</td>
<td>.01</td>
</tr>
<tr>
<td>capacity to develop</td>
<td>Within Groups</td>
<td>31.97</td>
<td>153</td>
<td>.209</td>
<td></td>
<td>.43</td>
</tr>
<tr>
<td>students’ higher order</td>
<td>Total</td>
<td>33.42</td>
<td>154</td>
<td></td>
<td></td>
<td>moderate</td>
</tr>
<tr>
<td>mathematical abilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>attitudes about students</td>
<td>Between Groups</td>
<td>.48</td>
<td>1</td>
<td>.484</td>
<td>2.505</td>
<td>.116</td>
</tr>
<tr>
<td>as learners of maths</td>
<td>Within Groups</td>
<td>28.98</td>
<td>150</td>
<td>.193</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29.46</td>
<td>151</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of higher order</td>
<td>Between Groups</td>
<td>.025</td>
<td>1</td>
<td>.025</td>
<td>.130</td>
<td>.719</td>
</tr>
<tr>
<td>mathematical abilities to</td>
<td>Within Groups</td>
<td>30.60</td>
<td>158</td>
<td>.194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>student learning</td>
<td>Total</td>
<td>30.63</td>
<td>159</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>potential impediments to</td>
<td>Between Groups</td>
<td>.01</td>
<td>1</td>
<td>.014</td>
<td>.049</td>
<td>.826</td>
</tr>
<tr>
<td>student learning</td>
<td>Within Groups</td>
<td>43.36</td>
<td>156</td>
<td>.278</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>43.37</td>
<td>157</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>importance of knowing set</td>
<td>Between Groups</td>
<td>.39</td>
<td>1</td>
<td>.394</td>
<td>1.812</td>
<td>.180</td>
</tr>
<tr>
<td>mathematical methods, facts, rules and procedures to students</td>
<td>Within Groups</td>
<td>34.35</td>
<td>158</td>
<td>.217</td>
<td></td>
<td></td>
</tr>
<tr>
<td>learning</td>
<td>Total</td>
<td>34.74</td>
<td>159</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the *maths as enjoyable to teach* independent variable, the ANOVA analysis revealed one statistically significant dependent variable at the $p=0.01$ level, namely, *teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities*. 

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The fifth and final analysis of variance (ANOVA) tested the effect of respondents’ expectation of how easy mathematics was going to be to teach on their attitudes and beliefs about mathematical teaching and learning as defined through the DVs.

Table 4.15: Results ANOVA ‘pre-service expectation of maths’—Easy

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>Sig. of F</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities</td>
<td>Between Groups</td>
<td>1.93</td>
<td>153</td>
<td>1.929</td>
<td>9.416</td>
<td>.01*</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>31.55</td>
<td>154</td>
<td>.205</td>
<td>.169</td>
<td>.353</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>33.47</td>
<td></td>
<td>1.929</td>
<td>9.416</td>
<td>.01*</td>
</tr>
<tr>
<td>attitudes about students as learners of mathematics</td>
<td>Between Groups</td>
<td>.17</td>
<td>150</td>
<td>.169</td>
<td>.867</td>
<td>.353</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>29.34</td>
<td>151</td>
<td>.194</td>
<td>.94</td>
<td>.718</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>29.51</td>
<td></td>
<td>.169</td>
<td>.867</td>
<td>.353</td>
</tr>
<tr>
<td>importance of higher order mathematical abilities to student learning</td>
<td>Between Groups</td>
<td>.03</td>
<td>158</td>
<td>.025</td>
<td>.131</td>
<td>.718</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>30.60</td>
<td>159</td>
<td>.194</td>
<td>.94</td>
<td>.718</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30.63</td>
<td></td>
<td>.131</td>
<td>.131</td>
<td>.718</td>
</tr>
<tr>
<td>potential impediments to student learning</td>
<td>Between Groups</td>
<td>.10</td>
<td>156</td>
<td>.095</td>
<td>.344</td>
<td>.559</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>43.34</td>
<td>157</td>
<td>.276</td>
<td>.276</td>
<td>.559</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>43.43</td>
<td></td>
<td>.344</td>
<td>.344</td>
<td>.559</td>
</tr>
<tr>
<td>importance of knowing set mathematical methods, facts, rules and procedures to students learning</td>
<td>Between Groups</td>
<td>.32</td>
<td>158</td>
<td>.321</td>
<td>1.470</td>
<td>.227</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>34.74</td>
<td>159</td>
<td>.219</td>
<td>.219</td>
<td>.227</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>35.07</td>
<td></td>
<td>1.470</td>
<td>1.470</td>
<td>.227</td>
</tr>
</tbody>
</table>

As with the previous three analyses one dependent variable produced a statistically significant result at the $p=0.01$ level, namely teacher (lack of) confidence in their capacity to develop students’ higher order mathematical abilities. The results show that the analysis for the DV related to teacher confidence was significant, $F(1,153)=9.42$, $p=.003$ (Cohen’s $d$ effect size=0.50; medium).

Respondents who thought mathematics was going to be either the most or second most difficult subject to teach were less confident of their capacity to develop students’ higher order mathematical abilities ($M = 2.34$, $SD=.43$) than respondents who did not think mathematics was going to be either the most or second most difficult subject to teach ($M=2.11$, $SD=0.48$).

The analysis is not significant for any of the remaining DVs [$F(1,150)=0.87$, $p=.353$; $F(1,158)=.13$, $p=.718$; $F(1,156)=0.34$, $p=.559$; $F(1,158)=1.470$, $p=.227$].
Therefore, based on the results of the multiple ANOVAs, the following data statement can be reported:

**Data Statement 4.7**
At the end of their studies, pre-service primary school teachers who are confident of their capacity to develop students' higher order mathematical abilities are more likely to:
- have experienced mathematics at school as being easy to do and relevant to their lives; and
- consider mathematics as a subject that is both easy and enjoyable to teach.

**Interpreting the ANOVAs**

Applying the Bonferroni-adjusted significance level to the ANOVA results reduced the increased risk of Type I error associated with making multiple, simultaneous comparisons in data. However, when controlling for Type I error through the application of more rigorous significance levels, the researcher is also increasing their risk of a Type II error occurring (Perneger, 1998; Saville, 1990) i.e., that “truly important differences are deemed non-significant” (Perneger, 1998, p. 1236).

Irrespective of whether the Bonferroni adjustment was applied to the ANOVAs, the issue of beginning teacher confidence in relation to classroom mathematical practice was identified as being an important, and ongoing, focus for this study.

**Qualitative Data Analysis**

**The Final Survey Question**

At the end of the survey participants were asked to articulate their personal philosophies of teaching and learning mathematics and identify how these philosophies would translate into their classroom practice. This question was free-response and limited space was provided for the written responses to encourage participants to be succinct and hopefully identify the key words and ideas that underpinned their developing identities as teachers of mathematics.
An open-ended, free-response question was used at the end of the survey to give respondents an opportunity to, for the first time in this survey, use their own words to “illuminate some aspect[s] of the phenomenon under study”, and to identify new themes and issues of importance to this study that had not been previously identified by the researcher (Teddlie & Tashakkori, 2009, p. 235).

**Preparing Data for Analysis: Data Entry**

The analysis of the qualitative data collected via the pre-service teacher survey was conducted using both Excel and Word office programs. At the same time that the data source was prepared for entry into PAWS by the researcher, an Excel spreadsheet was also constructed to contain all survey data. Once the individual records for each of the 200 respondents had been created using the unique numerical identifier on each survey, the responses to the final question were then added as a block of text ready for analysis.

Of the 200 survey respondents, 162 (81%) responded to this final question and the length of responses ranged from 3 to 75 words. While some focused on only one aspect of the question, allowing for limited analysis to occur, other responses were more comprehensive and provided insights into a range of respondents’ attitudes and understandings about mathematical teaching, learning and classroom practice.

**The Data Analysis Process**

The data collected from the final question was reduced and displayed using a repeated cycle of inductive and a priori coding that is most commonly associated with the constant, comparison method of qualitative data analysis (Miles & Huberman, 1994; Leech & Onwuegbuzie, 2008; Teddlie & Tashakkori, 2009). This method was selected as being appropriate in the context of this study as the “goal of constant comparison analysis is to generate a...set of themes” from data (Leech & Onwuegbuzie, 2008, p. 10).
The first stage of the coding process, known as open coding, used a combination of the Word Count and Keywords-in-Context (KWIC) techniques (Leech & Onwuegbuzie, 2008) to organise the data around respondent-generated and researcher-generated keywords, concepts and ideas. The second stage of the coding process, known as axial coding, involves grouping the open codes into categories (Leech & Onwuegbuzie, 2008). In this study, the keywords and the concepts and ideas they represented were displayed in frequency tables and then compared to the findings of other national and international research and literature to explain the patterns that were emerging within the data.

As a result of this examination, the keywords, concepts and ideas were coded into three categories: theories of teaching and learning mathematics; mathematics in the classroom; and mathematical confidence. The newly reduced data were then compared to the data statements generated from the quantitative component of the survey to identify similarities and differences within the data.

Open Coding using Word Count and Keywords-in-Context (KWIC)

Keyword identification, counting and examination were used as the initial means to code and reduce the data collected from the final survey question responses. As the responses were being entered into the Excel data source, a number of respondent-generated words and phrases (i.e., independent of the question wording) that kept appearing over and over again were identified.

Working from the “basic assumption...that the more frequently a word is used, the more important the word is” (Leech & Onwuegbuzie, 2008, p. 11), the responses were then transferred into a single Word document. The ‘Find’ function was then used to record the individual frequencies of these keywords and to examine how they were “used in context with other words” (Leech & Onwuegbuzie, 2008, p. 11) to determine what meaning they were given by the respondents and what underlying concepts, attitudes and beliefs they represented.
These keywords were then grouped into three sets of synonyms based on this contextual examination and the concepts underlying each set reflected the three components in the question stem: philosophy of teaching mathematics; learning mathematics; and how will they inform your classroom practice. Results of this coding are reported in Table 4.16.

Table 4.16: Respondent-Generated Word Count and Keywords-in-Context (KWIC) Analysis Results

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Total</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>relevant</td>
<td>32</td>
<td><strong>Teaching Mathematics</strong></td>
</tr>
<tr>
<td>real life/world</td>
<td>32</td>
<td>Mathematics teaching and mathematical activities should be relevant to students.</td>
</tr>
<tr>
<td>practical</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>meaningful</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>fun</td>
<td>28</td>
<td><strong>Learning Mathematics</strong></td>
</tr>
<tr>
<td>enjoyable</td>
<td>21</td>
<td>Mathematics has to be fun and engage the student for them to learn best.</td>
</tr>
<tr>
<td>engaging</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>interesting</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>hands-on</td>
<td>30</td>
<td><strong>Classroom Practice</strong></td>
</tr>
<tr>
<td>concrete</td>
<td>20</td>
<td>To make maths relevant and engage students use lots of hand-on activities and concrete materials.</td>
</tr>
</tbody>
</table>

As reported in Table 4.16, the most frequent keyword set used by respondents dealt with the issue of mathematical ‘relevance’. Mathematics teaching and activities had to be ‘relevant’ to students. The next most frequent keyword set dealt with the affective domain of student learning. Mathematics had to be ‘fun’ and ‘engage’ students for them to learn best. Finally, and often used directly with keywords from the first two sets, for classroom maths to be relevant and interesting it had to be ‘hands-on’ and use ‘concrete’ materials.

This process of examining the context of words related to the three components of the question stem was then extended by using the ‘Find’ function in Word to locate and count the occurrence of the following researcher-generated keywords:

- ‘student’ and ‘learn’ (which also located ‘learns’ and ‘learning’);
- ‘teach’ (which also located ‘teacher’ and ‘teaching’); and
- ‘math’ (which also located ‘maths’, ‘mathematics’ and ‘mathematical’).
Once located, each separate occurrence of the keywords was examined in context and classified based on what meaning it had been given by the respondent. Results of this coding are reported in Table 4.17.

Table 4.17: Researcher-Generated Word Count and Keywords-in-Context (KWIC) Analysis Results

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Count</th>
<th>Context</th>
<th>Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>students/</td>
<td>28</td>
<td>attitude to maths</td>
<td>student as an individual learner</td>
</tr>
<tr>
<td>learn</td>
<td>24</td>
<td>learning styles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>mathematical ability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>constructivist model</td>
<td>learning theory</td>
</tr>
<tr>
<td>teachers</td>
<td>25</td>
<td>attitude to maths</td>
<td>attributes of the teacher</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>teaching style</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>mathematical conceptual knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>teacher-as-facilitator</td>
<td>teaching orientation</td>
</tr>
<tr>
<td>maths</td>
<td>35</td>
<td>specific pedagogy, resources &amp; activities—puzzles, ICT, games, group work, cooperative learning, individual tasks</td>
<td>pedagogy</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>as a collection of facts, skills &amp; concepts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>problem-solving</td>
<td>curriculum</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>as a set of higher order abilities i.e., applying, explaining</td>
<td></td>
</tr>
<tr>
<td>anxiety</td>
<td>10</td>
<td>negative statements about their own capacity to do and/or teach mathematics</td>
<td>maths anxiety</td>
</tr>
</tbody>
</table>

It is important to note that it was at this stage that a fourth ‘keyword’ (anxiety) was included in the analysis and is reported in Table 4.17. Although ‘anxiety’ was not an actual word used by respondents, this category was identified by the researcher during the process of contextualising the other keywords. A response was classified as being ‘anxious’ whenever a respondent made a negative comment about their own capacity to ‘do’ and/or teach mathematics.

**Axial Coding: Using Categories to Consolidate Data**

The next step in the data analysis process was to group the coded data into categories. This process was informed by an examination of other research and literature related to the keywords, and the concepts and ideas they represented, to explain the patterns that were emerging within the data.

As a result of this examination, the following three categories were established: theories of teaching and learning mathematics;
mathematics in the classroom; and mathematical confidence. Table 4.18 details how the keywords, concepts and ideas were coded into the categories.

Table 4.18: Results of Axial Coding of Data Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Concept</th>
<th>Keywords/Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>theories of teaching and learning mathematics</td>
<td>attributes of the teacher</td>
<td>attitude to maths, teaching style, mathematical conceptual knowledge</td>
</tr>
<tr>
<td></td>
<td>teaching orientation</td>
<td>teacher-as-facilitator vs teacher directed</td>
</tr>
<tr>
<td></td>
<td>attributes of the student</td>
<td>attitude to maths, learning styles, mathematical ability</td>
</tr>
<tr>
<td></td>
<td>learning theory</td>
<td>constructivist model</td>
</tr>
<tr>
<td>mathematics in the classroom</td>
<td>relevant, fun and hands-on</td>
<td>relevant, real life/world, practical, fun, enjoyable, engaging, interesting, hands-on, concrete</td>
</tr>
<tr>
<td></td>
<td>pedagogy</td>
<td>specific pedagogy, resources and activities</td>
</tr>
<tr>
<td></td>
<td>mathematics curriculum</td>
<td>as a collection of facts, skills and concepts, problem-solving, as a set of higher order abilities</td>
</tr>
<tr>
<td>mathematical confidence</td>
<td>maths anxiety</td>
<td>negative statements about their own capacity to do and/or teach mathematics</td>
</tr>
</tbody>
</table>

**Category 1: Theories of Teaching and Learning Mathematics**

When recording their understandings about teaching mathematics, respondents tended to either focus on ‘teaching’ and/or ‘the teacher’. When responses were framed in terms of ‘teaching’, respondents described a “range of orientations...that could be placed on a continuum from traditional direct instruction to teacher-as-facilitator” (Brady, 2007, p. 147).

As in Brady’s (2007) study, while no respondents to this survey “advocated adopting solely a traditional direct teaching approach” (p. 147) some did identify that there was room for a balanced approach:

Child-centred approach with some teacher directed activities.

I feel that a mix of hands-on approach and a book approach is a great way to teach, especially mathematics.
I think that to teach mathematics effectively there needs to be a balance between traditional ‘written’ methods of teaching and constructivist contemporary methods.

Others were more firmly at the teacher-as-facilitator end of the continuum:

- The teacher should take on a facilitator role encouraging problem-solving group work.
- The teacher should allow students to discover and achieve independently and in groups. I think this is applicable to all KLAs.

When responses were framed in terms of ‘the teacher’, respondents more often identified teacher attitude as being an important attribute of an effective teacher of mathematics:

- Enthusiastic teacher = Enthusiastic students. Enthusiastic students = Lots of learning!

than they did their pedagogical knowledge:

- To be an effective teacher of mathematics it is important that one has skills in using a variety of teaching strategies which cater to the students’ needs.

or their content knowledge:

- To teach maths you need to have an understanding of the concepts in order to be able to teach students successfully.

When recording their understandings about learning mathematics, respondents focused on ‘the student’ as an individual learner with individual needs that had to be met in order for successful learning to occur.

Respondents identified that fostering a positive attitude towards mathematics and catering for different learning styles and ability levels were all important considerations when planning for student learning:

- Students need to be positive about maths.
- Individual learning styles need to be catered for.
Maths should be applicable to the skill level of the students, while allowing them to gain confidence and then extend their maths knowledge and ability.

This “view of learners as individuals” is closely aligned with ‘constructivist’ understandings of learning as “building upon existing knowledge” (Brady, 2007, p. 148), which was also evident in the responses:

For students to enjoy maths and learn, it needs to be related to their previous knowledge and their world.

I believe that every new maths concept should begin with concrete materials and draw on students' prior knowledge.

Students need to be able to construct their own learning and maths needs to be taught in a meaningful context.

I believe students' best learn how to do mathematics through constructing their own understanding of processes and problem-solving and having the opportunity to articulate this with peers and teachers.

Learning needs to be engaging for the students, building upon their prior knowledge.

Therefore, based on the results of the coding process, the following data statement can be reported:

<table>
<thead>
<tr>
<th>Data Statement 4.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of their studies pre-service primary school teachers' theories of mathematical teaching and learning are:</td>
</tr>
<tr>
<td>• primarily constructivist (where teachers facilitate and students build their own knowledge)</td>
</tr>
</tbody>
</table>

and are prefaced on the understanding that:

• a student's capacity to learn successfully is based on their attitude towards mathematics, their preferred learning style and their mathematical ability; and

• a teacher's capacity to teach successfully is based on their attitude towards mathematics, their pedagogical knowledge and their mathematical content knowledge.

**Category 2: Mathematics in the Classroom**

When describing how their understandings and beliefs about teaching and learning mathematics would inform their classroom practice, respondents focused on practice being both the ‘curriculum’ and ‘pedagogy’ of mathematics.
Some responses referred to mathematics as a discrete subject within the teaching program while others talked of integrating numeracy across the curriculum. Some responses viewed practice as teaching content (skills, concepts, rules, procedures, formula, and methods of problem-solving) with some also providing opportunities for students to apply, discuss and explain what they know. Other responses looked at practice as a range of pedagogical methods (cooperative learning, individual work, group work) and/or processes (introducing the concept and then building knowledge using different activities).

However, when looking at the frequency of terms and keywords across all the responses it was clear that mathematics in the classroom had to ‘motivate’, ‘engage’ and ‘interest’ all students through the use of activities that were ‘relevant’, ‘real-life’, ‘real-world’, ‘practical’ and ‘meaningful’, ‘fun’, ‘enjoyable’, and ‘hands-on’ using ‘concrete materials’. The use of these terms and keywords by pre-service primary school teachers to describe classroom practices that they believe would enhance students’ mathematical learning are consistent with the findings of other studies (Brady, 2007; Klein, 2008).

However, the authors of these studies also identify that the use of these terms are somewhat problematic in that mathematics teaching predicated on these understandings may not always be the most conducive for robust student learning in mathematics (Brady, 2007; Klein, 2008). Klein (2008) argues that when teachers “concentrate on fashioning the learning environment to supposedly make it non-threatening, ‘enjoyable’ and ‘relevant’” they often “teach little mathematics” and students do not have the “opportunity to construct robust mathematics and generative and idiosyncratic ways of thinking and reasoning in mathematics” (p. 311).

For Brady (2007), who looked particularly at pre-service teachers’ imagined classrooms, it was that they reflected a highly idealised view of teaching mathematics. In these imagined classrooms, “where mathematics was “fun and enjoyable” and lessons would be
“interactive and relevant”...learning was never going to be difficult or boring, even though some of the prospective teachers...[viewed mathematics]...as difficult and frightening” (p. 151).

Therefore, based on the results of the coding process, the following data statement can be reported:

**Data Statement 4.9**
At the end of their studies pre-service primary school teachers are most likely to imagine their mathematics classrooms as being somewhat idyllic spaces where learning is always:
- fun and enjoyable;
and lessons are always:
- relevant and meaningful; and
- incorporate lots of hands-on learning with concrete materials even though for some:
- their own views, experiences and expectations of mathematics and its teaching and learning acknowledge that this is not always so.

**Category 3: Mathematical Confidence**

When examining the responses to this survey question it became apparent that the thread of negativity that kept appearing at various stages of the data analysis was also present in the responses to the final survey question. As such, it was an issue that needed to be acknowledged and addressed in this study.

It is widely accepted—as it is based on strong research evidence—that many adults in Western societies suffer from maths anxiety (Grootenboer, 2003; Haylock, 2001) and that it is a significant issue for many primary school teachers and pre-service primary school teachers (Brady, 2007; Grootenboer, 2003; Haylock, 2001). Haylock (2001) identified that maths anxiety manifests itself in pre-service teachers as: feelings of anxiety and fear, stupidity and frustration; anxiety related to the expectations of others; anxiety related to teaching and learning styles; the image of mathematics as being difficult; and confusion about the language of maths.

The following statements made by 5% of the total survey sample, on the eve of their transition into teaching, illustrate just how debilitating maths anxiety can be for beginning primary school teachers.
I think mathematics is a hard subject to teach. I found that it is very difficult to explain to the children why we have to do it in a particular way.

I still find maths difficult.

I am someone that finds maths difficult.

I believe that every classroom should be a place of safety, respect and nurturing. However, my lack of mathematical ability is therefore seen, by me, as a potential threat to the abovementioned classroom environment.

Maths is a subject that I am not particularly confident in. I do work hard at learning mathematical concepts and I know I must continue to do so.

I am somewhat nervous about teaching maths—not because I am unable to do maths myself but I don’t know if I have the language to explain complex ideas; people may not understand what I’m trying to say.

Maths is a hard topic/subject to comprehend as a student and teacher.

I enjoyed learning mathematics, though am unconfident in teaching it as I have not had a lot of experience, and have doubts in my ability to teach it efficiently.

Don’t really have one [philosophy of teaching and learning mathematics] because I am petrified of maths and teaching maths from bad experiences at school.

I think in my early years I missed many maths fundamental steps which I then had to learn as an adult. This was not an easy thing to do. I feel determined that a student of mine will not have the same experiences! Hopefully!

**Integrating the Quantitative and Qualitative Data**

The final step in the data analysis process for this survey was the integration of the quantitative and qualitative data into a coherent whole that achieved the goals of the survey outlined in the introduction to this chapter. These goals were to:

- establish the representativeness of the survey sample;
- identify categories, themes and issues that would be used as initial filters and lenses when examining subsequent data collected as part of the study;
- provide a more detailed picture of the links between experience and the formation of beliefs, attitudes and understandings of pre-service primary school teachers; and
provide the first layer of information to be used in building the in-depth individual teacher case stories in the latter stages of the research.

This process of data integration involved another cycle of data reduction and comparison using the demographic profile information of the survey sample and the data statements generated through the analysis of the two types of data collected via the survey. At the end of this process the survey data was organised into three results sections:

- profile information;
- experience and expectation; and
- emerging tensions between theory and practice.

Once identified, each of the results sections were then examined to determine their overall representativeness based on comparisons with extant literature and research on pre-service primary school teachers and their beliefs, experiences and attitudes about teaching mathematics and their preparedness to teach mathematics.

Issues raised as a result of the survey data analysis were also examined to determine what, if any, implications they had for subsequent stages of the study.

**Pre-service Primary School Teachers’ Profile Information**

As reported in Table 4.19, and based on comparison with a number of reliable sources, the general personal and study-related details of the survey sample are highly representative of the total population of pre-service/beginning primary school teachers in Australia. Age and gender information of continuing research participants will be used for descriptive purposes only in the rest of the study.
On the eve of their transition into teaching, primary school teachers in Australia are:
- predominantly female; and
- mostly aged between 22-25 years old.

To qualify as primary school teachers in Australia they have:
- successfully completed a minimum of three subjects specifically related to mathematics/numeracy education and taught some mathematics in the primary school context through their participation in between 95-120 days of school-based professional experience as part of a 4-year undergraduate teacher education degree at an Australian university.

<table>
<thead>
<tr>
<th>Representative:</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources: MCEETYA, 2005; 2002 ACU, UC and CSU Handbooks; 2005 personal communications with ACU, UC and CSU Course/Maths coordinators; Louden et al., 2005; DEST, 2006a, 2006b; AEU, 2008; personal communication with ACT DET HR staff member.</td>
<td></td>
</tr>
<tr>
<td>Implications:</td>
<td>N/A</td>
</tr>
<tr>
<td>Further Action:</td>
<td>Y</td>
</tr>
<tr>
<td>Data on age and gender of research participants will be collected for descriptive purposes only.</td>
<td></td>
</tr>
</tbody>
</table>

**Pre-service Primary School Teachers’ Experience and Expectation of School Mathematics**

It has been established throughout this survey that the thread of negativity that kept appearing at various stages of the data analysis was generally consistent with the findings of other national and international research in relation to pre-service primary school teachers’ school experience of maths and their understanding about what maths was going to be like to teach (COAG, 2008; Grootenboer, 2003; Haylock, 2001; Lang, 2002; Macnab & Payne, 2003). As such, the survey results reported in Table 4.20 are highly representative of pre-service/beginning primary school teachers.

The analysis of data collected via this survey also established that there was a pattern of behaviour that emerged in relation to teacher confidence in their own capacity to develop higher order maths abilities in students and:

- their experience of school mathematics as being easy to do and relevant to their lives; and
• their expectation of mathematics as being a subject that is easy and enjoyable to teach.

As such, links between participants’ school experiences, how they compare teaching mathematics to other curriculum subjects, and the confidence they display in their own capacity to ‘do’ and/or teach mathematics will continue to be ongoing foci for this study.

Table 4.20: Survey Results—Pre-service Primary School Teacher Experiences and Expectations of School Mathematics

<table>
<thead>
<tr>
<th>On the eve of their transition into teaching, pre-service primary school teachers are more likely to:</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>• remember mathematics at school as a negative experience; and</td>
<td></td>
</tr>
<tr>
<td>• believe that mathematics will be one of the hardest and least enjoyable curriculum subjects to teach.</td>
<td></td>
</tr>
<tr>
<td>Pre-service primary school teachers who expect mathematics to be either the most, or second most, difficult subject to teach will be less confident of their capacity to develop students’ higher order mathematical abilities than those who do not.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Representative:</th>
<th>Y</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Implications:</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ANOVA results indicate a definite link between pre-service expectation of the difficulty of maths to teach and teacher confidence in their own capacity to develop higher order maths abilities in students. The results as a whole also show a pattern of relationship between negative school experiences and expectations and teacher confidence in the capacity which needs to be explored further.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Further Action:</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research participants involved in interviews/case story stages of study will be asked to record school experiences and rank curriculum subjects again for comparison and asked to elaborate further on these experiences and expectations (and any changes that have occurred in their responses) and how they affected their capacity/confidence as a beginning teacher.</td>
<td></td>
</tr>
</tbody>
</table>

**Emerging Tensions between Theory and Practice**

When comparing the quantitative and qualitative data as part of the integration process, it became increasingly apparent that there were a range of contradictions within the data based on how definite or ‘sure’ respondents’ seemed to be about the issues covered in the survey. These contradictions were framed as a list of ‘emerging tensions’ between what respondents’ ‘know’ as a result of their studies and what they ‘know’ from experience. These tensions are
listed in Table 4.21 and cover areas such as mathematics content, teaching orientation and learning theory, and respondents’ ideas about ‘good’ teachers of mathematics and students as learners of mathematics.

This interpretation of the data as a mismatch between the teaching, learning and classroom ‘ideal’ and the personal ‘real’ experiences of respondents as students and student teachers is consistent with the findings of other research and literature (Brady, 2007; Grootenboer, 2003; Haylock, 2001; Marland, 2007). This research and literature also suggest that while teacher education courses ‘challenge’ the “durable and powerful”, “personal and highly subjective” theories that pre-service teachers have when they commence their formal study (Marland, 2007, pp. 27-28), these ‘tensions’ are not always resolved appropriately at the completion of their study (Brady, 2007; Grootenboer, 2003; Haylock, 2001).

In the context of this survey, these ‘emerging tensions’ will be used as lenses when analysing data collected from interview and case/story research participants. The researcher will identify how the ‘tensions’ manifest themselves in an individual’s classroom practice and/or changing beliefs and attitudes and how, or indeed if, they are ‘resolved’ by participants in the early years of their teaching careers.
Table 4.21: Survey Results—Emerging Tensions between Theory and Practice

On the eve of their transition into teaching, pre-service primary school teachers are most likely to imagine their mathematics classroom as being somewhat idyllic spaces where:

- learning always happens

and lessons are always:

- fun and enjoyable;
- relevant and meaningful; and
- incorporate lots of hands-on learning with concrete materials

even though for some:

- their own views, experiences and expectations of mathematics and its teaching and learning acknowledge that this is not always so.

<table>
<thead>
<tr>
<th>Representative:</th>
<th>Y</th>
</tr>
</thead>
</table>

Implications: Y

Listed below as emerging tensions between what teachers’ ‘know’ as a result of their studies and how this contradicts what they ‘know’ from experience.

Emerging Tensions:

<table>
<thead>
<tr>
<th>I know what maths it is important for students to learn</th>
<th>but I’m not as sure that I can teach the higher order maths skills.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I know that most students can be expected to learn the mathematical skills, facts and methods that they need</td>
<td>but I’m not as sure that they will understand more complex mathematics and I’m not sure whether or not maths will be hard work for most students.</td>
</tr>
<tr>
<td>I know that learning and teaching is primarily constructivist (where teachers facilitate and students build their own knowledge)</td>
<td>but I think using traditional, teacher-directed teaching works sometimes as well.</td>
</tr>
<tr>
<td>I know that maths learning should be hands-on and use lots of concrete materials</td>
<td>but I don’t necessarily think that the use of textbooks and other written resources will impede student learning in mathematics.</td>
</tr>
<tr>
<td>I know that having a positive attitude to maths and enjoying maths is really important if students are going to learn maths</td>
<td>but I also know that students can still be good at maths even if they don’t like it.</td>
</tr>
<tr>
<td>I know that that it is really important that a teacher models a positive attitude towards maths and shows enthusiasm for it</td>
<td>but I also know that maths anxiety is an issue for many adults including teachers (and maybe even me).</td>
</tr>
<tr>
<td>I know it is important that teachers have a sound pedagogical and content knowledge</td>
<td>but I also know that some teachers may not have, or don’t feel that they have, this knowledge at the end of their studies.</td>
</tr>
</tbody>
</table>

Further Action: Y

Data collected from research participants involved in interviews/case story stages of this study will be examined using these understandings as filters in order to identify how the ‘tensions’ that apply to them as individuals manifest themselves in their classroom practice/changing beliefs and attitudes and how they are ‘resolved’.
Conclusion

This chapter provided a full description of the data analysis process and presented the initial data analysis results of the first stage of this study. The goals outlined in the chapter introduction have been achieved as the results of the data analysis have:

- established that the survey sample is highly representative of pre-service primary school teachers in Australia;
- provided a more detailed picture of the links between experience and the formation of beliefs, attitudes and understandings of pre-service primary school teachers;
- identified categories, themes and issues that will be used as initial lenses when examining data collected from the second stage of the study; and has
- provided the first layer of information to be used in building the in-depth individual teacher case stories of the third stage of the study.

In keeping with the data analysis framework of the overall research design, the results of the data analysis presented in this chapter will be integrated with the data collected and analysed from the second and third stages of this study. The result of this integration process will be presented in Chapter 7 where all the study data will be integrated to address the research questions and produce the findings of the study.
Chapter 5: The Beginning Teacher

Introduction

The data for the second stage of this study were collected by surveying and then interviewing ten beginning primary school teachers who had previously completed the pre-service teacher survey. As identified by Teddlie and Tashakkori (2009), a survey and interview data collection combination “allows for the strengths of each strategy to be combined in a complementary manner with the strengths of the other” (p. 240) to “generate complex mixed data” (p. 233).

The purpose of the second survey, administered at the end of the participants’ first year of teaching, was to collect baseline descriptive data about the first year experience and school context of the participants that, when analysed, would:

- describe the transition experience of these participants which would then be compared to the findings of other national and international research to determine how representative it was of beginning primary school teachers in general;
- identify points of interest, tension, contradiction and congruence within (comparing individual’s responses in both surveys) and between (comparing responses across the participants in this survey only) the data collected from participants that would inform the development of the interview guide; and
- provide the second layer of information to be used in building the in-depth individual teacher case stories in the final stage of the research.

The purpose of the interviews, conducted in the second year of the participants’ teaching careers, was to provide participants with an opportunity to actively participate in the data analysis process in order to:
• check the overall validity of the survey data analysis by providing clarification and/or suggesting alternative interpretations of the data results not previously considered;
• identify, describe and explain their attitudes and beliefs about teaching mathematics as a result of their teaching experiences; and
• provide the third layer of information to be used in building the in-depth individual teacher case stories in the latter stages of the research.

As such, the data collected at this stage of the study were the primary source of data used to address the second research question. It also provided another layer of description to the data used to address the first research question and provided baseline data for the third and fourth research questions (see Box 5.1).

Box 5.1: The Research Questions

Research Question 1
How does an individual’s experience of mathematics as a school student and as a pre-service teacher influence their beliefs and attitudes about mathematical teaching and learning on the eve of their transition into the primary school classroom? Data clarification and description provided.

Research Question 2
How do factors of school context and the first year experience reinforce and/or change beginning primary school teachers’ pre-existing beliefs and attitudes about teaching and learning mathematics?

Research Question 3
To what extent is a beginning primary school teacher’s classroom practice an artefact of their beliefs and attitudes formed as a result of their experiences as:
• a school student;
• a pre-service teacher;
• a beginning teacher;
• a teacher within a particular school context; and
• part of developing an individual teacher identity?

Research Question 4
Can we use these understandings of the links between teacher beliefs, attitudes and practice to construct a model that allows schools to provide more targeted and effective support for beginning primary teachers to develop as effective teachers of mathematics?

Note: bold font used to highlight specific parts of questions where survey data will be used in formulating answers.
The Data Analysis Process

As shown in Figure 5.1, the beginning teacher survey and interview data were analysed using a repeated cycle of data reduction, display, comparison and integration in a four-stage process that constantly refined the data so that robust and meaningful inferences could be made (Miles & Huberman, 1994; Punch, 1999; Onwuegbuzie & Teddlie, 2003). More detailed information about each stage in the data analysis process is provided in the following section.

Preparing the Data for Analysis

Prior to commencing the data analysis, the survey and interview data were converted into more easily managed data sources. The survey data was entered into an Excel spreadsheet and the interview data into a record of interview for each participant.

Survey Data

Before entering the data into the Excel spreadsheet, each survey question and/or item was given a descriptive code and each possible response to that question and/or item was allocated a numerical code starting at ‘1’ where ‘1’ was the most positive response. The coding process for the beginning teacher survey was closely aligned to that used previously in the pre-service teacher survey. This process also included reverse coding one survey item to ensure that the directionality of the responses was consistent with all other items when making comparisons within the data. More detailed information about question and item coding will be provided in the following reporting of the data analysis results.

Once the initial coding system was developed, the descriptive codes for the questions and/or items and individual responses were then entered into the data source ready for analysis. Information provided in comment boxes were added as text and linked to the appropriate question. Answers to the open, free-response questions were also added as blocks of text.
Figure 5.1: Data Analysis Process

Beginning Teacher Surveys and Interviews – Data Analysis Process

Stage 1

QUAN data – reduce, display, compare
- reduced using descriptive statistics
- displayed using frequency tables
- compared to other research
- compared to Pre-service Teacher data
- Data Statements and Data Checks generated

QUAL data – reduce, display, compare
- reduced using categories and a continuum to code responses
- displayed using matrix
- compared to other research
- compared to Pre-service teacher data
- Data Statements and Data Checks generated

Stage 2

QUAN and QUAL data - Integrated
- Data Statements and Data Checks compared and classified
- reduced to three results areas using selective coding
- displayed using survey results tables
- compared to other research

Beginning Teacher Survey Results
- Induction Profile
  establishing the induction experience as representative and ‘variance’ as a key study focus/lens
- School Context Profile
  establishing the school context experience as representative and ‘variance’ as a key study focus/lens
- Areas of Interest for Practice
  establishing inconsistency between beliefs and practice as a key study focus/lens

Stage 3

Key Focus Area (KFA) data – reduce, display, compare
- reduced by coding using KFAs
- displayed using matrices
- compared to study survey data
- compared to other research
- Data Statements and Data Checks generated

Stage 4

Integrating the Beginning Teacher Data
- Data Statements and Data Checks compared and classified
- reduced to three profile categories using selective coding
- displayed using profile category tables
- compared to other research

Beginning Teacher Survey Results
- Confidence
  establishing indicators of teacher confidence to profile development
- Coherence
  establishing indicators of school program coherence to profile development
- Consistency
  establishing consistency between beginning teacher beliefs and practice as a key focus/lens for the study

Source: Figure adapted from Figure 11.2 in Teddlie & Tashakkori, 2009, p. 277
Interview Data

Once the interviews were completed, a record of interview was created for each participant. The record of interview included visual components that allowed the researcher to include all the data associated with the interview—including the participants’ previously collected survey data that were used in the interviews—in one data source. For example, Box 5.2 shows how the responses of one participant to the question relating to their own experience of mathematics at school were recorded on their record of interview. As this question had been asked both at interview in 2007 and in the pre-service teacher survey in 2005, both responses were included.

Box 5.2: Sample of Use of Record of Interview

When transcribing the discussion that occurred as a result of comparing the pre-service and beginning teacher responses to this question into the record of interview, the researcher was able to link the text to the appropriate visual component. This meant that the researcher was able to access all relevant data from one data source when conducting the subsequent analysis. The researcher was also able to move the visual components within each record of interview to reflect where specific questions were asked and/or focus areas discussed in each interview to preserve the original ‘flow’ of the interview.
Analysing the Data

The first two stages of the process involved the initial analysis of data collected via the beginning teacher survey. This initial analysis of the survey data occurred separately to the analysis of the interview data as the survey was administered six to 12 months prior to the interviews being conducted and the results were used, in conjunction with the analysis of the pre-service teacher survey, to develop the interview questions and focus areas. Once the interviews were conducted, the survey and interview data were integrated and analysed in the third and fourth stages of the process to form a cohesive picture of the total data collected.

Stage 1: Individual Survey Questions

Data collected from each question in the survey were reduced and displayed using frequency tables and matrices, and where appropriate, were clarified, described and explained using the participants’ comments. The data displays and comments-based elaborations were then compared to those of other survey questions, to the findings of the pre-service teacher survey and other national and international research and literature, and/or to the researcher’s experiences to identify similarities and differences within the data. At the end of this process a range of data statements and data checks were generated for further investigation.

Stage 2: Integrating the Survey Data

Once all the survey questions had been analysed individually, the data statements and data checks generated from this process were further reduced using selective coding to compare and classify the data into three main areas. These areas were labelled as:

- induction profile;
- school context profile; and
- areas of interest for classroom practice.
The data was then displayed in three survey results tables and compared to the findings of the pre-service teacher survey and to the findings of other national and international research and literature. At the end of this process, the general representativeness of the induction and school context experience of the sample were established and the concepts of ‘variance’ and ‘inconsistency between beliefs and practice’ were identified as being key focus areas and lenses for the interviews and the overall study.

Stage 3: Analysing Interview Data in Key Focus Areas

The data collected from the beginning teacher interviews were analysed using the constant, comparison method of qualitative data analysis (Leech & Onwuegbuzie, 2008; Miles & Huberman, 1994; Teddlie & Tashakkori, 2009). This initially involved using a repeated cycle of inductive and a priori coding to reduce and display the data.

In the first stage of the coding process, known as open coding (Leech & Onwuegbuzie, 2008), the researcher grouped the classified words, phrases and chunks of text using the broad focus areas identified in the interview guide. In the second stage of the coding process, known as axial coding (Leech & Onwuegbuzie, 2008), the researcher grouped the classified data from all the participants into a separate document for each identified focus area.

Once the interview data were coded and grouped into the focus area documents, relevant pre-service and beginning teacher survey data were added to create a picture of relationships between each focus area and how they developed over the course of the study. The data were displayed using tables and matrices.

The data displays and comments were then compared to those of other key focus areas, the findings of the pre-service and beginning teacher surveys, other national and international research and literature, and/or the researcher’s experiences to identify similarities, differences and patterns that were emerging within the data. At the
end of this process, data statements and data checks related to the key focus areas were generated for further investigation.

Stage 4: Integrating the Survey and Interview Data

The final stage of the data analysis process involved integrating the analyses of the survey and interview data. The data statements and checks generated from the interview data were compared with the pre-service and beginning teacher survey results, and other national and international research and literature, and reduced using selective coding into three beginning teacher profile categories:

- confidence—a measure of the personal factors that influence beginning teacher development;
- coherence—a measure of the school and system factors that influence beginning teacher development; and
- consistency—establishing the consistency between stated beliefs and classroom practice as a measure of beginning teacher development.

These categories would then be used to profile participants, inform the selection of the case story participants, provide a framework for the presentation of the case stories, and provide the filters and lenses through which the data collected in the final stage of the study would be analysed.

Reporting the Data Analysis Results

The results of the beginning teacher survey and interview data analysis are reported in four stages to reflect the sequential order of the data collection and analysis process as shown in Figure 5.1 and detailed in the previous Analysing the Data section. The initial analysis of the survey data is reported in the first two stages, followed by the third stage initial analysis of the interview data, which was informed by the pre-service and beginning teacher survey analysis results. The data analyses are then integrated in the fourth stage to form a cohesive picture of the development of the beginning
primary teacher’s mathematical understanding and classroom practice based on the data collected via the beginning teacher survey and interview instruments.

**Stage 1: Beginning Teacher Survey—Individual Questions**

The following description of the first year teaching experience is based on the question-by-question analysis of data collected via the beginning teacher survey. It has been reported in the following three sections that reflect the organisation of the survey instrument:

- beginning teachers' professional development;
- the school context; and
- mathematical teaching practices.

**Beginning Teachers’ Professional Development**

The questions in this section of the survey focused on a range of experiences that a beginning teacher can have during the course of their professional ‘socialisation’ into the world of teaching. These experiences are designed to assist individuals to develop their identities as teachers in general and as teachers of mathematics in particular (Atweh & Heirdsfield, 2003; Eisenschmidt & Poom-Valickis, 2003; Moss & White, 2003; Pietsch & Williamson, 2007, 2009; Wang, Odell, & Schwille, 2008).

They can be formal or informal, structured or unstructured, planned or incidental, in-school or ex-school, individual or collaborative, imposed or self-initiated, pedagogy-focused or content-focused (Australian Association of Mathematics Teachers [AAMT], 1995; Beck, Kosnik, & Roswell, 2007; Ginns, Heirdsfield, Atweh, & Watters, 1997; Hudson & Beutel, 2007). The purpose of this section of the data analysis report is to identify what professional development activities, and combinations thereof, were undertaken by participants in their first year of teaching.
Participation in Induction and Mentoring Programs

The use of induction and mentoring programs within schools and school districts is a common method of supporting beginning teachers in their transition into the teaching profession (DEST, 2006; Eisenschmidt & Poom-Valickis, 2003; Pietsch & Williamson, 2007). During their first year as beginning teachers (see Table 5.1), all participants reported that they had participated in a formal induction program and had been assigned an in-school mentor.

Table 5.1: Participation in Induction and Mentoring Programs—Individual Combinations

<table>
<thead>
<tr>
<th>Individual combinations of participation</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>External formal induction program AND in-school mentor</td>
<td>5</td>
<td>50%</td>
</tr>
<tr>
<td>External formal induction program AND school-based formal induction program AND in-school mentor</td>
<td>3</td>
<td>30%</td>
</tr>
<tr>
<td>School-based formal induction program AND in-school mentor</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td>Participants who participated in some form of induction and/or mentoring program</td>
<td>10</td>
<td>100%</td>
</tr>
<tr>
<td>Totals</td>
<td>10</td>
<td>100%</td>
</tr>
</tbody>
</table>

This reported level of 100% participation in an “organised programme of support” (DEST, 2006, p. 2) is higher than the percentage reported in a recent national Australian study of former teacher education students. This study, the Survey of Former Teacher Education Students (DEST, 2006) found that “just over half (55.3 per cent) of the schools employing the new teachers had an organised programme of support in place for their new employees” (p. 2). However, this result can be explained by the fact that, as the ACT is a small, geographically compact metropolitan region, the ACT DET is able to run a mandatory centralised induction program for beginning (and new to the ACT) teachers.

At the time this data was collected, participants described this induction program as beginning with a full-day orientation to the Department prior to the commencement of Term 1, with participants then required to attend a further 8 half-day modules throughout the year. Four of these modules were compulsory (identified by participants as Cultural Awareness of Indigenous People, Acceptable
Use of ICT, The Professional Code of Ethics, and Mandatory Reporting) and four were elective in that teachers could select workshops over a range of topics. While some participants indicated that there were mathematics workshops offered as part of the suite of electives, no participants reported attending any of these as part of their induction.

Only one participant working within the public school system reported that they did not participate in the Departmental induction program (see Table 5.2), but clarified their negative response with the following comment:

Contract teacher—started T1W3.

Table 5.2: Participation in Induction and Mentoring Programs—By Type

<table>
<thead>
<tr>
<th>As a beginning teacher did you:</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>participate in a formal induction program external to your school*</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>participate in a formal induction program at your school</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>have an assigned in-school mentor</td>
<td>10</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

* Note: One participant taught at an independent school and did not have access to an external induction program.

At the time this data was collected it was possible that, if a beginning teacher was employed on a series of short-term contracts, they could work at a single school for an extended period of time without accessing the formal ACT DET induction program. This comment is consistent with the findings of other research (DEST, 2006; Pietsch & Williamson, 2007) that acknowledge beginning teachers who start their careers as casual or relief staff do not have access to the same level of support as their permanently appointed peers.

In addition to the ACT DET induction program, 50% of participants (see Table 5.2) reported that their school had provided an induction program for beginning, and new to the school, teachers. Typically, participants described these programs as providing general information on school-based administrative and organisational policies, procedures and expectations, and occurred prior to the start of the school year. Only two participants indicated that these
induction programs were ongoing after school commenced and no-one identified that their induction program had contained specific information related to mathematics.

Similarly, while all participants (see Table 5.2) reported that they had been assigned an in-school mentor as part of their induction as a beginning teacher, only three specifically identified that their mentor had assisted them with their mathematics program.

It is important to note the reported variance in experiences of participants within the three induction and mentoring programs is consistent with the findings of other studies and research that show that the mere existence of a support program for beginning teachers does not necessarily presuppose that there will be universal access to it (DEST, 2006; Pietsch & Williamson, 2007) or that it will be effective in meeting the individual needs of the beginning teacher (DEST, 2006; Eisenschmidt & Poom-Valickis, 2003; Pietsch & Williamson, 2007).

Data Check

This variance in the participants’ descriptions of the induction and mentoring programs they accessed as beginning teachers was also interesting in the questions they raised about how similar programs can be experienced—and reported—very differently by individuals. For example, the descriptions of the mandatory ACT DET induction program ranged from being brief and limited in their identification and explanation of the various program components:

It was a general info session—not specifically related to maths—one day duration.

to providing a more detailed explanation of the year-long program:

Departmental Induction Program (ACT)
• Initial Induction Seminar—"working in the Department"
• 8 associated professional development seminars
• 4 mandatory (code of conduct, mandatory reporting)
• Program ran throughout the year
• Maths PD as part of Induction Program available but optional
Did this variance mean that the participant who described the program as “a general info session” did not attend the rest of the year-long program? Or did they attend the 8 workshops and seminars, not realising that they and the initial seminar were components of a larger program? Was the program so misaligned with the individual needs of that participant that it really didn’t register with them as a support program at all? Or was the participant accessing the support they needed from within their school context? Or, is the variance a result of different levels of individual participant engagement with the survey instrument in particular and/or the study in general?

Similarly, there was also significant variance in the participants’ descriptions of their mentor program and relationship. Some participants described their mentor experience as a rather intense, daily collaboration where their mentor was heavily involved in all facets of their teaching experience:

Interacted with mentor on a daily basis. Assistance provided included advice on school policies, procedures and expectations. Also worked with mentor on programming and lessons which included mathematics and exploring appropriate teaching avenues and topics of maths for Kindergarten age group. Mentor also provided ‘listening post’ and advice past programming/lessons and in situations where I may be able to enhance my teaching including maths teaching.

Others described a more distant, sporadic relationship where the mentor was “on-call as required”:

I went to my mentor when I had questions.

When comparing and analysing these responses, it does not necessarily stand to reason that the beginning teacher in this sample who only “went to their mentor when they had questions” was worse off than their peer who “interacted with their mentor on a daily basis”.

Factors of school context can affect the way in which mentor programs operate in a particular site. Was the mentor in the same teaching team as the participant? If not, did the participant team plan with other teachers in their year groups and receive informal mentoring in their planning from this context. Was the role of the
‘assigned’ mentor in their school to provide more general, whole school, administrative advice only as a supplement to the teaching team-based support provided to the beginning teacher?

The competence, and confidence, level of the individual beginning teacher and the personalities of both the beginning teacher and the mentor may also be major factors in how induction and mentoring programs are structured and/or experienced. Research shows that the earlier a beginning teacher acquires a clear concept of themselves as a teacher the quicker they will progress through the initial ‘survival’ stage of teacher development (Eisenschmidt & Poom-Valickis, 2003; Fuller, 1969; Katz, 1972). This rate of progress will affect the type and frequency of support that an individual needs from their induction and mentoring support programs.

If there is a mismatch between the needs of the individual beginning teacher and the support provided to them then the program will not be a worthwhile experience. Similarly, if there is a mismatch between the personalities involved in mentoring relationships where mentors are ‘assigned’ by the school then the program will have limited success in providing support to the beginning teacher.

Therefore the following data statement can be reported, with the concept of ‘variance’ identified as a ‘check’ for further data analysis:

Data Statement 5.1
In their first year of teaching, beginning teachers in a small, geographically compact metropolitan region had access to an organised program of support that included a combination of:
• participation in a formal induction program (either in-school and/or ex-school); and
• meeting and working with an assigned in-school mentor.
This organised program of support:
• could vary significantly in its structure depending on individual school context; and
• generally did not provide support for beginning teachers specifically related to teaching mathematics.
Data Check: Variance
There was a considerable amount of variance in beginning teachers’:
• descriptions of program structures;
• experience of the programs; and
• access to these support programs.
Variance in access and program description was based on factors such as:
• employment status on commencement; and
• individual school context.
Variance in experience of these support programs may be based on:
• individual factors such as competence, confidence and personality
• school factors such as organisation of teaching staff and the teaching and
  learning programs; and
• how well the program aligns with, or meets, the needs of the individual
  beginning teacher operating in a particular context.

Participation in Other Mathematics-Related Professional Development Activities

Participants were provided with a list of other mathematics-related professional development activities and asked if they had participated in any of the activities in the first year of their teaching. As shown in Table 5.3, participation in external mathematics training was the most commonly undertaken activity in this list (70%), followed by regularly scheduled mathematics collaboration (50%), and individual or collaborative research on topics related to maths teaching (30%). Only one participant (10%) visited another school to observe mathematics teaching and none of the participants reported being members of the national Australian Association of Mathematics Teachers (AAMT), or a state-based maths teachers’ association, or a teacher network related to teaching mathematics.

Of the seven participants who had attended mathematics workshops or training, five attended ACT DET funded workshops related to the Count Me In Too (CMIT) early numeracy program including:

• CMIT (three workshops aimed at students in K-3 and focusing on number);
• Counting On (CMIT aimed at middle to upper primary focusing on number); and
• Count Me In Too Measurement (focusing on measurement).
Table 5.3: Other Professional Development Activities (Mathematics)—By Type

<table>
<thead>
<tr>
<th>In the last 12 months have you participated in:</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>workshops or training about mathematics education</td>
<td>7 70%</td>
<td>3 30%</td>
<td>10 100%</td>
</tr>
<tr>
<td>regularly scheduled collaboration, relating to teaching maths, with other teachers</td>
<td>5 50%</td>
<td>5 50%</td>
<td>10 100%</td>
</tr>
<tr>
<td>individual or collaborative research on a topic related to your maths teaching</td>
<td>3 30%</td>
<td>7 70%</td>
<td>10 100%</td>
</tr>
<tr>
<td>observational visits of mathematics teaching at another school</td>
<td>1 10%</td>
<td>9 90%</td>
<td>10 100%</td>
</tr>
<tr>
<td>a mathematics teacher related network (e.g., one organised by an outside agency)</td>
<td>0 0%</td>
<td>10 100%</td>
<td>10 100%</td>
</tr>
<tr>
<td>becoming a member of the national (AAMT) or a state maths teachers’ association</td>
<td>0 0%</td>
<td>10 100%</td>
<td>10 100%</td>
</tr>
</tbody>
</table>

At the time this data was collected, the CMIT professional development program was the only primary-focused mathematics training delivered by officers in ACT DET’s Literacy and Numeracy team. Participants did not have to pay to attend CMIT workshops and classroom release could be funded using some of the 15 professional development days allocated to beginning teachers in the first three years of their teaching. While the CMIT program also included network meetings held once a term after school for teachers using CMIT to meet and discuss teaching activities, none of the participants attended this part of the program.

Of the two participants who attending non-CMIT mathematics workshops or training, one had participated in a school-based orientation to Maths Tracks (a K-6 textbook-based maths program) as part of the implementation of the program at the school that year. The other participant had also attended a general, open workshop about using Maths Tracks to differentiate the curriculum and a workshop on open-ended problem solving in mathematics organised by ACT DET as part of the program of events marking the annual Literacy and Numeracy week celebrations.

When looking at the responses to this question by participant (see Table 5.4), all participants reported that they had undertaken some
form of professional development activity related to the teaching of mathematics in the first year of teaching.

Table 5.4: Other Professional Development Activities (Mathematics)—By Participant

<table>
<thead>
<tr>
<th>In the last 12 months have you participated in: (Key ● = yes)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>workshops or training about mathematics education</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>regularly scheduled collaboration, relating to teaching maths, with other teachers</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>individual or collaborative research on a topic related to your maths teaching</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>observational visits of mathematics teaching at another school</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>a mathematics teacher related network (e.g., one organised by an outside agency)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>becoming a member of the national (AAMT) or a state maths teachers' association</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

A comparison of these results with those of the previous question show that professional development activities were not necessarily associated with the participants' status as beginning teachers, i.e., they did not always occur as part of a formal induction program nor did their collaborations with colleagues necessarily occur as part of the participants' mentor program. This result shows that school-by-school variance in beginning teachers' support programs can be an indication of professional development being delivered via different combinations of system and school mechanisms and not that some beginning teachers are necessarily receiving less support than their peers.

Therefore the following data statement can be reported:

**Data Statement 5.2**

In their first year of teaching, beginning teachers in a small, geographically compact metropolitan region undertook some type of professional development activity related to their mathematics teaching.

This activity was:
- most likely to involve attendance at workshops or training;
- least likely to involve other outside-school activities such as observations of teachers at another school or memberships to mathematics-related teacher networks or associations;
- had an even chance of being regularly scheduled collaborations with colleagues; and
- was not necessarily associated with their status as beginning teachers i.e., did not occur as part of formal induction and/or with an assigned mentor.
Peer Observation and Feedback Related to Mathematics Teaching

As shown in Table 5.5, in their first year of teaching all participants reported that:

- their mathematics teaching had been observed by another teacher at their school at least once; and
- they had received feedback on their mathematics teaching from another teacher at the school at least once.

<table>
<thead>
<tr>
<th>In the last 12 months how frequently did other teachers at your school:</th>
<th>Once</th>
<th>2-3 times</th>
<th>Often</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>observe your maths teaching</td>
<td>30%</td>
<td>60%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td>provide you with feedback on your maths teaching</td>
<td>30%</td>
<td>20%</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: The survey instrument included a 4th response option of 'Never' but as no participants checked it for either of these items it has not been reported in this table.

Therefore the following data statement can be reported:

Data Statement 5.3
In their first year of teaching, beginning teachers in a small, geographically compact metropolitan region had, on at least one occasion, another teacher at their school:
- observe their maths teaching; and
- provide feedback on their maths teaching.

The School Context

The purpose of this section of the survey is to identify conditions that exist within the participants’ schools and classrooms and the extent to which they influenced what participants taught and how they taught it. Questions in this section looked at factors such as approaches to mathematics policies, curriculum organisation, programming and resourcing, and teacher collaboration as part of building a professional community.
School Organisation of Mathematics

Participants were presented with a list of different ways and means that schools commonly use to organise the teaching of mathematics and asked to identify what, if any, of these options were present at their schools. As shown in Table 5.6, the most common factors of school-based organisation of mathematics were:

- the use of scope and sequence charts to outline what concepts of mathematics had to be taught term by term (80%);
- having either mathematics curriculum committees (80%) and/or contact people (80%) who would typically monitor the maths teaching program and/or manage the maths resource budget; and
- having pre-set mathematics assessment items and diagnostic tests (80%) for teachers to use and administer.

Participants also reported that, of the schools in this sample:

- six had dedicated numeracy blocks within the school timetable where the whole school or sub-schools taught mathematics at the same time;
- six had some system of streamed maths classes where students were organised into ability-based classes across either the whole school or sub-school; and
- four had both of these systems in place at the same time.

Table 5.6: Mathematics Curriculum Organisers—By Frequency

<table>
<thead>
<tr>
<th>Does your school have any of the following:</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>maths scope and sequence chart that shows what has to be taught term by term</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>school-wide mathematics curriculum committee</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>designated maths curriculum contact person</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>prescribed maths assessment items and diagnostic tests</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>dedicated numeracy blocks (where the whole school/stage teaches mathematics at the same time)</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>streamed maths classes (where students move rooms to go to ability-based classes)</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>prescribed textbook-based maths program</td>
<td>2</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>
While all participants reported that their schools had at least three of these curriculum and/or teaching organisers in place, the individual school-based combinations of these organisers (as reported in Table 5.7) show that there is a significant difference in the amount, and type, of school level input into how individual teachers plan, program and teach mathematics in their classrooms.

Table 5.7: Mathematics Curriculum Organisers—By School/Participant

<table>
<thead>
<tr>
<th>Does your school have: (Key ● = yes)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>maths scope and sequence chart that shows what has to be taught term by term)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>school-wide mathematics curriculum committee</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>designated maths curriculum contact person</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>prescribed maths assessment items and diagnostic tests</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>dedicated numeracy blocks (where the school/ stage teaches mathematics at the same time)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>streamed maths classes (where students move rooms to go to ability-based classes)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>prescribed textbook-based maths program</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

It is also important to note that just because a school has some of these mathematics curricula and teaching organisers in place, it does not presuppose that they will support a beginning teacher in their professional development or inform their classroom practice. This is highlighted by the comments of a participant who, despite having checked ‘yes’ to four of these options as being present at the school, had this to say about the school level support for mathematics:

Committee meets about twice a term mostly to buy resources. Scope and sequence chart created but then folded about half way through the year. Did have set text to follow but again was folded half way through the year after being told we have to follow Counting On etc.

Therefore the following data statement can be reported:

**Data Statement 5.4**
Beginning primary school teachers will be exposed to a range of teaching and/or curriculum organisers used to organise mathematics teaching in their school.

The extent to which the school-based organisation of mathematics influences the development of beginning teachers’ classroom practice will vary depending on the amount, and type, of school level input into how individual teachers plan, program and teach mathematics in their classrooms.
The fact that only two participants (20%) in this sample reported that their school used a prescribed textbook-based maths program as part of the whole school organisation of mathematics curriculum and teaching program was of interest to the researcher as this result seemed to contradict the generally held understanding, both nationally and internationally, of teachers’ continuing reliance on using textbooks in the teaching of primary mathematics (DEST, 2004b; Forrester, 2009; Jamieson-Proctor & Byrne, 2008). However, this result did not mean that the other participants did not use textbooks to plan, program and teach mathematics in their classrooms, it just meant that there was no official, whole school directive to use a particular textbook-based program in place at their schools.

This clarification of the data is supported by the results of other survey questions that show that, while only two participants reported that their school used a prescribed textbook-based maths program:

- 60% of participants reported that how they taught mathematics was influenced either ‘to some extent’ or ‘to a major extent’ by textbooks purchased by their school (see Table 5.10); and
- 40% of participants reported that what they taught in their mathematics program was influenced either ‘to some extent’ or ‘to a major extent’ by textbooks purchased by their school (see Table 5.11).

As such, the following data check can be generated:

<table>
<thead>
<tr>
<th>Data Check: Textbooks</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a result of an initial comparison of data collected via a number of different survey questions:</td>
</tr>
<tr>
<td>- how and why teachers use textbooks in their mathematics teaching has been identified as a potential ongoing issue of interest in the beginning teacher data analysis process.</td>
</tr>
</tbody>
</table>

**Mathematics Resources**

Participants were presented with a list of statements about resource-related conditions for maths teaching and asked to rate how ‘true’
each one was in the context of their school and classroom using the categories: ‘To a major extent’, ‘To some extent’, ‘To a minor extent’ or ‘Not at all’.

As shown in Table 5.8, all participants agreed that these statements about resources were ‘true’, to a greater or lesser extent, in the context of their schools and classrooms. The strongest agreement rate (i.e., that the statements were ‘true’ to a ‘major’ or ‘some’ extent) was with the statements that resources could be purchased easily through the participants’ school (100%) and that participants had access to quality concrete materials (90%).

Table 5.8: Availability of Mathematics Resources

<table>
<thead>
<tr>
<th></th>
<th>To a major extent</th>
<th>To some extent</th>
<th>To a minor extent</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>quality maths resources are able to be purchased easily</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>quality concrete materials are available for maths teaching</td>
<td>50%</td>
<td>40%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td>quality computer software is available for maths teaching and learning</td>
<td>40%</td>
<td>30%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>calculators are readily available for student use</td>
<td>20%</td>
<td>60%</td>
<td>20%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: The survey instrument included a fourth response option of ‘Not at all’ but as no participants checked it for any items it has not been reported in this table.

Therefore the following data statement can be reported:

**Data Statement 5.5**

In their first year of teaching, beginning teachers in a small, geographically compact metropolitan region reported that they were able to access quality mathematics resources in their schools to support their maths teaching.

**Data Check**

The fact that such a high percentage of participants reported that they were able to access quality maths resources in their schools was of interest to the researcher as this result contradicted the generally held understanding that, while the availability and quality of mathematical resources varies between individual educational settings, many schools and classrooms would not be described as being particularly well-resourced for mathematics teaching (DEST, 2004a, 2004b).
However, the fact that 60% of participants taught in the junior school may have a bearing on this result as evidence also suggests that many schools will be better resourced with materials, particularly ‘hands-on’ resources, for the early primary years than they will be with those materials more typically associated with use in the later primary years, such as ICT and calculators (DEST, 2004b). This general data clarification is supported by the hierarchy of responses related to the availability of particular types of resources (see Table 5.8).

In light of the fact that 70% of participants went on to report that how they taught mathematics was influenced either ‘to some extent’ or ‘to a major extent’ by access to quality resources (see Table 5.10), the following data check can be generated:

<table>
<thead>
<tr>
<th>Data Check: Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a result of an initial comparison of survey data to the findings of extant literature and research:</td>
</tr>
<tr>
<td>- resource availability and use in the classroom has been identified as a potential ongoing issue of interest in the beginning teacher data analysis process.</td>
</tr>
</tbody>
</table>

Collaborative Interactions with Peers about Mathematics

Participants were presented with a list of five possible types of interactions they could have with other teachers about mathematics. Using the response categories, ‘Almost daily’, ‘Weekly’, ‘Monthly’, and ‘Rarely’, participants were asked to record how frequently they experienced these types of interactions in their first year of teaching.

As shown in Table 5.9, the most frequent types of collaborative, mathematics-related interactions participants had with their peers were working together to prepare maths teaching materials (60%) and discussing how to teach maths concepts (60%), followed closely by participants working with their peers to assess students’ mathematical progress (50%). Only one participant reported that observations of their mathematics teaching by a teaching colleague occurred more than ‘rarely’ and visiting other schools to observe maths teaching was not common. This result is consistent with the
results of earlier survey questions about peer observation and feedback (reported in Table 5.5) and type and frequency of professional development activities undertaken by participants in their first year of teaching (reported in Tables 5.3 and 5.4).

Table 5.9: Collaborative Interactions with Peers about Mathematics

<table>
<thead>
<tr>
<th>How often did you have the following interactions with other teachers</th>
<th>Almost Daily</th>
<th>Weekly</th>
<th>Sub-total %</th>
<th>Monthly</th>
<th>Rarely</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>working together on preparing maths teaching materials</td>
<td>20%</td>
<td>40%</td>
<td>60%</td>
<td>10%</td>
<td>30%</td>
<td>40%</td>
<td>100%</td>
</tr>
<tr>
<td>discussions about how to teach a maths concept</td>
<td>10%</td>
<td>50%</td>
<td>60%</td>
<td>30%</td>
<td>10%</td>
<td>40%</td>
<td>100%</td>
</tr>
<tr>
<td>working together to assess your own and other students’ work in maths</td>
<td>10%</td>
<td>40%</td>
<td>50%</td>
<td>20%</td>
<td>30%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>informal observations of your maths lessons by other teachers</td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>0%</td>
<td>90%</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>visits to other classrooms to observe others maths teaching</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

After completing this question, participants were given an opportunity to identify the collaborative interactions they thought would be of greatest benefit to their mathematics teaching. Of the eight participants who responded to this question:

- six identified that they would like to have more ‘discussion’ and ‘sharing’ opportunities with their peers;
- three identified that they would like to do more ‘team planning’ for mathematics, including ‘programming’, ‘resourcing’ and ‘assessment and moderation’;
- three identified that they would like to observe other ‘expert’ teachers teaching mathematics with two specifically mentioning the integration of Interactive WhiteBoards (IWBs) and other ICT into the mathematics teaching program; and
- no participants identified that they would like to have their mathematics teaching observed more often.
Therefore the following data statement can be reported:

Data Statement 5.6
In their first year of teaching, beginning teachers in a small, geographically compact metropolitan region reported that they regularly work collaboratively with their colleagues outside the classroom preparing, discussing and planning for mathematics and think that these types of collaboration have the greatest benefit for their maths teaching.

Statements about Mathematics, Teaching and the School

Participants were asked to use the following response categories, ‘Strongly agree’, ‘Agree’, ‘Disagree’, or ‘Strongly disagree’, to record their responses to three statements about mathematics and teaching at their school. Of the three statements, one was reverse-worded (or reverse-scored) and then reworded in the data analysis stage to ensure that the directionality of the responses to this item was consistent with all other items, i.e., that ‘1’ was the most positive response score. Details of the rewording of this item are shown in Box 5.3.

Box 5.3: Re-wording the Reverse-worded Item

<table>
<thead>
<tr>
<th>Original Item</th>
<th>Re-worded Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>This school seldom evaluates its programs and activities</td>
<td>This school regularly evaluates maths programs and activities</td>
</tr>
</tbody>
</table>

As reported in Table 5.10, all participants agreed that they could get good advice from their colleagues when they had a maths teaching problem, with 80% of participants ‘strongly’ agreeing with that statement. However, while 90% of participants agreed that most teachers in their school were seeking and learning new ideas about maths teaching and that their school regularly evaluated its mathematics teaching programs and activities, only 50% ‘strongly’ agreed with these statements.
Table 5.10: Statements about Maths, Teaching and the School

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Sub-total %</th>
<th>Disagree</th>
<th>Strongly disagree</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can get good advice from other teachers in this school when I have a maths teaching problem</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Most teachers in this school are seeking and learning new ideas about maths teaching</td>
<td>50%</td>
<td>40%</td>
<td>90%</td>
<td>10%</td>
<td>0%</td>
<td>10%</td>
<td>100%</td>
</tr>
<tr>
<td>This school regularly evaluates its maths programs and activities*</td>
<td>50%</td>
<td>40%</td>
<td>90%</td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: The item marked with an asterisk (*) has been re-worded to reflect the reverse-coding process used for data analysis. Please refer to Box 5.4 or Appendix D in this report to see original item wording.

Therefore the following data statement can be reported:

Data Statement 5.9
At the end of their first year of teaching beginning primary school teachers:
- agreed that they could get good advice from colleagues when they had a maths teaching problem; and
- most agreed that their colleagues were actively seeking new ideas about teaching maths and that the school maths program and activities were regularly evaluated.

School and Classroom Factors that Affect Pedagogy

Participants were asked to use the following response categories: ‘To a major extent’, ‘To some extent’, ‘To a minor extent’, and ‘Not at all’, to identify the extent to which a range of school and classroom factors influenced ‘how’ they taught maths in their classroom. Results are reported in Table 5.11.

When looking at the ‘to a major extent’ and ‘to some extent’ categories together, by far the most important influence on ‘how’ the participants taught mathematics was student ability levels (100%) and interest in mathematics (90%). These were followed closely by class organisation (80%), school-set guidelines (80%), and advice, discussion and shared ideas with other teachers (80%).
Factors relating to access to resources (70%), time allocated for teaching mathematics (70%), class size (70%), and parent and community expectations (70%), were the next most important set of influences. Behaviour management issues (60%), and textbooks purchased by the school (60%), were identified by participants as having the least amount of influence on their mathematical pedagogy.

Therefore the following data statement can be reported:

**Data Statement 5.7**

At the end of their first year of teaching, beginning primary school teachers identified that student ability level and interest in mathematics had the most influence over how they taught mathematics.

**School and Classroom Factors that Affect Curriculum**

Participants were then asked to use the same response categories, ‘To a major extent’, ‘To some extent’, ‘To a minor extent’, and ‘Not at all’, to identify the extent to which a range of school and classroom factors influenced ‘what’ maths they taught in their classroom. Results are reported in Table 5.12.
### Table 5.12: Factors that Influence Mathematics Curriculum

<table>
<thead>
<tr>
<th>To what extent does each of the following influence WHAT maths you teach in your classroom</th>
<th>To a major extent</th>
<th>To some extent</th>
<th>Sub-total %</th>
<th>To a minor extent</th>
<th>Not at all</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>your understanding of what motivates your students</td>
<td>80%</td>
<td>20%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>the maths curriculum framework in your state or territory</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>guidelines set by the maths curriculum committee/contact person in your school</td>
<td>40%</td>
<td>40%</td>
<td>80%</td>
<td>0%</td>
<td>20%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>state education department/employer guidelines</td>
<td>10%</td>
<td>70%</td>
<td>80%</td>
<td>0%</td>
<td>20%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>parent and community expectations</td>
<td>10%</td>
<td>60%</td>
<td>70%</td>
<td>20%</td>
<td>10%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>textbooks purchased by the school</td>
<td>20%</td>
<td>20%</td>
<td>40%</td>
<td>30%</td>
<td>30%</td>
<td>60%</td>
<td>100%</td>
</tr>
<tr>
<td>state maths tests</td>
<td>0%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>40%</td>
<td>70%</td>
<td>100%</td>
</tr>
</tbody>
</table>

When looking at the ‘to a major extent’ and ‘to some extent’ categories together, by far the most important influences on ‘what’ mathematics the participants taught were their understanding of what motivated their students (100%) and the mandated ACT DET curriculum document: *Every Chance to Learn: Curriculum Framework for ACT Schools Preschool to Year 10* (100%).

Factors relating to school-set and other system-set guidelines (both 80%) were the next most important influences on what participants taught followed closely by parent and community expectations (70%). Participants identified textbooks purchased by the school (40%) and state maths tests (30%) as having the least amount of influence on the mathematical content that they taught.

Therefore the following data statement can be reported:

**Data Statement 5.8**

At the end of their first year of teaching, beginning primary school teachers identified that student motivation and mandated curriculum documents had the most influence over what mathematics they taught.

**Mathematical Teaching Practices**

The purpose of the final section of the survey was to identify any changes to participants’ understandings about mathematics teaching, learning and classroom practice as a result of their teaching experiences. The responses to these items provided a personalised focus to the subsequent interview questions about the effect of the
first year teaching experience on the development of mathematical classroom practice.

Participants were re-asked a question from the pre-service teacher survey about teaching important aspects of mathematical learning and were then asked to reflect on their pre-service statement regarding their philosophy of teaching and learning mathematics and how it would inform their classroom practice. Finally, participants were asked to identify what changes they wanted to make to their mathematics teaching in their second year of teaching, based on their first year experience.

Aspects of Mathematical Learning

In the pre-service teacher survey, participants had rated the importance of eight aspects of mathematical learning to students’ learning. These aspects were presented to participants in two separate groups.

The aspects in the first group were closely aligned to the traditional, and prevailing, teachers’ view of mathematics as a pre-existing set of methods, facts, rules and procedures (Brady, 2007; Ernest, 1989; Grootenboer, 2003). The aspects in the second group were described by Macnab and Payne (2003) as “higher level mathematical abilities” (Findings section, p. 8) and were more closely aligned with the view of mathematics as a dynamic and expanding field of human endeavour (Brady, 2007; Ernest, 1989; Grootenboer, 2003).

In the beginning teacher survey, participants were presented with the same eight aspects of mathematical learning and asked to identify how often they taught these aspects in the classroom using the response categories, ‘Always’, ‘Often’, ‘Sometimes’ and ‘Never’ to record their responses. As shown in Table 5.13, all participants reported that they ‘always’ or ‘often’ explicitly teach problem-solving methods (100%), and most reported that they ‘always’ or ‘often’ explicitly teach mental methods of calculation (70%) and
mathematical facts (70%). Only 40% of participants reported that they ‘often’ explicitly teach standard written procedures for carrying out calculations.

When identifying how often students had opportunities to develop the higher order mathematical abilities listed in these items, 80% of participants reported that their students were ‘often’ given opportunities to improvise problem solving methods, apply known mathematics in unfamiliar contexts and undertake open-ended investigations, and 70% reported that their students ‘often’ had opportunities to explain mathematics to others. No participants reported that students ‘always’ had opportunities to develop the higher order mathematical abilities listed in this item.

Table 5.13: Frequency of Teaching Various Aspects of Students’ Mathematical Learning

<table>
<thead>
<tr>
<th>How often do you explicitly teach:</th>
<th>Always</th>
<th>Often</th>
<th>Sub-total %</th>
<th>Some times</th>
<th>Never</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>methods of problem-solving</td>
<td>40%</td>
<td>60%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>mental methods of calculation</td>
<td>20%</td>
<td>50%</td>
<td>70%</td>
<td>30%</td>
<td>0%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>mathematical facts (e.g., multiplication tables)</td>
<td>10%</td>
<td>60%</td>
<td>70%</td>
<td>20%</td>
<td>10%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>standard written procedures for carrying out calculations</td>
<td>0%</td>
<td>40%</td>
<td>40%</td>
<td>60%</td>
<td>0%</td>
<td>60%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How often do your students get to:</th>
<th>Always</th>
<th>Often</th>
<th>Sub-total %</th>
<th>Some times</th>
<th>Never</th>
<th>Sub-total %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>improvise mathematical approaches to solving problems</td>
<td>0%</td>
<td>80%</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>apply known mathematics in unfamiliar contexts</td>
<td>0%</td>
<td>80%</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>undertake open-ended mathematical investigations</td>
<td>0%</td>
<td>80%</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>explain mathematics to others</td>
<td>0%</td>
<td>70%</td>
<td>70%</td>
<td>30%</td>
<td>0%</td>
<td>30%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Therefore the following data statement can be reported:

**Data Statement 5.10**

Based on the self-reports of beginning primary school teachers at the end of their first year of teaching, when observing their maths teaching an observer would:

- most likely see the explicit teaching of methods of problem solving;
- often see the explicit teaching of mental methods of calculation and mathematical facts; and
- sometimes see the explicit teaching of standard written procedures for calculations.

They would also:

- often see students being given opportunities to develop a range of higher order mathematical abilities.

The results of this question were then compared to that of the pre-service teacher survey question that asked participants to rate the importance of the eight aspects to students’ mathematical learning.

The aspects within each group were ranked based on the subtotal of the two most positive response categories in each question and then these rankings were compared across the two surveys. As reported in Table 5.14, this comparison showed that the overall ranking patterns of the pre-service and beginning teacher survey responses to these learning aspects were very similar.

**Table 5.14: Frequency of Teaching Various Aspects of Students’ Mathematical Learning Compared to Pre-service Importance Ratings**

<table>
<thead>
<tr>
<th>Aspects of Mathematical Learning</th>
<th>Pre-service Teacher Survey</th>
<th>Beginning Teacher Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>How important is it for students to learn:</td>
<td>How often do you explicitly teach:</td>
</tr>
<tr>
<td></td>
<td>Very Important/Important Sub-total %</td>
<td>Always/Often Sub-total %</td>
</tr>
<tr>
<td>methods of problem-solving</td>
<td>99% 1</td>
<td>100% 1</td>
</tr>
<tr>
<td>mental methods of calculation</td>
<td>98% 2</td>
<td>70% 2</td>
</tr>
<tr>
<td>mathematical facts (e.g., multiplication tables)</td>
<td>95% 3</td>
<td>70% 2</td>
</tr>
<tr>
<td>standard written procedures for carrying out calculations</td>
<td>90% 4</td>
<td>40% 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aspects of Mathematical Learning</th>
<th>Pre-service Teacher Survey</th>
<th>Beginning Teacher Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>How important is it for students to be able to:</td>
<td>How often do your students get to:</td>
</tr>
<tr>
<td></td>
<td>Very Important/Important Sub-total %</td>
<td>Always/Often Sub-total %</td>
</tr>
<tr>
<td>improvise mathematical approaches to solving problems</td>
<td>97% 1</td>
<td>80% 1</td>
</tr>
<tr>
<td>apply known mathematics in unfamiliar contexts</td>
<td>97% 1</td>
<td>80% 1</td>
</tr>
<tr>
<td>undertake open-ended mathematical investigations</td>
<td>96% 3</td>
<td>80% 1</td>
</tr>
<tr>
<td>explain mathematics to others</td>
<td>91% 4</td>
<td>70% 4</td>
</tr>
</tbody>
</table>
Therefore the following data statement can be reported:

**Data Statement 5.11**

Based on the self-reports of beginning primary school teachers at the end of their first year of teaching, the frequency with which they teach and/or incorporate the learning of particular aspects of mathematical learning into their classroom practice is directly related to how important they thought these aspects were to students’ mathematical learning at the end of their pre-service teacher education.

*Reflecting on Understandings of Mathematics Teaching, Learning and Classroom Practice*

The final two questions of the beginning teacher survey required participants to reflect on their first year experience of teaching mathematics and use this reflection to:

- define, clarify and/or refine their understandings about teaching and learning mathematics; and
- identify how their experience will affect their future classroom practice.

At the end of the pre-service teacher survey, participants had been asked to articulate their personal philosophies of teaching and learning mathematics and identify how these philosophies would translate into their classroom practice. Each participant’s response to this question was then copied into their uniquely numbered copy of the beginning teacher survey and participants were then asked to review their pre-service statements and update them on the basis of their first year teaching experiences.

As shown in Table 5.15, when recording their current philosophy of mathematics teaching and learning, eight participants (80%) agreed or confirmed that their pre-service understandings were still valid in light of their first year teaching experiences. They then went on to either elaborate on the meaning, or classroom application of, the ideas/concepts in their pre-service statement or introduce new ideas/concepts or understandings about classroom practice to describe their current philosophy.
Of the other two participants, one did not respond to the original question in the pre-service teacher survey and was simply asked to provide their current philosophy of mathematics teaching and learning. The other participant made no reference to their pre-service statement provided when providing their current philosophy, i.e., they just provided new, unrelated information and ideas.

Table 5.15: Initial Coding of Reflections on Mathematics Teaching Learning and Classroom Practice—By Participant

<table>
<thead>
<tr>
<th>Questions and Codes</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Current philosophy of maths teaching and learning</td>
<td>NA</td>
</tr>
<tr>
<td>Did participant agree (A), disagree (D) or not address (NA) with their pre-service statements?</td>
<td>N</td>
</tr>
<tr>
<td>Did participants elaborate (E) on their pre-service statements or add new (N) information?</td>
<td>Y</td>
</tr>
<tr>
<td>Proposed changes to maths teaching based on 1st year experiences</td>
<td>P</td>
</tr>
<tr>
<td>Focus of reflections on mathematics teaching, learning and classroom practice</td>
<td>L</td>
</tr>
<tr>
<td>Did reflections focus on self (S), teaching (T), teaching for learning (L) or students (St)?</td>
<td>1 Participant did not respond to this question in the pre-service teacher survey so was re-asked the original question rather than reflecting on their pre-service statements.</td>
</tr>
</tbody>
</table>

Therefore the following data statement can be reported:

**Data Statement 5.12**
Based on their self-reports at the end of their first year of teaching, most beginning primary school teachers identify that their pre-service understandings of mathematics teaching and learning are still valid and inform their current understandings of mathematics teaching and learning and developing classroom practice.

Participants were then asked to identify what, if any, changes they would like to make to their mathematics teaching in the next year based on their first year experiences and current understandings on mathematical teaching and learning. As reported in Table 5.15, participants proposed a variety of changes that could be coded into the following focus areas: teaching content, pedagogy, resources, or assessment. Changes relating to teaching content (‘problem solving’)
and pedagogy (‘rich tasks’, ‘best way to teach for different learning styles’) were most commonly proposed, followed by changes related to resources (‘include more ICT resources in the classroom’, ‘make more time to prepare maths resources’) and assessment (‘refining my assessment techniques’).

Therefore the following data statement can be reported:

Data Statement 5.13
Based on their self-reports at the end of their first year of teaching, beginning primary school teachers identified various issues related to teaching content, pedagogy, resources and student assessment as being focus areas for the ongoing development of their mathematical classroom practice.

Data Check

During the coding process it was also identified that, while all the changes proposed by the participants could be coded into the same four focus areas, the sample as a whole could be almost evenly ‘split’ into two dichotomous groups based on whether or not they framed their response in terms of changing and improving the overall structure of their mathematics teaching program. Of the nine participants who responded to this question, four participants (40%) specifically identified that they would like to change how they structured their mathematics teaching program in the coming year:

More solid structure...similar to the literacy block. Predictable, safe, enjoyable.

Structured scope and sequence for the whole year.

At the moment I do a ‘subject’ a week...Next year I will look at doing each subject for longer.

More ‘solid/designated’ time spent on key concepts/foundation skills.

This result was consistent with the initial analysis of data from earlier survey questions relating to school-based induction programs and curriculum organisers that identified that the mere existence of school level programs does not presuppose that they will support the development of beginning teachers’ classroom practice.
As such, the following data check has been generated:

**Data Check – Program Structure**

As a result of an initial analysis of survey data:
- mathematical program structure

has been identified as a potential ongoing issue of interest in the beginning teacher data analysis process.

The information provided in the last two survey questions was then coded as to whether it focused primarily on the participant, on teaching, on learning, or on students as individual learners. These coded categories, as described in Box 5.4, form a continuum that broadly tracks a beginning teacher’s progress through the initial ‘early teaching’ (Fuller, 1969, as cited in Fuller & Bown, 1975) or ‘survival’ (Katz, 1972) stage of teacher development, which “may last throughout the first full year of teaching” (Katz, 1972, p. 50).

This progress is characterised by a shift in the focus of the individual from meeting their own, normally short-term needs to meeting the individual needs of students (Fuller & Bown, 1975; Katz, 1972).

### Box 5.4: Mathematical Reflections Focus Continuum

<table>
<thead>
<tr>
<th>Self</th>
<th>Teaching</th>
<th>Learning</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self</td>
<td>Participant statements focus primarily on themselves and/or their own needs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>Participant statements focus on how and what they are teaching in the classroom.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning</td>
<td>Participant statements focus on learning as students start to gain equal importance as the teacher/teaching.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>Participant statements focus primarily on students as individual learners as opposed to a more homogenous collective.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coding categories and continuum are based on the seminal works of Katz (1972) and Fuller (1969), Fuller, Parsons and Watkins (1974) and Fuller and Bown (1975) that underpin our understandings of the developmental stages of teachers as they transition into their teaching careers.

As shown in Table 5.15, based on the statements they made regarding their past, current and future understandings about mathematics teaching and learning and classroom practice:
• two participants (20%) were strongly focused on the 'self' and how they were meeting their own needs;
• three participants (30%) were focused on being a teacher and what and how they were teaching;
• two participants (20%) were strongly focused on learning in that their statements about teaching and practice were linked to students learning; and
• three participants (30%) were on the cusp of the teaching and learning foci where the link between their teaching and student learning was beginning to appear in their statements.

Therefore the following data statement can be reported:

Data Statement 5.14
At the end of their first year of teaching, beginning primary school teachers will be located at various points along the continuum associated with moving through the initial 'survival' stage of teacher development.

Stage 2: Integrating the Survey Data

The final step in the data analysis process for this survey was the integration of the survey data analysis into a coherent whole that achieved the goals of the survey outlined in the introduction to this chapter. These goals were to:

• establish the representativeness of the survey sample in relation to the transition experience of beginning primary school teachers;
• identify points of interest, tension, contradiction and congruence that would inform the development of the interview guide and identify categories, themes and issues to be used as filters and lenses when examining subsequent data collected as part of the study; and
• provide the second layer of information to be used in building the in-depth individual teacher case stories in the final stage of the research.
This process of data integration involved another cycle of data reduction and comparison using the data statements and data checks generated through the analysis of the survey data. At the end of this process, the survey data were organised into three results sections:

- inducting the first year primary school teacher;
- the school context; and
- areas of interest for classroom practice.

Once identified, the first two results sections were examined to determine their overall representativeness based on comparisons with extant literature and research on beginning teacher transition and teacher development. This process also identified the implications of issues raised for the subsequent stages of the study.

The areas of interest identified in the third results section became focus areas for the beginning teacher interviews. The researcher wanted to collect more detailed data about the issues raised as a result of the initial analysis of the survey data prior to doing any further analysis and wanted to present the initial interpretations of the data to participants for their feedback.

**Inducting the First Year Primary School Teacher**

As reported in Table 5.16, and based on comparison with a number of reliable sources, while beginning teachers employed in ACT public schools reported having a greater opportunity to access a system-wide formal induction program than teachers in other states and territories, the general induction experience of the survey sample is highly representative of the broader population of beginning primary school teachers.

One of the major ways in which the induction experience of this sample is representative of that of the broader beginning teacher population is in how differently individual participants experienced very similar events and/or processes (DEST, 2006b; Eisenschmidt &
Poom-Valickis, 2003; Pietsch & Williamson, 2007). Although individuals participated in quite similar formal induction programs and worked in similar ways with in-school mentors, they reported quite different experiences of how these programs worked and opinions of how effective they had been in supporting their transition. As such, the general theme of ‘variance’ will continue to be an ongoing foci for this study.

Table 5.16: Survey Results: Inducting the First Year Primary Teacher

<table>
<thead>
<tr>
<th>In their first year of teaching beginning primary school teachers in the ACT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• had access to an organised program of support that included a combination of participation in some form of induction program and working with an in-school mentor.</td>
</tr>
<tr>
<td>However, the overall effectiveness of these programs in supporting beginning teacher transition into teaching varied depending on the nature of the program, the school context and the individuals involved.</td>
</tr>
<tr>
<td>Representitive: Y</td>
</tr>
<tr>
<td>Implications: Y</td>
</tr>
<tr>
<td>In providing insight into what type of support should be offered at different stages of a teacher’s development, is it a matter of designing a better program of support or is it finding better ways to match support to the needs of the individual?</td>
</tr>
<tr>
<td>Further Action: Y</td>
</tr>
<tr>
<td>Issue of variance to be further explored in interview and case story stages of the study.</td>
</tr>
</tbody>
</table>

The School Context

As reported in Table 5.17, the theme of ‘variance’ previously mentioned in relation to the general induction experience of beginning primary teachers is also present in the analysis of survey data pertaining to school context. It was established in this survey that the mere existence of a mathematics program structure at a school does not automatically mean that it will meet the development needs of individual teachers or that it will have a major impact on individual classroom practice. This finding was generally consistent with the findings of other national and international research that identified ‘program coherence’, a “measure of integration of the different elements in the school as an organisation” (DEST, 2004, p. 15) as an important factor in supporting teacher development as effective teachers of mathematics (DEST, 2004; Newmann, King, & Youngs, 2000; Newmann et al., 2001). As such, ‘program coherence’
will be used as a lens when investigating further the links between participants’ understandings about mathematics teaching, learning and their classroom practice.

Table 5.17: Survey Results—The School Context

<table>
<thead>
<tr>
<th>In the first year of teaching, beginning primary school teachers:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• taught in classrooms across Kindergarten to Year 6;</td>
</tr>
<tr>
<td>• were exposed to a range of teaching and/or curriculum organisers used to organise mathematics teaching;</td>
</tr>
<tr>
<td>• were able to access quality mathematics resources;</td>
</tr>
<tr>
<td>• regularly worked collaboratively with their colleagues to prepare, discuss and plan for mathematics;</td>
</tr>
<tr>
<td>• undertook some type of mathematics-related professional development</td>
</tr>
<tr>
<td>• felt that they could get good advice from their colleagues if they had a maths teaching problem; and</td>
</tr>
<tr>
<td>• most felt that their colleagues and school were actively seeking new ideas about teaching maths and regularly evaluating their maths activities and programs.</td>
</tr>
</tbody>
</table>

However, the extent to which the school-based organisation of mathematics, professional development undertaken and the professional collaboration of colleagues influenced the development of beginning teachers’ classroom practice varied depending on the overall coherence of the mathematics program within the school.

<table>
<thead>
<tr>
<th>Representative:</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources:</td>
<td>DEST, 2004; Newmann, King, &amp; Youngs, 2000; Newmann et al., 2001.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Implications:</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>With reference to how factors of school context support and influence the mathematical development of beginning primary school teachers, it would seem that it is the ‘sum of all parts’ that is more important than the individual pieces. How well the maths program, the PD program and the school as a learning community unify overall will determine the level of influence school-based programs will have on classroom teaching practice and supporting beginning teacher development.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Further Action:</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factors of school context and the overall program coherence will be focus areas for the interviews and case study stages of study.</td>
<td></td>
</tr>
</tbody>
</table>

Areas of Interest for Classroom Practice

As reported in Table 5.18, at the end of their first year of teaching, beginning teachers described their mathematical teaching programs and classroom practices as being strongly student-centred and that this primarily constructivist view of mathematical teaching and learning was closely aligned with their beliefs and understandings formed as a result of their pre-service teacher education.

However, when analysing the survey data as part of the data analysis process, a number of areas of interest were identified in
relation to what influences the development of beginning teachers’ mathematical programming (what they teach and how this is structured as part of the broader curriculum within the classroom), pedagogy (how they teach and what resources they use in the classroom), and their beliefs and understandings about teaching and learning. These areas of interest are reported in Table 5.18.

Table 5.18: Survey Results—Areas of Interest for Classroom Practice

<table>
<thead>
<tr>
<th>Areas of Interest:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics program structure (curriculum)</td>
<td></td>
<td>Includes textbooks, school organisers and mandated curriculum documents.</td>
</tr>
<tr>
<td>Mathematics teaching (pedagogy)</td>
<td></td>
<td>Includes textbooks, concrete materials, ICT, calculators.</td>
</tr>
<tr>
<td>The alignment of beliefs and practice</td>
<td></td>
<td>How close is the alignment of what teachers believe to what they do? Where does the closest alignment occur and where do mismatches occur? How have beginning teachers ‘resolved’ tensions between teaching beliefs (theory) and the reality of the classroom (practice)? What implications does this have for where they are in the teacher development process? What role has the school had in this process?</td>
</tr>
</tbody>
</table>

Further Action: Y

Areas of interest will be used as focus areas for the beginning teacher interviews and data from this stage of the study will be examined using these understandings as filters in order to identify how the ‘tensions’ manifest themselves in classroom practice and/or changing beliefs and how or if they are ‘resolved’.
These areas of interest were identified when data from one survey question seemed to contradict data from other survey questions and/or expectations based on the findings of existing research and literature. When comparing the data statements and data checks generated from the initial analysis of survey data as part of the integration process, these contradictions seemed to identify potential inconsistencies between what beginning teachers ‘say’ they do and what they actually ‘do’ in their classrooms.

This understanding that contradictions within and between the survey data highlight potential inconsistencies between participants' beliefs and their classroom practice is consistent with the findings of other research and literature (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006). These findings identify that in response to the ‘reality shock’ associated with their transition into the classroom, beginning teachers will initially teach in ways that are at odds with what they believe about mathematics teaching.

This research and literature also suggests that these inconsistencies are not always resolved quickly, appropriately or indeed at all, and that this will, to a large degree, determine how quickly beginning teachers progress through the various stages of teacher development and how effective their classroom practice is at the ‘end’ of the process (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006). In the context of this stage of the study, these ‘areas of interest’ provide focus areas for the subsequent beginning teacher interviews and are used as lenses in the next two stages of the beginning teacher data analysis process.

**Stage 3: Analysing the Interview Data**

During the course of analysing both the pre-service and beginning teacher survey data, a number of issues were identified as being of ongoing interest in this study. These issues were:
• the general pattern of relationship between school experience and pre-service expectations of maths and teachers' confidence in their own capacity to teach;
• the link between a teacher’s expectation of the difficulty of teaching mathematics and their confidence in their own capacity to develop students' higher order maths abilities;
• the role of school context and overall mathematics program coherence in beginning teacher development; and
• how teachers’ descriptions of teaching mathematics vary, contradict and/or support their theories about teaching and learning mathematics and provide insights into their development as teachers of mathematics.

In order to gain a better understanding of these issues, participants were asked to re-answer, review, compare, clarify and elaborate on their own responses to relevant questions from both surveys and/or comment on the researcher’s initial analysis of all the data collected from each survey.

The results of the initial analysis of the interview data are reported below and are organised into the following focus areas: school experience of mathematics; teaching mathematics compared to other curriculum subjects; teacher confidence and concerns about their mathematics teaching; using textbooks and hands-on resources in the classroom; factors that influence teacher decision making; and improving support for beginning teachers in mathematics. As the interviews involved supplementing the existing analysis of data from both the pre-service and beginning teacher surveys, each focus area analysis builds on previous survey data analysis results that identified areas of further investigation in this study.

School Experience of Mathematics

As detailed in The Literature Context (Chapter 2), there is extensive national and international research that firmly establishes that teacher’ beliefs, attitudes and understandings about the nature of mathematics as a field of study, themselves as “learners and doers
of mathematics” (Wilson & Thornton, 2006, p. 38), and how mathematics should be taught, are formed initially as a result of their own experience of maths at school as a student. These ‘pre-formal’ theories are subsequently challenged by the individual’s pre-service training experience and their experience of maths as a teacher and are then confirmed, modified or rejected (Grootenboer, 2003; Marland, 2007; Wilson & Thornton, 2006).

Therefore in the context of this study, where analysis of the pre-service teacher survey data identified that there was a relationship between the school experiences of participants and their confidence (or lack thereof) in developing students’ higher order mathematical abilities, it was important that participants were re-asked about their school experience of mathematics at interview to elaborate on their pre-service teacher survey responses to this question and identify what, if any, changes had occurred as a result of their initial teaching experience.

In both the pre-service teacher survey and beginning teacher interviews, participants were asked to record their own experience of mathematics at school on three semantic differential 7-point bipolar rating scales. Participants’ pre-service and beginning teacher responses to this question were then used to allocate them to one of two groups based on whether they had a ‘negative’ or ‘non-negative’ (i.e., either positive or neutral) experience of mathematics at school.

Each of the rating scales were presented as number line continua with 7 possible response values of ‘1’, ‘1.5’, ‘2’, ‘2.5’, ‘3’, ‘3.5’ or ‘4’ where ‘1’ was the most positive response, ‘4’ was the most negative response, and ‘2.5’ was the neutral, mid-point of each separate scale. In the pre-service teacher survey, data analysis process participants who registered a response of either ‘3’, ‘3.5’ or ‘4’ were classified as having a ‘negative’ experience for that scale. For the purposes of this data analysis process, an overall rating for each participant’s ‘school experience of mathematics’ was calculated by adding the three individual scale values together. This meant that ‘3’
was the most positive response and ‘12’ was the most negative response. Participants with an overall rating of between ‘9’ and ‘12’ were classified as having had an overall ‘negative’ experience of mathematics at school and all other participants were classified as having had a ‘non-negative’ (i.e., either positive or neutral) experience of school mathematics.

This consistency in the classification of participants’ responses across the study allowed for direct comparisons to be made between the participants’ pre-service and beginning teacher responses to this question and maintained the overall integrity of the data analysis process. The results of this classification process are reported in Table 5.19.

Table 5.19: Participants School Experience of Mathematics—Pre-service and Beginning Teacher Comparison

<table>
<thead>
<tr>
<th>School Experience of Mathematics</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10</td>
</tr>
<tr>
<td>2005 Pre-service Teacher</td>
<td>Overall mark</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Non-negative</td>
</tr>
<tr>
<td>2007 Beginning Teacher</td>
<td>Overall mark</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Non-negative</td>
</tr>
<tr>
<td>2005-2007 Comparison Change Category</td>
<td>Key: Nil = N</td>
</tr>
<tr>
<td></td>
<td>Minor = M</td>
</tr>
<tr>
<td></td>
<td>Significant = S</td>
</tr>
</tbody>
</table>

As shown in Table 5.19, the comparison of participants’ 2005 pre-service teacher responses with their 2007 beginning teacher responses resulted in the identification of three main change categories: ‘nil’, ‘minor’ and ‘significant’. Five participants (50%) were deemed to have had ‘nil’ changes occur as the total of their beginning teacher responses on the three rating scales was the same as the total of their pre-service responses and three
participants (30%) were deemed to have had a ‘minor’ change occur as the change that did occur in their responses did not affect the overall ‘negative’ or ‘non-negative’ classification of their ‘school experience of mathematics’.

So, for eight participants (80%) their first year teaching experience had no discernible effect on their recollection of their experience of maths at school and the following data statement can be reported:

**Data Statement 5.15**
Based on self-reports, the pre-service recollections of beginning primary school teachers’ own experience of school mathematics were generally unaffected by their initial experience of teaching.

This finding is consistent with the understanding that a teacher’s first theories of teaching and learning, formed as a result of their own experiences as a school student, are “durable and powerful” (Marland, 2007, p. 27) influences on their teaching as are their understandings of maths and themselves as maths ‘doers’ that are formed at the same time (Grootenboer, 2003; Wilson & Thornton, 2006).

**Data Check**

However, while eight participants’ (80%) initial experience of teaching did not have a discernible effect on their recollection of their own experience of mathematics, for two participants (20%) it did. These participants were deemed to have had a ‘significant’ change occur as the changes resulted in a re-classification of their overall ‘school experience of mathematics’.

When asked to explain why they thought their recollections had changed, one participant stated that their positive experience of teaching mathematics allowed them to reflect on the mathematics teaching they had received at school and re-evaluate it in a more positive light, hence the re-classification of their experience of school mathematics from ‘negative’ to ‘non-negative’. Similarly, the other participant explained that the change that led to a re-classification of their school mathematics experience from ‘non-negative’ to ‘negative’
was due to them comparing their positive beginning teaching experience to their experience of mathematics teaching at school and re-evaluating it as ‘boring’.

So, while the outcome of the re-classification process for these two participants was different, when using their positive experience of teaching mathematics to re-evaluate their own experience of school mathematics they both focused on **how the mathematics had been taught**. In contrast to this, when the participants whose recollections of school mathematics did not change significantly over time elaborated on their school experiences they tended to focus on **themselves as mathematicians or ‘doers’ of maths** regardless of whether these experiences were ‘negative’:

- Found it very difficult.
- I found it difficult.
- I was a very low achiever in maths.
- I couldn’t ‘do’ maths.
- I was struggling.

or ‘non-negative’:

- I was dyslexic and had trouble with literacy so maths and science were my joy because I could do it.

So, does the change in some participants’ perceptions and the ‘non-change’ in others indicate that teaching experience is more likely to challenge and modify aspects of an individual’s pre-existing theories of teaching mathematics than it will their understanding of maths as a field of study and/or themselves as mathematicians?

In the context of this study, how individuals use new experiences to critically analyse their existing theories of teaching and learning and indeed of themselves as maths teachers and/or maths ‘doers’ is of interest and as such the following data check has been generated:
Data Check: Experience as an Indicator of Theory and Self-Concept
As a result of comparative analysis of survey and interview data over time:
• the link between how an experience is remembered and the development of teaching and learning theory and teacher self-concept
has been identified as an ongoing issue of interest in the beginning teacher data analysis process.

Teaching Maths Compared to Other Curriculum Subjects

As detailed in The Pre-service Teacher (Chapter 4), pre-service primary school teachers who expected maths to be one of the least enjoyable and most difficult curriculum subjects to teach were less confident of their capacity to develop students’ higher order mathematical abilities than those who did not. Therefore, in the context of this study it was important that participants were re-asked about their attitude towards teaching maths compared to other curriculum subjects at interview to elaborate on their pre-service teacher survey responses to this question and identify what, if any, changes had occurred as a result of their initial teaching experience.

In both the pre-service teacher survey and beginning teacher interviews, participants were asked to rank, using the numbers 1 to 6, the core curriculum subjects of Society and Environment, Science and Technology, The Arts, Personal Development, Health and Physical Education (PDHPE), and English and Mathematics according to how ‘enjoyable’ and ‘easy’ they were to teach.

Participants’ responses to this question were then combined into one overall ‘1-6’ ranking scale which was used to allocate them to one of two groups based on whether they had a ‘negative’ or ‘non-negative’ (i.e., either positive or neutral) attitude towards teaching mathematics. In the pre-service teacher survey data analysis, participants who ranked Mathematics as either ‘5’ or ‘6’ were classified as having a ‘negative’ expectation of teaching mathematics, i.e., that it would be one the most difficult and least enjoyable subjects to teach. This classification scale was also used in the analysis of the beginning teaching responses to this question to allow direct comparisons to be made between the participants’
pre-service and beginning teacher responses and to maintain the overall integrity of the data analysis process.

As shown in Table 5.20, eight participants (80%) reported a more positive overall attitude towards teaching mathematics after their first year of teaching.

Table 5.20: Attitude towards Teaching Maths Compared to Other Curriculum Subjects—Pre-service and Beginning Teacher Comparison

<table>
<thead>
<tr>
<th>Teaching Mathematics—Attitude</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2005 Pre-service Teacher</td>
<td></td>
</tr>
<tr>
<td>Ranking (1-6)</td>
<td>6</td>
</tr>
<tr>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>Non-negative</td>
<td></td>
</tr>
<tr>
<td>2007 Beginning Teacher</td>
<td></td>
</tr>
<tr>
<td>Ranking (1-6)</td>
<td>3</td>
</tr>
<tr>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>Non-negative</td>
<td></td>
</tr>
<tr>
<td>2005-2007 Comparison Change Category</td>
<td>Key: Nil = N</td>
</tr>
<tr>
<td>S</td>
<td>M</td>
</tr>
</tbody>
</table>

Four participants (40%) were deemed to have had a ‘significant’ change occur as the changes resulted in a re-classification of their overall attitude towards teaching maths from ‘negative’ to ‘non-negative’. This meant that, while as pre-service teachers they expected maths to be one of the least enjoyable and more difficult subjects to teach in comparison to other curriculum areas, their actual experience of teaching maths was significantly more positive.

A further four participants (40%) were deemed to have had ‘minor’ changes occur as, while their overall ‘non-negative’ classification of their attitude towards teaching maths did not change, their actual experience of teaching maths in comparison to other subjects was more positive than their pre-service expectations, i.e., maths was ranked higher than it had been in the pre-service teacher survey.
As such, the following data statement can be reported:

**Data Statement 5.16**
Based on a comparison of survey and interview data, most participants reported a more positive overall attitude towards teaching mathematics compared to other subjects after their initial experience of teaching.

*Data Check*

Two participants (20%) were deemed to have had ‘nil’ changes occur in their overall attitude towards teaching mathematics despite the fact that they, along with the other participants, reported that their initial experience of teaching mathematics had been positive. For these participants their ‘negative’ pre-service expectation of teaching maths was realised as their actual experience of maths was that it was one of the least enjoyable and more difficult subjects to teach in comparison to other curriculum areas.

When asked to elaborate on their initial experience of teaching mathematics, both participants indicated that while they felt their maths teaching was successful overall, they were still concerned enough about certain aspects of their maths teaching to rank it second last or last in terms of enjoyment and difficulty. Teacher concerns will be examined in more detail as a separate key focus area of the beginning teacher data analysis process.

*Teacher Confidence and Concerns about Teaching Mathematics*

As mentioned in the previous key focus area, the data analysis process of the pre-service teacher survey identified that pre-service primary school teachers who expected maths to be one of the least enjoyable and most difficult curriculum subjects to teach were also more likely to be less confident of their capacity to develop students’ higher order mathematical abilities than those who did not. This definite link between pre-service teachers’ attitude towards teaching maths and their confidence to teach maths according to the “alternative, non-traditional…constructivist” (Frid & Sparrow, 2007, p. 295) teaching and learning model taught and promoted in primary
education degree courses (Frid & Sparrow, 2007; Sparrow & Frid, 2002) was identified as an area of further investigation for this study.

Therefore, having established in the beginning teacher interviews that most participants reported having a more positive overall attitude towards teaching mathematics after their initial experience of teaching it was important in the context of this study to determine if participants’ had a corresponding increase in their confidence to teach constructivist maths to students.

The first step in investigating this relationship further was to present the participants’ pre-service data relating to their ‘confidence’ so that they could be compared to the data collected about participants pre-service ‘attitude’ towards teaching mathematics and school ‘experience’ of mathematics. In the pre-service teacher survey, participants had been asked to rate their confidence in assisting students to develop four higher order mathematical abilities using the response categories: ‘Very confident’, ‘Confident’, ‘Not very confident’, and ‘Not at all confident’. As none of the participants in this stage of the study used the ‘Not at all confident’ rating in their pre-service teacher survey it does not appear as a classification category in further analysis of the data.

For the purposes of this analysis, participants’ responses to the four confidence items were first scored and then combined into one overall ‘confidence’ mark. In order to score the participant responses the following scoring system was used:

- ‘1’ for a ‘Not very confident’ response;
- ‘2’ for a ‘Confident’ response; and
- ‘3’ for a ‘Very confident’ response.

Based on this system, the minimum ‘confidence’ mark a participant could receive was ‘4’ and the maximum was ‘12’. This mark was then used to sort participants into one of three categories based on whether they were ‘not very confident’, ‘confident’ or ‘very confident’
of their capacity to develop students’ higher order mathematical abilities.

Seven participants (70%) had ‘confidence’ marks of ‘4’, ‘5’ or ‘6’ (i.e., they had rated themselves as ‘not very confident’ on at least two of the four confidence items) and were considered to be ‘not very confident’ overall of their capacity to develop students’ higher order mathematical abilities. Of the remaining three participants (30%), only one (10%) was deemed to be ‘very confident’ with the maximum ‘confidence’ mark of ‘12’, i.e., they rated themselves as ‘very confident’ on all four confidence items in the pre-service teacher survey. The other two participants (20%) had a ‘confidence’ mark of ‘8’ (i.e., they had rated themselves as ‘confident’ on all four confidence items) and were deemed to be ‘confident’.

Again, for the purposes of this analysis, these three categories were used to form two groups (‘not very confident’ and ‘confident/very confident’) and participants were then allocated to one of the groups. The decision to use two groups where one was primarily ‘negative’ (‘not very confident’) and the other was ‘non-negative’ (‘confident/very confident’) was made so that the classification scales used in the analysis of the ‘confidence’ items would be consistent with both the previous ‘school experience’ and ‘teaching attitude’ questions. As such, it would allow for more meaningful comparisons to be made between the participants’ pre-service and beginning teacher responses and to maintain the overall integrity of the data analysis process. The results of this classification process of participants’ pre-service teacher survey data are reported in Table 5:21.

As shown in Table 5.21, at the end of their pre-service teacher studies, seven participants (70%) reported that they were not very confident in their capacity to develop students’ higher order mathematical abilities; a major feature of a constructivist approach to teaching mathematics.
Table 5.21: Pre-service Teacher Confidence to Develop Students’ Higher Order Mathematical Abilities

<table>
<thead>
<tr>
<th>Teaching Mathematics—Confidence</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2005 Pre-service Teacher</td>
<td></td>
</tr>
<tr>
<td>Overall Mark (4-12)</td>
<td>5</td>
</tr>
<tr>
<td>Not Very Confident</td>
<td>●</td>
</tr>
<tr>
<td>Confident/Very Confident</td>
<td></td>
</tr>
</tbody>
</table>

As such, the following data statement can be reported:

**Data Statement 5.17**

Based on survey data, as pre-service teachers, most participants reported that they lacked confidence in their capacity to develop students’ higher order mathematical abilities.

The next step in investigating any changes between participants pre-service and beginning teacher confidence in their ability to teach constructivist maths was to interrogate the interview data to identify what participants were confident about or concerned about in relation to their mathematics teaching after their initial teaching experience.

In keeping with the data analysis process used in the pre-service teacher survey, the interrogation of the interview data was completed using a repeated cycle of inductive and a priori coding most commonly associated with the constant, comparison method of qualitative data analysis (Miles & Huberman, 1994; Leech & Onwuegbuzie, 2008; Teddlie & Tashakkori, 2009).

The first stage of this process, known as open coding, used the Keywords-in-Context (KWIC) technique to organise the interview data around respondent-generated and researcher-generated keywords associated with constructivist teaching and learning (including keywords used in both the pre-service and beginning teacher survey questions and responses) and the two bipolar contrasting descriptors ‘confidence’ and ‘concern’.

Interview transcripts were initially examined to locate and highlight a range of single words and/or word groups that were synonymous with the idea of ‘constructivism’ and ‘confidence’ versus ‘concern’.
Examples of the words and word groups identified within the interview transcripts are detailed in Box 5.5.

<table>
<thead>
<tr>
<th>Category</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructivism</td>
<td>fun, engage, hands-on, enjoy, attitude, content, concept, relevant, integrate, interesting, activity, teach, learn</td>
</tr>
<tr>
<td>Confidence</td>
<td>confidence, confident, happy, strengths, like, joy, better, can, did, positive, love, brilliant, do, well, good</td>
</tr>
<tr>
<td>Concern</td>
<td>concern, worry, can’t, didn’t, frustrating, struggling, tricky, hard, difficult, pressure, stressful, dissatisfied, challenge, problem</td>
</tr>
</tbody>
</table>

Once the words and/or word groups were highlighted, they were then examined to see how they were “used in context with other words” (Leech & Onwuegbuzie, 2008, p. 11) to determine what meaning they were given by the participant and whether they represented an area of teaching ‘confidence’ or ‘concern’ for the participant.

The second stage of the process, known as axial coding, involved grouping the participants’ statements (Leech & Onwuegbuzie, 2008) into categories that identified what aspects of their maths teaching they were confident or concerned about. This coding process was informed by the survey results of this study and an examination of the recent work of Frid and Sparrow (2007) that organised the knowledge, skills, understandings and competencies beginning teachers needed to teach primary mathematics constructively in contemporary Australian classrooms into a three-part pre-service teacher education framework.

Frid and Sparrow’s (2007) Three C’s Mathematics Framework identified that beginning teachers needed to have mathematics content knowledge (including a sound understanding of curriculum documents), pedagogical competence, and professional confidence in order to be “empowered” professionals capable of authentically
applying what they know about mathematics teaching and learning in the classroom (p. 297).

Using Frid and Sparrow’s (2007) framework as a base, the following four confidence categories were established in order to identify how participants were developing as teachers of mathematics in the early years of their careers: curriculum confidence, content area confidence, pedagogical confidence, and professional confidence. Table 5.22 defines each category and demonstrates how the participants’ statements and the concepts they represented were coded into the categories.

**Table 5.22: Results of Axial Coding of Data Categories**

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>curriculum confidence</td>
<td>Statements/data that show if the participant is confident/concerned about interpreting curriculum documents to construct a whole year’s maths program. Statements/data that show if the participant is confident/concerned about integrating maths with other areas of the curriculum.</td>
</tr>
<tr>
<td>content area confidence</td>
<td>Statements/data that show if the participant is confident/concerned about their general maths content knowledge and capacity. Statements/data that show if the participant is confident/concerned about their maths content knowledge and capacity relative to the year level they teach. Statements/data that show if participant is confident/concerned about their content knowledge in relation to selecting appropriate learning activities.</td>
</tr>
<tr>
<td>pedagogical confidence</td>
<td>Statements/data that show whether the participant feels they are teaching ‘constructively’ or not, i.e., the context around constructivist keywords.</td>
</tr>
<tr>
<td>professional confidence</td>
<td>Statements/data that show the participant’s commitment to, participation in and access to professional development opportunities in mathematics including taking on school leadership roles.</td>
</tr>
</tbody>
</table>

**Category One: Curriculum Confidence**

The first category identified in the coding process was ‘curriculum confidence’ and referred to how well participants felt they were covering the topic areas mandated in internal and external mathematics curriculum documents. We know from the results of the beginning teacher survey reported earlier in this chapter that most participants reported having access to school-based scope and sequence charts to outline what mathematical topics had to be taught term by term and that mandated curriculum documents were a major influence on what they taught in the classroom.
However, we also know that for five participants (50%), the development of a more robust mathematical program structure (identifying what topics to teach, how long to teach them for, and in what sequence to teach them in across the year) was a major priority for them after their first year of teaching. This was confirmed during the interview as participants reflected on this aspect of their first year teaching experience:

In the first year I was thinking I might not have enough stuff to sustain me for two weeks on data.

I didn’t really feel happy with the way I taught maths last year…I was worried because you could only teach something for a week.

I felt dissatisfied at the end of the year that I hadn’t taught what I knew I had to teach because there wasn’t a structure.

One of the big problems I had when I came out was not knowing what they were supposed to know by the end of the year.

However, these initial concerns that participants had about curriculum coverage and organisation were largely a non-issue when interviewed in their second year of teaching, with all participants (100%) reporting that they were confident that the current structure of their mathematics program met both internal and external curriculum requirements and their own understandings of what they needed to teach, and when to teach it, over a school year.

As such, the following data statement can be reported:

**Data Statement 5.18**
Based on interview data, in their second year of teaching all participants reported that they were confident that their mathematics program satisfied all curriculum requirements related to what to teach over a school year.

**Data Check**

From a constructivist teaching perspective, only two participants (20%) reported that they routinely, or indeed effectively, integrated mathematics across the curriculum when planning their teaching program. For the most part, participants reported that maths was programmed and taught as a standalone curriculum area. For some
participants, this failure to integrate mathematics across the curriculum was attributed to the way in which mathematics was organised at the school level into set numeracy blocks or mandated minimum teaching periods:

I have to teach numeracy 5 ½ hours a week and I am struggling to find it so I don’t teach maths outside my timetabled maths lessons.

even though they acknowledged that this did not restrict their ability to integrate literacy across the curriculum:

We will often do unit work in literacy rotations as they fit more easily...[than maths].

For others, it was attributed to the nature of mathematics in that it did not naturally integrate with other curriculum areas:

I don’t force it...[integrating maths into units]...if it fits it fits and if it doesn’t it doesn’t. When we were doing the human body I found some cute little skeleton worksheets so that was an example.

It...[maths]...really doesn’t work in the units we do.

However, one participant identified that this was an area of concern for them in that, rather than being related to factors of school organisation or the nature of mathematics, it highlighted a ‘gap’ in their own mathematical understanding:

While I know instinctively that maths is as interconnected...[as literacy]...I can’t figure it out. I can’t explicitly verbalise how to get that idea across to kids or program in such a way as to show it. Of all the KLA’s I still feel that maths is a silo on its own and should be taught on its own. It’s frustrating because I don’t know how to break down that barrier.

Category Two: Content Area Confidence

The second category identified in the coding process was ‘content area confidence’ and referred to how confident participants were about their mathematical content knowledge. In general, when examining the interview transcripts for statements relating to participants’ confidence in themselves as mathematical ‘doers’, for six participants (60%) it was their recollections of themselves as school students that gave an initial indication about how they felt about their content area knowledge. Of these participants only one
(10%) explicitly described themselves as being a competent, and confident, mathematician:

Maths and science were my joy because I could do them.

For the other five (50%), these recollections and self-portraits were ostensibly negative:

At school it felt completely irrelevant...I was struggling...tearing my hair out...dread...frustrated...I am sure I missed fundamental concepts.

It wasn't until I started teaching that I realised how little [maths] I knew.

I was a very low achiever in maths.

I don't remember anything good about it at all.

My concept of what I knew in maths was very poor...no confidence at all.

Some participants (40%) then went on to explicitly identify how their mathematical content knowledge affected their teaching. One participant was confident that their self-reported high level of mathematical content knowledge helped them as a teacher:

I can see the gaps...see where the students' difficulties are lying and meet their needs.

Another participant, using a similar analogy, was concerned that their level of content area knowledge impeded their teaching of mathematics:

I still worry...that these kids are going to have gaps caused by my teaching.

[Interviewer asks if this is a pedagogical or content issue and participant replies]

No, it's the content really.

[Later in the interview]

I will always worry about my maths teaching.

Similarly for another participant, who reported confidence that they had an appropriate level of mathematical content knowledge to be an
effective Kindergarten teacher, it could be inferred that they might be more concerned about their level of content knowledge if they had been teaching a higher year level:

I’m not as worried about the content as I thought I would be…

[Interviewer asks why and participant replies]

Grade level.

Yet another participant reported that, while they were confident of their procedural maths skills, they felt their lack of deep content area knowledge affected their teaching in some topic areas:

You know it’s the concepts. I can add and subtract and do division and multiplication…it’s the concepts like algebra and symmetry and isosceles triangles and all those other things [that make] you go…arrgghh.

During the course of the interviews, a further two participants (20%) identified that they had difficulties identifying the concepts and content in mathematical teaching activities and resources and/or assessment tasks and instruments:

Open-ended activities give you so much more in understanding how kids are working things out but they can be hard to formulate…finding an idea that will test what I want to test.

There’s lots of CMIT games and resources made up but someone needs to show me how to use them and when to use them…

I choose them now because they look fun…I went to the CMIT course and did the SENA testing but how to use that to inform your teaching is the bit I’m struggling with.

On the whole, seven participants (70%) gave some indication during their interview that their level of mathematical content knowledge underpinned an area of ongoing concern for them in their development as teachers of mathematics.

As such the following data statement can be reported:

**Data Statement 5.19**

Based on interview data, there are indications that after their initial experience of teaching, when participants report a concern (or lack of confidence) about their mathematics teaching, it is most likely to be associated with their level of mathematical content knowledge.
Category Three: Pedagogical Confidence

The third category identified in the coding process was ‘pedagogical confidence’ and referred to participants’ confidence related to how they were teaching and the resources they were using in the classroom.

We know from the findings of survey data analysis presented in The Pre-service Teacher (Chapter 4) that on the eve of their transition into teaching, pre-service teachers imagined their mathematical classrooms as primarily constructivist learning spaces. Throughout their interviews, participants described classrooms that were pedagogically consistent with their pre-service understandings of a constructivist approach to teaching. They talked of lessons that:

- began with a whole class introduction of the concept;
- continued with group, partner or individual hands-on exploration (usually in a rotation with the teacher working specifically with a group or individual students); and
- finished with whole class discussions about how students completed the activities and/or explicit conversations about how this maths related to the real-world.

The tasks and activities selected by the participants (games, worksheets or open-ended opportunities for problem solving) were selected to engage student interest and maximise their enjoyment. Participants also indicated that these activities were differentiated based on student ability which was often established through the administration of pre and post assessment activities. Participants’ descriptions were not only pedagogically consistent with their pre-service understandings, they were also linguistically consistent, using the same keywords and terms that were present in the pre-service teacher survey: ‘engage’, ‘interesting’ ‘relevant’, ‘real-life’, ‘real-world’, ‘practical’, ‘meaningful’, ‘fun’, ‘enjoyable’, and ‘hands-on’ using ‘concrete materials’. 
However, as reported in The Pre-service Teacher (Chapter 4), there is evidence that the use of these high frequency terms can be somewhat problematic in that mathematics teaching predicated on these understandings may not always be the most conducive for robust student learning in mathematics (Brady, 2007; Klein, 2008).

This seemed to be a concern for two participants (20%) in relation to using activities that were ‘fun’, ‘interesting’ and ‘engaging’. As previously reported, the participant who stated that they selected their maths games and activities because they ‘looked fun’ and not because they necessarily supported the learning of a particular concept, seemed to be questioning their current definition of ‘fun’ teaching and whether or not it equates to ‘robust’ learning. Similarly, another participant identified that it was:

…hard to keep thinking of fun, engaging activities…it’s more difficult than what I thought it would be.

While they were happy that the activities they used in their teaching related to the concept and skills they wanted students to acquire, they were still worried that their teaching wasn’t ‘fun enough’.

However, while many participants identified specific aspects of their classroom practice that needed further development, on the whole most participants (90%) seemed confident in their teaching pedagogy.

As such, the following data statement can be reported:

**Data Statement 5.20**

Based on interview data, in their second year of teaching most participants reported that they were confident in the overall efficacy of their mathematics pedagogy.

**Category Four: Professional Confidence**

The fourth and final category identified in the coding process was ‘professional confidence’ and is defined by Frid & Sparrow (2007, p. 303) as an individual’s ability “to enact teaching practices” that reflect “their beliefs, values and philosophy” even though they may “differ to
those of colleagues" and be challenged by school-based organisational factors. Frid and Sparrow (2007) also identified that a teacher’s professional confidence is “not independent” of their pedagogical knowledge as they need to know “how to translate their beliefs and philosophy into practice” (pp. 303-304) in order to enact them. This relationship was certainly in evidence in this study as the nine participants (90%) who were pedagogically confident were also professionally confident irrespective of the mathematics teaching delivery model that existed in the schools in which they taught.

Participants who reported that they team taught or team planned with their more experienced colleagues also reported that they were equal partners in that process. Participants who indicated that they planned, implemented and evaluated their mathematics program virtually independent of any collegial and/or school direction were also confident of the efficacy of what they were doing and that it was in-line with the expectations of others.

Similarly, those participants who seemed to be operating with the most external constraints, i.e., implementing a prescribed program or working in streamed classes across a year/grade level reported that they were still able to develop, evaluate and modify their teaching within these parameters to deliver the best possible learning environment for students. Participants also reported being actively involved in maths related professional dialogue and internal and external professional development opportunities within their teaching teams and schools, with two participants (20%) holding leadership roles as school maths coordinators in their second year of teaching.

As such, the following data statement can be reported:

**Data Statement 5.21**

Based on interview data, in their second year of teaching participants who reported that they were confident in the overall efficacy of their mathematics pedagogy were also confident in their professional role as teachers of mathematics within their wider school context.

After all the interview data was interrogated and coded, the results were tabulated to create a ‘confidence profile’ for each participant.
and for the sample in general. The results of this process are reported in Table 5.23.

Table 5.23: Beginning Teacher Confidence to Teach Constructivist Mathematics—by Sample and Participant

<table>
<thead>
<tr>
<th>Confidence Category: (Key ● = yes)</th>
<th>Sample % Confident</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum Confidence</td>
<td>100%</td>
<td>● ● ● ● ● ● ● ● ● ●</td>
</tr>
<tr>
<td>Pedagogical Confidence</td>
<td>90%</td>
<td>● ● ● ● ● ● ● ● ● ●</td>
</tr>
<tr>
<td>Professional Confidence</td>
<td>90%</td>
<td>● ● ● ● ● ● ● ● ● ●</td>
</tr>
<tr>
<td>Content Area Confidence</td>
<td>30%</td>
<td>● ● ● ● ● ● ● ● ● ●</td>
</tr>
<tr>
<td>Overall Confidence Rating</td>
<td>Mark (1–4)</td>
<td>4 4 3 3 4 3 1 4 3 1</td>
</tr>
<tr>
<td>Not Very Confident</td>
<td></td>
<td>● ● ● ● ● ● ● ● ● ●</td>
</tr>
<tr>
<td>Confident/Very Confident</td>
<td></td>
<td>● ● ● ● ● ● ● ● ● ●</td>
</tr>
</tbody>
</table>

As shown in Table 5.23, in their second year of teaching:

- all participants (100%) were confident that their mathematics program met internal and external curriculum requirements and their own understandings what to teach when; and
- most participants (90%) were also confident that their mathematics teaching was pedagogically and theoretically sound and that they were participating fully in mathematics-related professional dialogue and development activities.

However, for most participants (70%) their concerns about their teaching in their second year of teaching seemed to indicate that their level of content area knowledge (often accompanied by a negative view of themselves as maths ‘doers’) may impede their ability to fully realise the constructivist classrooms they envisaged at the end of their pre-service training.

For the purposes of further comparative analysis, participant confidence was scored in each of the four categories and combined into one overall ‘confidence’ mark. If a participant was deemed to be confident in a category (i.e., the data showed that they had nil or only minor concerns in that area) they were scored as a ‘1’ for that category. If they were not deemed to be confident in a category (i.e., they had significant concerns in that area), they received a ‘0’ score.
for that category. Based on this scoring system the minimum ‘confidence’ mark a participant could receive was ‘0’ and the maximum was ‘4’. This mark was then used to sort participants into one of two categories based on whether they were ‘not very confident’ or ‘confident/very confident’ of the efficacy of their mathematics teaching.

The decision to use these two groups where one was primarily ‘negative’ (‘not very confident’) and the other was ‘non-negative’ (‘confident/very confident’) was made so that the classification scales used in the analysis of the ‘confidence’ categories would be consistent with those used in the pre-service ‘school experience’, ‘teaching attitude’ and ‘confidence’ survey items. As such, it would allow for more meaningful comparisons to be made between the participants’ pre-service and beginning teacher data and maintain the overall integrity of the data analysis process.

As shown in Table 5.23, nine participants (90%) were given ‘confidence’ marks of ‘3’ or ‘4’, (i.e., they had been rated as being ‘confident’ across at least three of the four categories) and were considered to be ‘confident/very confident’ overall of the efficacy of their mathematics teaching; while one participant (10%) with a ‘confidence’ mark of ‘1’ (i.e., they had been rated as ‘confident’ in only one of the four categories) was considered to be ‘not very confident’.

The final step in investigating any changes between participants pre-service and beginning teacher confidence in their ability to teach constructivist maths was to compare their pre-service and beginning teacher ‘confidence’ ratings. The results of this comparison are reported in Table 5.24, which shows that in their second year of teaching, six of the seven participants who had not been very confident in their capacity to develop students’ higher-order maths abilities as pre-service teachers, were confident that they were effective teachers of mathematics.
### Table 5.24: Confidence to Teach Maths—Pre-service and Beginning Teacher Comparison

<table>
<thead>
<tr>
<th>Participants</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005 Pre-service Teacher</td>
<td>Score (4-12)</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>8</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Not Very Confident</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td></td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Confident/Very Confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>2007 Beginning Teacher</td>
<td>Score (0-4)</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Not Very Confident</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>•</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Confident/Very Confident</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>2005-2007 Comparison Change Category</td>
<td>Key:</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Nil = N</td>
<td>Change = C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This overall increase in confidence is supported by the following comments made by the six participants (60%) who reported a change in their pre-service and beginning teacher confidence levels.

Yeah, I love it [teaching maths] more now.

I quite like teaching it [mathematics].

Teaching maths…it’s been a positive experience.

Yes, I’m really confident about how I’m getting students to understand.

The experience has been more positive than I thought it would be.

Yes, I feel confident in my ability to teach mathematical concepts.

As such, the following data statement can be reported:

**Data Statement 5.17**

Based on a comparison of survey and interview data, in their second year of teaching most beginning teachers are confident of the overall efficacy of their mathematics teaching even though they may not have been very confident in their final year of pre-service education.

However, when looking specifically at the concerns raised by participants, content area knowledge was identified as a major issue for beginning teachers as they develop as teachers of mathematics.
Using Textbooks and Hands-on Resources in the Classroom

When analysing the interview data pertaining to teaching practice, particular attention was paid to participants’ descriptions of the use of textbooks and hands-on resources in their classrooms. In the context of this study, the use of textbooks and hands-on resources in the classroom was identified as important as there had been some interesting results around this issue in both the pre-service and beginning teacher survey data analysis.

For pre-service teachers, it was framed as an emerging tension between their educational theory and classroom practice as the analysis of the survey data identified an inconsistency between what pre-service teachers ‘knew’ about maths teaching and learning theory as a result of their pre-service training:

...mathematics teaching and learning should be hands-on and use concrete materials (as per the tenets of constructivist learning theory)...

and what they ‘knew’ about maths teaching and learning as a result of their own student and student teacher experiences of maths classroom practice:

...using textbooks and other written resources (usually associated with the more ‘traditional’ transmission teaching approach) does not necessarily impede student learning.

In the analysis of the beginning teacher survey data, the participants reported low level textbook usage and high level access to quality hands-on resources which initially seemed to contradict other national and international research that pointed to an over reliance on mathematics textbooks in generally resource-poor primary classrooms (DEST, 2004a, 2004b; Forrester, 2009; Jamieson-Proctor, & Byrne, 2008).

Upon further investigation of the data, however, it was found that while only two participants (20%) reported using textbooks that were prescribed by the school, a further six participants (60%) indicated that textbooks informed their teaching practice to some extent even though they weren’t required to use them by their school. As such,
textbook and hands-on resource usage (what, why, when and how they were used in the classroom) was identified as an issue that required further investigation to determine what it could reveal about the development of beginning teacher’s classroom practice.

During the course of the beginning teacher interviews, eight participants (80%) reported using textbooks in some fashion in the planning, implementation and evaluation of their mathematics program. This confirms the initial survey result and is generally consistent with extant literature and research that found that the “teaching of mathematics relies on textbooks more than any other subject area...[and they are]...used 86.6% of the time during scheduled lessons” in Australian schools (Jamieson-Proctor & Byrne, 2008, p. 295).

But what does this level of textbook usage tell us about beginning teachers’ development as teachers of mathematics? Traditionally, textbook usage is associated with the transmission method of teaching and, as such, is at odds with the tenets of the constructivist teaching and learning theory that participants universally espoused in this study. So, did the fact that so many participants reported using textbooks in their teaching mean that there were not, in fact, realising the primarily constructivist classrooms they described in the beginning teacher survey?

Not necessarily. While research indicates that teachers “who hold beliefs about mathematics education consistent with a traditional approach to teaching and learning” (Jamieson-Proctor & Byrne, 2008, p. 296) will use textbooks more frequently than those who do not; it also identifies that there are other reasons why teachers use textbooks in their classrooms (Forrester, 2009; Jamieson-Proctor & Byrne, 2008). In a link back to the previous key focus area that identified teacher confidence regarding their content area knowledge as an issue requiring further investigation in this study, there is research evidence to suggest that “teachers with low levels of confidence in their subject matter knowledge in
mathematics…become textbook dependent as they believe…textbook authors possess more mathematical expertise” than they do (Jamieson-Proctor & Byrne, 2008, p. 300).

Of the six participants (60%) identified in the previous key focus area as potentially having issues related to their level of mathematical content knowledge, five (50%) reported using textbooks in the mathematical teaching. However of those five participants, three (30%) indicated that they used textbooks primarily because of an external factor.

External factors that influence textbook usage in the classroom can be as explicit as the school mandating the use of a particular textbook across the school or in a particular year level or more implicit such as general expectations that students will produce and/or teachers record a certain amount or type of maths work samples (Forrester, 2009; Jamieson-Proctor & Byrne, 2008). This was the case for five participants (50%) in this sample where:

- two participants (20%) used a textbook-based program that was prescribed by their school;
- two participants (20%) used certain textbooks to be consistent with other teachers in their teaching teams; and
- one participant (10%) reported using textbook worksheets primarily as they “felt under some pressure to get things in books”.

Therefore, just because a teacher uses textbooks as part of their classroom practice, it doesn’t necessarily mean that they believe in the efficacy of a more traditional, transmission approach to teaching or that they lack confidence in the content area knowledge. It could be that textbooks are used because it is a requirement of the school or that they are used in certain ways at certain times to meet the expectations of others in the wider school community.

What is important is to look at how teachers are using textbooks as research also shows that there are ways of using textbooks that are
consistent with a constructivist approach to teaching (Forrester, 2009; Jamieson-Proctor & Byrne, 2008).

All six participants (60%) who used textbooks when not required to do so by their school reported that they did not follow the textbook sequence in their teaching program and that they ‘cherry-picked’ activities from a range of different textbooks or modified activities to suit the needs of their students. This result is consistent with recent Australian research that found that primary school teachers who espouse a constructivist approach to mathematics are more likely to “reorganise the sequence…proactively select what…is appropriate…to present…[and]…cater to individual abilities and student needs when using textbooks in mathematics lessons” than those who do not (Jamieson-Proctor & Byrne, 2008, p. 298).

However, of these six participants (60%), only one (10%) reported that they used the teacher resource book as well as the student textbook of a particular program. This is important as it is the teacher resource book that provides the conceptual information about the mathematics being taught, while the “inherent features” of student textbooks are “procedural” (Forrester, 2009, p. 199). As such, even if the participants' beliefs about teaching are primarily constructivist, their use of pages from student textbooks as the “written component of mathematics lessons…[could impede their]…efforts to teach mathematics for conceptual understanding [and]…encourage students to see mathematics as facts, skills and procedures” (Forrester, 2009, p. 199).

However, the two participants (20%) who used a textbook-based program that was prescribed by their school reported that, in addition to using the student workbooks, they also extensively used the teacher resource book in their mathematics teaching. In their description of the programs they were using the participants reported that the teacher resource book provided them with:

- a detailed explanation of the concept that was being taught;
- instructions on how to introduce the concept to the class;
• a list of hands-on activities (often differentiated to cater for individual student ability) and resources that could be used and/or made that would allow students to explore the concept; and
• details on how to assess student learning and evaluate the teaching.

Certainly, for these participants, their descriptions of the textbook-based programs they used and how they implemented them in the classroom indicated that they had moved beyond the transmission teaching approach usually associated with textbook usage.

In further investigating the role of textbooks in the development of participants’ classroom practice via the analysis of the interview data, it became apparent that it cannot be assumed that textbook usage automatically means that teachers believe in, or are employing, the more traditional, transmission method of teaching in their classrooms. However, it was also apparent that knowing why, and how, participants’ use textbooks can assist in the identification and explanation of any inconsistencies between a beginning teacher’s beliefs about the nature of mathematics and how it is best taught and learnt and what is occurring in their classrooms.

Having established that it is problematic to accept the simplified notion that ‘textbook = bad’, is it also the case that we cannot accept on face value that ‘hands-on = good’ when it comes to classroom practice? In order to explore this question, the interview data that related specifically to participants’ reported exposure to, and use of, the Count Me In Too (CMIT) early numeracy program in their classrooms was interrogated.

As reported earlier in this chapter, in the beginning teacher survey five participants (50%) reported that they had attended CMIT professional development workshops in their first year of teaching. It was identified at that time that CMIT was the only ongoing, primary-focused mathematics training delivered by officers in the ACT DET Literacy and Numeracy team.
During the course of the beginning teacher interviews (i.e., by the time they were in their second year of teaching) six participants (60%) reported that they had attended CMIT training and five (50%) reported that they used CMIT program components in some way in their teaching practice. This result was consistent with data analysis results from the beginning teacher survey data where it was identified that, at the time the study data was collected, the CMIT program was prevalent in public primary schools across the ACT. As such, it was a commonality between a significant proportion of the beginning teacher sample and could be used when analysing the data related to teaching practice and the use of hands-on resources and activities.

The CMIT numeracy program is a non-textbook based mathematics program and its “two main aims are to help teachers understand children’s mathematical development and to improve children’s achievement in mathematics” (Bobis, 2009, p. 1). As such, the program calls for teachers and schools to participate in an ongoing professional development program around the implementation and evaluation of the program via three main program components:

- the Scheduled Early Number Assessment (SENA) 1 and 2;
- the Learning Framework in Number (LFIN); and
- the Developing Early Number Strategies (DENS) activity and resource books 1 and 2.

In the ACT, at the time this data was collected, the CMIT professional development program consisted of a series of three one-off workshops and ongoing network meetings. The workshop program showed teachers how to administer the SENA and use the results to identify student’s understanding of number concepts and then how to group students in class based on their results and create appropriate teaching programs to develop student learning. The network meetings were held once or twice a term and were designed to help teachers gain a better understanding of how to use CMIT games and activities and common hands-on resources (i.e., MAB blocks,
number lines and dice) to develop student’s understanding of particular early number concepts.

The recommended implementation of the CMIT program in schools and classrooms supports a constructivist approach to teaching and learning mathematics in that a teacher would:

1. administer the appropriate SENA assessment to each student on a one-to-one basis to establish the student’s prior knowledge of a given concept;
2. use the assessment data to locate the students’ development in each concept area on the sequential learning framework (LFIN) to identify the appropriate point of teacher intervention in a student’s learning of a given concept;
3. refer to the LFIN for a description of what the student is able to do now, where they need to go to keep developing their understanding of the concept, and decide what types of “learning experiences...will be most useful” in scaffolding the student’s learning (Bobis, 2009, p. 1);
4. refer to the DENS activity books (and others) to select activities and resources (games) to use and/or make that will allow the student to construct their own learning through hands-on, active exploration of a given concept; and
5. re-administer the appropriate sections of the SENA after the teaching has occurred and re-assess the student’s conceptual understanding to identify what progress has been made and plan for the next stage of learning.

However, of the five participants (50%) who went to CMIT professional development and used CMIT in their classrooms, only one (10%) reported that they had gone to a network meeting and only two (20%) had reported using the learning framework (LFIN) when implementing CMIT in their classrooms.

So, just as participants were less likely to access and use the component of a textbook-based program that contained information that would support the conceptual teaching of mathematics—the
teacher workbook—when using textbooks in the classroom, they were also less likely to access the components of the CMIT program (the network meetings and the LFIN) that explicitly identified how to select appropriate hands-on resources and activities and use them to develop students’ understanding of particular mathematical concepts.

This result was interesting in that, as reported in the previous key focus area, while participants were more likely to be concerned about their ability to develop in their students a robust and rich conceptual understanding of maths than any other aspect of their teaching, they did not seem to be accessing the components of the programs they were using that were most likely to help them do this.

As such, the following data statement can be reported:

**Data Statement 5.18**
Based on the analysis of survey and interview data, in contemporary primary school classrooms a beginning teacher’s beliefs about:
- themselves as mathematical doers;
- teaching and learning mathematics; and
- the nature of mathematics
cannot be automatically assumed via the presence, or absence, of textbooks and/or hands-on resources and activities in their teaching practice.

However, investigating what, why, when, where and how beginning teachers use textbooks and/or hands-on resources and activities in the classroom can help to:
- identify any inconsistencies between beginning teacher’s reported teaching theory and practice; and
- provide valuable insight into how the beginning teacher experience and factors of school context interplay with beginning teacher’s pre-existing beliefs to inform their classroom practice and influence their subsequent development as teachers of mathematics in the early years of their career.

*Factors of School Context that Influence Teachers’ Decisions about Teaching Mathematics*

The results of the beginning teacher survey analysis indicated that the extent to which factors of school context support and influence the development of beginning primary school teachers depended on the overall coherence of the school mathematics program and its capacity to meet the needs of individual teachers. To investigate how mathematics program coherence affects the level of influence school-based programs have on classroom teaching practice and
supporting beginning teacher development, participants were asked at interview to describe and explain how they planned, delivered and evaluated their mathematical teaching and learning program.

From the initial analysis of the data generated as part of these discussions, it was identified that teachers made six major decisions when developing their mathematics teaching and learning program that could be classified into three broad areas:

- curriculum—what to teach (content) and when to teach it (sequence);
- pedagogy—how to teach the content (teaching method) and when to teach it within the class program (timetabling); and
- evaluation—how to determine the effectiveness of maths teaching (program evaluation) and how to improve it (professional development).

Once these decisions were identified, participants’ responses were analysed to determine what information underpinned the decisions they made in these six key areas and what the source of that information was. As part of this process, it was identified that participants accessed three main sources of information when making decisions: the overall school mathematics program; their teaching colleagues; and their own individual beliefs, knowledge or independent research related to teaching mathematics.

In order to classify the participant responses the following five-point scoring system was used:

- ‘0’ allocated when information from that source had no effect on the participant’s decision;
- ‘1’ allocated when information from that source had a minimal effect on the participant’s decision (i.e., it was mentioned by the participant but not as a major influence);
- ‘2’ allocated when information from that source had some effect on the participant’s decision;
- ‘3’ allocated when information from that source had a
• major effect on the participant’s decision (i.e., was not the only thing mentioned by the participant but was the major influence on the decision making process); and
• ‘4’ allocated when information from that source was the only influence on the participant’s decision.

Once score points were allocated it was possible to total the scores for each of the six decisions made across the sample (maximum score = 40 (4 x 10 participants)) and then rank the three main information sources to determine where participants were more likely to access the information that would assist them in making decisions about their mathematics teaching. The results of this classification and ranking process can be found in Table 5.25.

As reported in Table 5.25, while school program-based factors were ranked first in influencing decisions participants made about curriculum content (“knowing what topics to cover over the year”) and timetabling maths within the wider classroom program (“blocks between recess and lunch”, “45 minutes a day”, “four days a week”, “five sessions a week”) they were ranked last in influencing the other four major decisions participants made about planning, delivering and evaluating their mathematics teaching and learning program.

Of the other four decisions, participants were more likely to be influenced by their teaching team/colleagues when sequencing the curriculum (“we taught the same topics over a term”), while the decisions they made about teaching method and how effective their mathematics program were made with minimal input from colleagues or the wider school mathematics program.

When deciding what activities to undertake to develop themselves as teachers of mathematics, participants were as likely to consult a colleague (“my teaching partner was a CMIT guru and recommended I go to the workshops”) as they were to source these activities independently.
Table 5.25: Factors that Influence Teacher’s Decisions about Teaching Mathematics—by Decision and Participant

<table>
<thead>
<tr>
<th>Decisions</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Level: What maths to teach and when to teach it</td>
<td></td>
</tr>
<tr>
<td><strong>Curriculum Content</strong></td>
<td></td>
</tr>
<tr>
<td>School document/direction</td>
<td>1 [16]</td>
</tr>
<tr>
<td>Negotiated with colleague/s</td>
<td>2 [14]</td>
</tr>
<tr>
<td>Individual decision</td>
<td>3 [10]</td>
</tr>
<tr>
<td><strong>Curriculum Sequence</strong></td>
<td></td>
</tr>
<tr>
<td>School document/direction</td>
<td>3 [8]</td>
</tr>
<tr>
<td>Negotiated with colleague/s</td>
<td>1 [22]</td>
</tr>
<tr>
<td>Individual decision</td>
<td>2 [10]</td>
</tr>
<tr>
<td><strong>Classroom Level: How and when to teach maths</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Teaching Method</strong></td>
<td></td>
</tr>
<tr>
<td>School-based approach</td>
<td>3 [8]</td>
</tr>
<tr>
<td>Teaching Team approach</td>
<td>2 [12]</td>
</tr>
<tr>
<td>Individual approach</td>
<td>1 [20]</td>
</tr>
<tr>
<td><strong>Timetabling Maths</strong></td>
<td></td>
</tr>
<tr>
<td>School-based policy</td>
<td>1 [19]</td>
</tr>
<tr>
<td>Teaching Team arrangement</td>
<td>2 [11]</td>
</tr>
<tr>
<td>Individual decision</td>
<td>3 [10]</td>
</tr>
<tr>
<td><strong>Individual Teacher Level: Developing as a teacher of mathematics</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Program Evaluation</strong></td>
<td></td>
</tr>
<tr>
<td>School program scrutiny</td>
<td>3 [3]</td>
</tr>
<tr>
<td>Teaching Team discussions</td>
<td>2 [12]</td>
</tr>
<tr>
<td>Individual process</td>
<td>1 [25]</td>
</tr>
<tr>
<td><strong>Professional Development</strong></td>
<td></td>
</tr>
<tr>
<td>School approach/focus</td>
<td>3 [10]</td>
</tr>
<tr>
<td>Teaching Colleague initiated</td>
<td>1 [15]</td>
</tr>
<tr>
<td>Individually initiated</td>
<td>1 [15]</td>
</tr>
</tbody>
</table>

Scoring system: 0 = Nil Effect; 1 = Minimal Effect; 2 = Some Effect; 3 = Major Effect; 4 = Total Effect

Cumulative Factor Effect on Decisions

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Program</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>17</td>
<td>4</td>
<td>4</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Teaching team/Colleagues</td>
<td>5</td>
<td>0</td>
<td>12</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>16</td>
<td>17</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Individual Knowledge/Research</td>
<td>17</td>
<td>20</td>
<td>8</td>
<td>12</td>
<td>20</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Overall Effect Rating</td>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td>I/C</td>
<td>I/C</td>
<td>I</td>
<td>S</td>
<td>C</td>
<td>C*</td>
</tr>
<tr>
<td>School Program Influence Rating</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

* Note: participants allocated an overall effect rating of ‘S’ as the focus of their collegial work was the implementation of a robust and clearly articulated school mathematics program.
However, it is also possible at this point to look at each individual participant’s cumulative scores to determine what, if any, source of information had the most effect on, i.e., was the major influence on, all six decisions they made about teaching mathematics and developing as teacher of mathematics. In order to allocate an overall effect rating to a participant the following classification process was used and the results also reported at the end of Table 5.25.

In the first instance, from a total score of 24 (4 point maximum x 6 decisions), if one of the three information sources had a score total that was equal to, or higher than, 16 points (2/3 of the total score) it was deemed to have had the primary overall influence on the decision making process for that participant. The application of this cut-off score yielded an unambiguous result for six participants where one was allocated an ‘S’ (school program) classification, two were allocated a ‘C’ (teaching team/colleague) classification, and three were allocated an ‘I’ (individual knowledge/research) classification.

The scores for the remaining four participants showed that in each case the participant had a combination of two information sources that added up to 20 or more points (4/5 of the total score) and it was deemed that this combination had the primary overall influence on the decision making process for that participant. Of these four participants, two were most strongly influenced by a school program/teaching team/colleague combination (S/C) while the other two were most strongly influenced by an individual/teaching team/colleague combination (I/C).

As a result of a further analysis of the survey and interview data of the two participants with the school program/teaching team/colleague combination (S/C), their classification was modified to ‘S’. This was because, while the participants reported a strong collegial influence in their decision making, they also identified that this occurred within the framework of a robust, clearly articulated school mathematics program deliberately designed to be implemented and evaluated at the teaching team level. As such, when compared to the data
collected from the participant allocated with an ‘S’ classification in the initial coding process there were striking similarities.

However, further analysis and comparison of the data of the two participants with the individual/teaching team/colleague combination (I/C) revealed that there was enough difference between these participants and those allocated with either a ‘C’ or ‘I’ classification for this to remain as a distinct classification subset within the data.

At the end of this classification process each participant was then allocated a school program influence rating of either ‘high’ or ‘low’ based on the level of influence the whole school program had on the decisions they made about their mathematics teaching.

Where participants reported that their decision making occurred within the framework of a robust, clearly articulated school mathematics program that was uniform throughout the whole school and closely linked to the professional development program, the capacity of the school program to influence teacher decision making was deemed to be ‘high’. Where participants reported that there was a strong collegial influence on their decision making, i.e., the teaching team had a uniform approach to programming mathematics that was approved by the school executive and had some links to the professional development program, the capacity of the school program to influence teacher decision making was also deemed to be ‘high’.

Where participants reported that there was no uniform whole school approach to, or focus for professional development related to, mathematics and that they programmed and planned with their direct teaching partners only using a range of textbook and other programs as syllabus and teaching guide, the capacity of the school program to influence teacher decision making was deemed to be ‘low’. Where participants reported that there was no school mathematics program and that they programmed and planned with colleagues in a very limited fashion only, i.e., ensuring that they taught the same topics in the same term/semester for reporting purposes and any mathematics
professional development they undertook was not linked to a wider school focus, the capacity of the school program to influence teacher decision making was also deemed to be ‘low’.

At the end of this classification process it was found that only half of the participants (50%) were strongly influenced by factors of school context (the overall mathematics program and/or the professional learning community that existed within the school) when making decisions about teaching mathematics and developing as teacher of mathematics. This result is consistent with that of the beginning teacher survey data where it was established that the mere existence of elements of a mathematics program structure at a school does not automatically mean that it will have a major impact on individual teachers’ classroom practice.

As such, the following data statement can be reported:

Data Statement 5.19
Based on survey and interview data, beginning teachers make six major decisions about teaching mathematics:

**curriculum decisions**
- what to teach
- what sequence to teach it in

**pedagogical decisions**
- when to teach it within the class timetable
- how to teach it

**teacher development decisions**
- how to determine the effectiveness of teaching
- how to improve/develop as a teacher of mathematics

To assist then in making those decisions, beginning teachers have three main sources of information they can access:

- **the overall school mathematics program** (most commonly used to decide what to teach and when to teach it within the class timetable);
- **their teaching colleagues** (most commonly used to determine the sequence to teach maths in and what activities to undertake to improve/develop as a teacher of mathematics); and
- **their own individual knowledge and understandings and/or independent research** (most commonly used to decide how to teach maths in the classroom, how to determine the effectiveness of that teaching and what activities to undertake to improve/develop as a teacher of mathematics).

By identifying which of these sources an individual teacher accesses most to make these decisions it is possible to determine the level of influence factors of school context have on beginning teachers’ mathematical classroom practice and on their development as teachers of mathematics.
Suggestions for Improving Support for Beginning Teachers in Mathematics

As previously reported in this chapter (see Tables 5.16 and 5.17), the beginning teacher survey established that as beginning teachers, participants had access to an organised program of support that included participation in a combination induction/mentor program and had undertaken some type of mathematics-related professional development activity in their first year of teaching. The beginning teacher survey also established that the overall effectiveness of these programs and activities in supporting participants’ development as teachers of mathematics varied depending on the nature of the program, the overall coherence of the mathematics program within the school, and the individuals involved.

In the context of this study, where one of the research questions (see Box 5.1) asks how schools and education systems can better assist beginning teachers to develop as effective teachers of mathematics, it was important that participants were asked to suggest ways in which this could be done based on their experience. These suggestions were then coded and are reported in Table 5.26.

Table 5.26: Initial Coding of Suggestions to Improve Support for Beginning Teachers’ Mathematical Teaching Development—by Participant

<table>
<thead>
<tr>
<th>Participants</th>
<th>1</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Suggested to improve beginning teacher support based on own experiences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was response focused on curriculum (C); pedagogy (P); resources (R); assessment (A)</td>
<td>P</td>
<td>CAR</td>
<td>P</td>
<td>PR</td>
<td>CPR</td>
<td>CPR</td>
<td>CP</td>
<td>-</td>
<td>P</td>
<td>CAP</td>
</tr>
<tr>
<td>Was response critical of ex-school activities?</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was response framed as part of overall program structure?</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

As reported in Table 5.26, participants made a range of suggestions that could be coded into the following focus areas: curriculum, pedagogy, resources, or assessment.

Suggestions relating to pedagogical support (80%), in particular providing opportunities for beginning teachers to observe best practice teaching:
Seeing others teach using group rotations.

or, to a lesser extent, be observed by an experienced colleague:

Come in and watch me teach

were most commonly proposed by participants.

The next most common suggestions proposed by participants involved providing beginning teachers with explicit curriculum program support (50%):

Having a skeleton program to support you.

Provide a Term 1 program.

Participants also made suggestions relating to providing beginning teachers with resource support (40%):  

Getting a beginner’s resource pack.

Having resources provided.

Being shown how to use [resources] in the classroom.

and assessment support (20%):

Having a really good assessment tool and being taught how to use it.

Given time to assess students at the beginning of the year.

This result, where participants’ suggestions are strongly focused on day-to-day classroom operation and linked to learning from other more experienced teachers, are consistent with generally held understanding that the most effective professional development for beginning teachers in the initial ‘survival’ stage of teacher development was that which provided them with “on site support and technical assistance” and “colleague advice” (Katz, 1972, p. 3).

The efficacy of providing on-site professional development support for beginning teachers was also highlighted by some participants’ comments about the effectiveness of formal maths related training and/or workshops external to the school. Of the nine participants
(90%) who reported at interview that they had attended formal maths related training and/or workshops outside the school in their first two years of teaching, six (60%) questioned its suitability for beginning teachers especially when it wasn’t part of a wider, whole school mathematics program.

I think that type of PD helps but you can sometimes be overwhelmed by it so for a while you need to get yourself established and have a little bit of experience before you can really take in a lot of what the PD is telling you.

We did the CMIT professional development (PD) but then once it was over there wasn’t a lot of time or follow-up back at school.

The hardest thing about formal PD is trying to implement it into the crowded program.

PD is also great but it has to be the right PD at the right time.

An after-school network is just another thing I’d have to do and I wouldn’t enjoy it.

Doing PD after school after a full day of teaching makes it really hard to get your head around what you’re supposed to do.

It is also interesting to note that during the coding process it was identified that, while all the suggestions proposed by the participants could be coded into the same four focus areas, the sample as a whole could be almost evenly ‘split’ into two dichotomous groups based on whether or not their responses were framed in terms of professional development being explicitly linked to the whole school mathematics program.

Five participants (50%) specifically identified that the most effective way to support beginning teachers was to have a coherent and consistent approach to teaching mathematics across the school and/or within teaching teams.

Having a program that is used by everyone and will continue to be used all year...[and]...linked to the PD you do.

Working with an experienced CMIT teacher last year...[as well as doing the CMIT PD]...really set me on a good path.
We all did different things...I struggled until I found two early childhood textbooks that were recommended by another teacher but no one else uses them here...I don’t feel we were shown how to program.

Providing really good support and a great syllabus...with a beginner’s resource pack...as my arrival here coincided with the introduction of the dedicated program it was a shared experience with my colleagues.

You really need to pull the school together for maths...having a skeleton program to support you and let your new teachers sit and watch other teachers.

This result is consistent with that of the beginning teacher survey data where it was established that the mere existence of mathematics and/or support programs at a school does not automatically mean that it will meet the needs of individual teachers or have a major impact on their classroom practice. Rather, it is the school ‘program coherence’, a “measure of integration of the different elements in the school as an organisation” (DEST, 2004, p. 15) that is the critical factor in supporting teacher development as effective teachers of mathematics (DEST, 2004; Newmann, King, & Youngets, 2000; Newmann et al., 2001).

Therefore the following data statement can be reported:

**Data Statement 5.20**

In their second year of teaching, participants suggested various ways that schools could better support beginning primary school teachers to teach mathematics.

Initial professional development should:
- **be closely linked to the day to day operation of the classroom** and focus on pedagogy, curriculum, resources and assessment;
- **be delivered on site** as much as possible;
- **include opportunities** for teachers to **observe teaching practice** and access colleagues for advice; and
- **be embedded** within a **cohesive school mathematics program** and learning community.

**Stage 4: Integrating the Beginning Teacher Data**

The final stage of the data analysis process involved integrating and reducing the beginning teacher survey and interview data analyses into the following three categories:

- teacher **confidence**—a measure of the personal factors that influence beginning teacher development;
• school program coherence—a measure of the school factors that influence beginning teacher development; and
• consistency of practice—establishing the consistency between stated beliefs and classroom practice as an indicator of beginning teacher development.

These categories were then used to develop a model for beginning teacher development (see Figure 5.2) that would be used to profile participants, inform the selection of case story participants, provide a framework for the presentation of the case stories and provide the filters and lenses through which the data collected in the final ‘case story’ stage of the study would be analysed.

![Figure 5.2: Beginning Teacher Development Model](image)

**Teacher Confidence**

The issue of teacher confidence was first identified as an area of interest in this study in the analysis of the pre-service teacher survey data. The importance of teacher confidence in the development of beginning teachers as teachers of mathematics was then confirmed as part of the analysis of the beginning teacher interview data.
As a result of the data analysis process, teacher confidence can also be conceptualised as having two distinct components: teaching confidence; and mathematical confidence. An individual’s teaching confidence is the measure of their confidence in their ability to teach mathematics and is based on their level of curriculum confidence (knowing what maths topics to teach and when to teach them), pedagogical confidence (knowing how to teach) and professional confidence (confidence in their professional role as teachers of mathematics within the wider school context).

On the other hand, an individual’s mathematical confidence is the measure of their ability to do and understand mathematics and is based on how they perceive themselves as mathematicians, how they view mathematics as a field of study and on their level of content knowledge (knowing the big concepts behind the maths topics they have to teach). In addition to conceptualising teacher confidence, the data from both the pre-service teacher survey and beginning teacher interviews can also be quantified (‘very confident/confident’ or ‘not very confident’) and used to profile participants’ confidence as pre-service and second year beginning teachers.

These profiles can then be analysed to identify what, if any, changes have occurred in teacher confidence levels in the early years of their teaching careers. Once changes and constants in confidence levels are identified for each participant they can be further investigated to determine how the initial teaching experience (the context in which these first stages of teacher development are occurring) influences the development of beginning teachers as teachers of mathematics.

School Program Coherence

The identification of school program coherence as a factor in the development of beginning teachers as teachers of mathematics was derived from extant literature and research and was a major assumption that underpinned the construction of the beginning teacher survey.
As a result of the beginning teacher data analysis process, it was identified that the mere existence of a school mathematics program did not presuppose that it would either meet the needs of individual teachers or that it would have a major influence on the decisions they were making about how to teach mathematics in the classroom.

The subsequent analysis of the data from the beginning teacher interviews—where participants provided more information about their initial teaching experience within a school context—showed that the level of influence a school mathematics program had on the decisions they were making about how to teach mathematics in the classroom could also be quantified as either ‘high’ or ‘low’ and used to profile the overall coherence of a school’s mathematics program. These profiles can then be used, along with participants’ pre-service and beginning teacher confidence profiles, to contextualise the changes to teacher confidence in the initial years of their teaching careers and determine what factors of school context had the strongest positive and negative influences on the development of beginning teachers as teachers of mathematics.

*Consistency of Practice*

The efficacy of using ‘consistency’ as a lens or filter in the data analysis process in this study was established in the first stage of data collection. While participants, as pre-service teachers, uniformly reported that they wanted to teach the constructivist maths that had been espoused during their university study as the model of effective mathematics teaching and learning, inconsistencies within the data identified an underlying concern for some participants that they may not be able to realise this constructivist teaching ‘ideal’ in the classroom.

Similarly in the beginning teacher data, while participants reported to teach in primarily constructivist classrooms, inconsistencies within the data identified that some aspects of their classroom practice (‘what they did’) seemed to contradict there stated beliefs (‘what they said’) about mathematics teaching and learning.
As such, identifying and investigating areas of consistency and inconsistency in the data of individual participants in the final stage of data collection can help determine how different factors of the initial teaching experience, both at a school program coherence level and individual teacher confidence level, influence the development of beginning teachers as teachers of mathematics.

Conclusion

This chapter provided a full description of the data analysis process and presented the initial data analysis results of the second stage of this study. The goals outlined in the chapter introduction have been achieved as the results of the data analysis have:

• described the transition experience of these participants and established that the sample is highly representative of beginning primary school teachers in Australia;
• identified a model of teacher development that uses teacher confidence, school program coherence and consistency of practice to contextualise this process; and has
• provided further information to be used in building the in-depth individual teacher case stories in the third stage of the study.

In keeping with the data analysis framework of the overall research design, the results of the data analysis presented in this chapter will be integrated with the data collected and analysed from the third stages of this study. The result of this integration process will be presented in Chapter 7 of this report where all the study data will be integrated to address the research questions and produce the findings of the study.
Chapter 6: Beginning Teacher Case Stories

Introduction

The data for the third and final stage of this study were drawn from the survey and interview data instruments used in the first two stages of the study and, for some participants, supplemented with new data collected via further interviews, classroom observations and the administration of a mathematical test. These data were then used to develop and present individual, longitudinal case stories for participants that described their development as teachers of mathematics at the beginning of their teaching careers.

These stories of individual participants are the result of the data analysis of the third research method used as part of the mixed methods research design of this study—the case study. Most typically associated with the qualitative research paradigm, a case study is the “intensive and detailed description and analysis of one or more cases” (Christensen, Johnson, & Turner, 2011, p. 374) that focus on investigating a “contemporary phenomenon within a real-life context” where the “investigator has little or no control over events” (Yin, 2009, p. 2).

In the context of this study, the individual case stories of the selected participants were developed in order to:

- describe and compare the development of individual participants as teachers of mathematics at the beginning of their teaching careers using the Beginning Teacher Development Model (BTDM) (Figure 6.2), to better understand the relationship between teacher confidence, school context and classroom practice;
- identify points of contradiction and congruence within the participant-generated data (participant self-reports via survey and interview responses) and researcher-generated data (mathematical testing results and the observation of mathematics teaching); and
• integrate the data from all stages of the study and present it as an interesting and convincing story that demonstrates the development of beginning primary school teachers as teachers of mathematics taking into consideration individual and school context factors.

As such, the data used at this stage of the study were the primary source of data used to address the third and fourth research questions (see Box 6.1).

Box 6.1: The Research Questions

Research Question 1
How does an individual’s experience of mathematics as a school student and as a pre-service teacher influence their beliefs and attitudes about mathematical teaching and learning on the eve of their transition into the primary school classroom?

Research Question 2
How do factors of school context and the first year experience reinforce and/or change beginning primary school teachers’ pre-existing beliefs and attitudes about teaching and learning mathematics?

Research Question 3
To what extent is a beginning primary school teacher’s classroom practice an artefact of their beliefs and attitudes formed as a result of their experiences as:
• a school student;
• a pre-service teacher;
• a beginning teacher;
• a teacher within a particular school context; and
• part of developing an individual teacher identity?

Research Question 4
Can we use these understandings of the links between teacher beliefs, attitudes and practice to construct a model that allows schools to provide more targeted and effective support for beginning primary teachers to develop as effective teachers of mathematics?

The Data Analysis Process

As shown in Figure 6.1, the beginning teacher data collected and/or retrieved in this final stage of the study were analysed using a repeated cycle of data reduction, display, comparison and integration in a five-stage process that constantly refined the data so that robust and meaningful inferences about them could be made (Miles &
More detailed information about each stage in the data analysis process is provided in the following Reporting the Data Analysis Results section.

Source: Figure adapted from Figure 11.2 in Teddlie & Tashakkori, 2009, p. 277.
**Analysing the Data**

The first two stages of the data analysis process involved retrieving existing survey and interview data for each of the ten participants who had participated in the first two stages of this study, organising and presenting it using the BTDM, and then using the results to identify extreme cases for further study.

The next two stages of the data analysis process involved analysing the additional mathematical assessment and teaching observation data collected for the participants who also participated in this final data collection stage of the study, and then integrating this data with the BTDM participant data to present three extended case stories for further study.

Once the extended case stories were developed, all BTDM profiling data and case story data were integrated and analysed in the final stage of the data analysis process to form a cohesive picture of the total data collected. More detailed information about each stage in the data analysis process is provided in the following **Reporting the Data Analysis Results** section.

**Reporting the Data Analysis Results**

The results of the beginning teacher profile and case story data analysis are reported below in five stages to reflect the sequential order of the data analysis process as shown in Figure 6.1.

**Stage 1: Profiling the Participants Using the Beginning Teacher Development Model (BTDM)**

Having developed the BTDM (see Figure 6.2) from the results of analysis of both pre-service and beginning teacher data, the next step was to develop an initial descriptor or 'narrative' for each of the profile categories contained in the model. This process of “qualitising numeric data” (Teddlie & Tashakkori, 2009, p. 271) to formulate comparative profiles is a feature of “conversion mixed data analysis” (Teddlie & Tashakkori, 2009, p. 269) and is used to identify “easy to
understand and communicate” (Teddlie & Tashakkori, 2009, p. 273) sub-groups in a single variable or unit of study.

This “narrative profile formation” (Teddlie & Tashakkori, 2009, p. 271) initially involved locating the source of the analysed data that informed the development of the profile categories used in the BTDM and using this information to create the initial profile descriptors. The results of this process are reported in Table 6.1.

Having created the initial profile category descriptors, the next step in the data analysis process was to record the developmental journey of all 10 participants using the BTMD. This involved retrieving each participant’s profile category data from the relevant data sources detailed in Table 6.1 and then organising them into a BTDM matrix.
### Table 6.1: Beginning Teacher Development Model—Initial Profile Category Descriptors

<table>
<thead>
<tr>
<th>Profile Category</th>
<th>Profile Category Descriptor</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-service Teacher</td>
<td>I am very confident/confident of my ability to develop students’ higher-order maths skills.</td>
<td>PST Survey q. 5 Table 5.24</td>
</tr>
<tr>
<td></td>
<td>I am not very confident of my ability to develop students’ higher-order maths skills.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overall mathematics was not a negative experience for me at school and I found it more likely to be relevant and either fun and/or easy to do.</td>
<td>PST Survey q. 2 BT Interview q.1 Table 5.19</td>
</tr>
<tr>
<td></td>
<td>Overall mathematics was a negative experience for me at school and I found it to be irrelevant and either boring and/or difficult to do.</td>
<td></td>
</tr>
<tr>
<td>Beginning Teacher</td>
<td>I am very confident/confident that I am an effective maths teacher. I know what to teach, how to teach it and where and how to get the things I need to teach it well.</td>
<td>BT Interview DS 5.18 DS 5.20 DS 5.21 Table 5.23 Table 5.24</td>
</tr>
<tr>
<td></td>
<td>I am not very confident that I am an effective maths teacher. I know what to teach but am not sure that I am teaching it well and am unsure where to go to get the things I need to improve.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I am very confident/confident in my capacity to ‘do’ and understand mathematics and my maths content knowledge is not a concern for my teaching.</td>
<td>BT Interview DS 5.19 Table 5.23</td>
</tr>
<tr>
<td></td>
<td>I am not very confident in my capacity to ‘do’ and understand mathematics and my concerns about my teaching are linked to my maths content knowledge.</td>
<td></td>
</tr>
<tr>
<td>School Program Coherence</td>
<td>The influence of my school’s maths program on the decisions I make about what, how and when I teach maths and how to develop as a teacher of maths is high.</td>
<td>BT Interview DS 5.19 Table 5.25</td>
</tr>
<tr>
<td></td>
<td>The influence of my school on the decisions I make about what, how and when I teach maths and how to develop as a teacher of maths is low. If I plan with colleagues at all, it is with my direct teaching colleague only and/or is limited to ensuring that we cover the same topics for reporting purposes.</td>
<td></td>
</tr>
</tbody>
</table>

The results of this retrieval and organisational process are reported in Table 6.2 and, as this is the first time longitudinal data for each participant has been presented as an individual case, names (pseudonyms) have been used to identify the participants rather than the numbers used in the previous chapter.

It is important to note at this time that the process of profiling the participants using the BTDM also underpinned the selection of participants for both extreme and extended case stories. Further
details about this selection process will be provided in the following reporting of data analysis results.

Table 6.2: Beginning Teacher Development Model—Participant Profiling

<table>
<thead>
<tr>
<th>Participant*</th>
<th>Pre-service Teacher Confidence</th>
<th>School Program Coherence</th>
<th>Beginning Teacher Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucette</td>
<td>Teaching CVC</td>
<td>HIGH</td>
<td>Teaching CVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Sue</td>
<td>Teaching NVC</td>
<td>HIGH</td>
<td>Teaching NVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Sally</td>
<td>Teaching CVC</td>
<td>HIGH</td>
<td>Teaching CVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Ally</td>
<td>Teaching NVC</td>
<td>LOW</td>
<td>Teaching NVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Jackie</td>
<td>Teaching NVC</td>
<td>LOW</td>
<td>Teaching NVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Cate</td>
<td>Teaching CVC</td>
<td>HIGH</td>
<td>Teaching CVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Kate</td>
<td>Teaching NVC</td>
<td>HIGH</td>
<td>Teaching CVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Beth</td>
<td>Teaching NVC</td>
<td>LOW</td>
<td>Teaching NVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Emerald</td>
<td>Teaching NVC</td>
<td>LOW</td>
<td>Teaching NVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
<tr>
<td>Anna</td>
<td>Teaching NVC</td>
<td>LOW</td>
<td>Teaching NVC</td>
</tr>
<tr>
<td></td>
<td>Mathematical</td>
<td></td>
<td>Mathematical</td>
</tr>
</tbody>
</table>

* Pseudonyms used for all participants.

Once the BTDM matrix was complete, the next step in the process was to extract and compare individual data units from the matrix to investigate the link between teacher confidence levels and school program coherence ratings. The results of this extraction and comparison process are reported in Figures 6.3, 6.4 and 6.5.

When looking first at participants’ developing confidence as teachers of mathematics, and as reported in Table 6.2, of the three participants (30%) who were confident/very confident in their ability to teach constructivist maths as pre-service teachers, all were confident they were effective teachers of mathematics in their second year of teaching.

As shown in Figure 6.3, of the seven participants (70%) who were not very confident in their ability to teach constructivist maths as pre-
service teachers, six (60%) were confident they were effective teachers of mathematics by the time they were in their second year of teaching. It is interesting to note at this stage that for five participants (50%), this increase in confidence in their ability to teach maths seemingly occurred independently of any input from their school context in that they categorised as low the influence of their school on the decisions they made about what, how and when to teach maths and how to develop as a teacher of maths.

It is also interesting to note that Sue, the sole participant (10%) who was still not confident in her ability to teach mathematics in her second year of teaching, categorised the influence of her school on the decisions she made about what, how and when to teach maths and how to develop as a teacher of maths as high.
As such the following data statement can be reported:

<table>
<thead>
<tr>
<th>Data Statement 6.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>In their second year of teaching most beginning teachers are confident of the overall efficacy of their mathematics teaching.</td>
</tr>
<tr>
<td>Beginning teachers who were confident as pre-service teachers maintained this confidence during their initial teaching experience.</td>
</tr>
<tr>
<td>Most beginning teachers who were not very confident as pre-service teachers developed confidence in the ability to teach maths during their initial teaching experience.</td>
</tr>
<tr>
<td>This change in mathematical teaching confidence occurred regardless of whether or not the participants identified that they were teaching at schools with highly coherent maths programs that had a strong influence on their development as teachers of mathematics.</td>
</tr>
</tbody>
</table>

When looking at participant confidence in their ability to do and understand mathematics over time, Table 6.2 shows that as pre-service teachers, five participants (50%) reported that their experience of school mathematics was not a particularly negative experience and they were more likely to have found it to be relevant and either more fun and/or easy to do than their fellow participants. However, as shown in Figure 6.4, as second year teachers, three of these participants (30%) maintained this pre-service level of confidence in their ability to do and understand maths and did not identify a lack of content area knowledge as a major issue for them as beginning teachers of mathematics.

Of the two participants (20%) who apparently lost confidence in their ability to do and understand mathematics when they started teaching, one—Sally—categorised the influence of her school on the decisions she made about what, how and when to teach maths and how to develop as a teacher of maths as high while the other participant—Ally—categorised the influence of her school on the decisions she made about what, how and when to teach maths and how to develop as a teacher of maths as low.
This leaves five participants (50%), as shown in Table 6.2, who reported as pre-service teachers that they had a negative experience of school mathematics in that they were more likely to have found mathematics irrelevant, boring and hard to do. As shown in Figure 6.5, as second year teachers, all of these participants (50%) maintained this pre-service level lack of confidence in their ability to do and understand maths and identified content area knowledge as a major issue for them as beginning teachers of mathematics. Of those five participants, two (20%) categorised the influence of their school on the decisions they made about what, how and when to teach maths and how to develop as a teacher of maths as high.

It is interesting to note that the only participant who reported a positive change in their confidence to ‘do’ and understand mathematics—Jackie—categorised the influence of her school on the decisions she made about what, how and when to teach maths and how to develop as a teacher of maths as low.
As such, the following data statement can be reported:

**Data Statement 6.2**
In their second year of teaching half of the beginning teachers sampled were not very confident of their ability to ‘do’ and/or understand mathematics and lack of content knowledge was identified as a major issue for their mathematics teaching.

All of these beginning teachers reported having negative experiences of themselves as mathematicians as pre-service teachers and did not develop confidence in this area even though they saw themselves as good teachers of mathematics after their initial teaching experience.

However, of the beginning teachers who were confident in themselves as mathematicians as pre-service teachers, some of them did not maintain this level of confidence after their initial teaching experience.

What, if any, affect school program coherence had on these results was less clear-cut than the affect noted for mathematical teaching confidence.

**Data Check**

At this stage in the data analysis process, the role of school program coherence on the development of beginning teachers as teachers of mathematics seems to be either minimal or contradictory. Certainly, in the case of developing mathematical teaching confidence, the reported positive change in beginning teachers who lacked confidence as pre-service teachers occurred regardless of the level of influence the school program had on their maths teaching.
Similarly, for those beginning teachers who reported no change from their negative pre-service perception of themselves as mathematicians, i.e., ‘doers’ of maths, some were at schools with reported high levels of influence on their mathematical teaching.

For the two participants who reported a loss of confidence in themselves as mathematicians after their initial teaching experience, only one of them—Ally—was at a school where the maths program had a minimal influence on their maths teaching. The other participant—Sally—was at a school where she felt her maths teaching was highly influenced by the school program.

As such, the following data check can be generated:

**Data Check: School Program Coherence**

Initial data suggests that the overall coherence of a school maths program does not necessarily have a strong influence on the development of an individual’s mathematical teaching confidence during the initial experience of teaching.

Developing confidence as a teacher of mathematics seems to be an intrinsic process linked to ‘surviving’ the transition to classroom teacher rather than being dependent on positive or negative extrinsic factors of school context.

Initial data also suggests that that the overall coherence of a school maths program does not necessarily have a strong influence on the development of mathematical content knowledge and confidence as a ‘doer’ of mathematics during the initial experience of teaching.

As a result of this finding, further investigation of the role of school program coherence on the development of beginning teachers as teachers of mathematics has been identified as an ongoing issue of interest in the case study research and data analysis process.

At the completion of the profiling process reported above, the following five participants were selected to progress to the next stage of the study and become the individual case stories that would provide the narrative of this research: Lucette, Sue, Sally, Ally, and Jackie.

As shown in Table 6.2, Lucette and Sue were selected on the basis of being extreme cases and their stories were constructed using the data collected from the survey and interview process. On the other hand, Sally, Ally and Jackie were selected as extended case stories, as they were willing and available to participate in the additional mathematical assessment and lesson observation data collection.
processes. This additional data was used in conjunction with the existing survey and interview data to construct their stories.

**Stage 2: Extreme Case Stories**

In the context of the BTDM and this research, Lucette and Sue represent the extremes of the beginning teacher model for development as teachers of mathematics and, as such, it is very important that their stories are told and examined as part of this research.

Lucette is certainly the ‘ideal’ case, displaying the organisational, pedagogical and conceptual knowledge and understandings we want to see in a beginning teacher of primary mathematics. She is also working in an ‘ideal’ school context where there is a cohesive and effective mathematics program that is strongly influencing her classroom practice. What lessons can we learn, as school leaders and mathematical educators responsible for developing effective primary school mathematics teachers, from Lucette’s story?

On the other hand, Sue’s journey as a beginning teacher of mathematics reads almost as a cautionary tale for mathematics educators, schools and education departments. Not confident in either her teaching or understanding of mathematics at the end of her pre-service teacher training, Sue, despite identifying that she too was working in an ‘ideal’ school context, had made little progress in her development after her initial teaching experience. Where did we fail Sue? What else could we have done? How often will a scenario like Sue’s occur in our schools and classrooms and what implications has it had for Sue’s career as a teacher?
Case Story One: Lucette

Biographical Details

Lucette was a mature-age entrant to primary teaching and entered pre-service training after working for 15 years in the field of children’s speech and hearing development. In addition to her Bachelor of Education qualifications she also holds a Bachelor of Science in Botany and a Master’s in Audiology.

Beginning Teacher Journey

As reported in Table 6.2 and shown in Figure 6.6, Lucette:

- left her pre-service teacher training highly confident in her ability to do and understand mathematics and to teach mathematics following a constructivist model of teaching and learning;
- worked in a school with a coherent mathematics program that strongly, and positively, influenced the decisions she made about teaching maths and developing as a teacher of mathematics; and
- remained confident in her effectiveness as a maths teacher and a mathematician after her initial teaching experience.
Pre-service Teacher Confidence

In the context of this study, Lucette was the only pre-service teacher (0.5%) out of 200 who completed a survey whose individual story reflects such a positive profile in relation to her high levels of confidence in herself as a mathematician and as a maths teacher. In Question 2 of the pre-service teacher survey, Lucette recorded having an unambiguously positive experience of mathematics as being relevant, fun and easy to do at school. Then, in Question 5, Lucette indicated that she was very confident of her ability to develop all four of the listed higher-order mathematics skills in her students.

When looking at the internal consistency of Lucette’s responses within the pre-service teacher survey, she also:

- ranked maths as one of the three most enjoyable and easy curriculum areas to teach out of the six curriculum areas listed (Question 3); and
- articulated a personal philosophy about teaching and learning mathematics that reflected a primarily constructivist model of teaching and learning without making any comments that would indicate that she was suffering from any manifestation of maths anxiety (Question 8).

Fast forward two years and, armed with the data analysis of both the pre-service and beginning teacher surveys, we meet Lucette again in the latter half of her second year of teaching to interview her about her journey as a beginning teacher of primary mathematics.

The initial focus of the interview was to verify aspects of Lucette’s individual pre-service teacher data and discuss it in light of the general thread of negativity that was identified as part of the collective pre-service teacher survey data analysis process (see The Pre-service Teacher, Chapter 4). At interview, Lucette confirmed both her positive experience of mathematics at school and her confidence in herself as a mathematician, explaining that:
I was dyslexic and had trouble with literacy so maths and science were my joy because I could do it.

When discussing her positive experience in light of the thread of negativity identified in the analysis of the sample as a whole, Lucette went on to say that:

I was at an all-girls school for most of my school life and...I didn’t realise that girls didn’t do science or maths until I got to university where I was routinely one of two [girls] in a cohort of 50 people in a science or maths class.

She then acknowledged that, as a pre-service teacher she:

...didn’t have the same [negative] attitude to maths that I saw around me...with all the other beginning teachers who went ‘aarrgghhh’ whenever maths was talked about. I don’t understand it because I don’t have that.

Beginning Teacher Confidence

As detailed in The Beginning Teacher (Chapter 5), overall teacher confidence was identified as being made up four separate confidence categories: curriculum; pedagogy; professional; and content area. An analysis of Lucette’s beginning teacher survey and interview data confirmed that she was confident in all four categories and was very confident overall of her ability to both ‘do’ and teach mathematics. As such, Lucette had maintained her high pre-service teacher levels of mathematical confidence during her initial teaching experience.

Classroom Practice

In both the within and between analysis of Lucette’s data from both surveys and interview, there was nothing to suggest any incongruence between her reported teaching practice and her confidence as a teacher of mathematics. Lucette was confident that the commercial, textbook-based maths teaching program she was using met all external curriculum requirements and was able to identify where and how maths was integrated across the curriculum and in the daily routines of the classroom.

Throughout her interview, Lucette’s descriptions of her teaching and classroom were also pedagogically consistent with her pre-service
understandings of a constructivist approach to teaching. She talked of lessons that:

- began with a whole class introduction of the concept;
- continued with group, partner or individual hands-on exploration; and
- finished with whole class discussions and explicit conversations about how this maths related to the real world.

Lucette described the tasks and activities she used in the classroom as part of the program (the games, worksheets or open-ended problem solving) as enjoyable and engaging for students. Lucette also identified that these activities were differentiated based on student ability, which was established through the administration of pre- and post-assessment activities.

As a teaching professional within a learning community of teachers, Lucette appreciated and enjoyed the professional dialogue she had with her peers across the school regarding the implementation and evaluation of the prescribed textbook-based program. When some colleagues expressed concern with the program:

...having niggles about ‘this isn’t there...and I’ve supplemented it here and there’...

Lucette listened but then continued on with the program as it was presented. After the first year, she was then confident (‘comfortable’) to use her own experience and the feedback of her peers to help her “fill in any gaps” that she saw in the program. At no point in the analysis of the survey or interview data did Lucette give any indication that, halfway into her second year of teaching, she was anything other than the independent, competent and confident mathematician and mathematics teacher she reported herself to be.
Case Story Two: Sue

Biographical Details

Like Lucette, Sue was a mature-age entrant to primary teaching and entered pre-service training after working in the social welfare arena. In addition to her Bachelor of Education qualifications she also holds tertiary qualifications specific to her work in the field of youth counselling and justice.

Beginning Teacher Journey

As reported in Table 6.2 and shown in Figure 6.7, Sue left her pre-service teacher training not very confident in her ability to do and understand mathematics or to develop higher-order math skills in her students. While Sue reported that she worked in a school with a coherent mathematics program that strongly, and positively, influenced the decisions she made about teaching maths and developing as a teacher of mathematics, she remained doubtful of her effectiveness as a maths teacher and a mathematician after her initial teaching experience.

Figure 6.7: Sue Beginning Teacher Developmental Journey

<table>
<thead>
<tr>
<th>Pre-service Teacher</th>
<th>Initial Teaching Experience</th>
<th>Beginning Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Confidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ability to teach mathematics</td>
<td>I am not very confident of my ability to develop students' higher-order maths skills.</td>
<td></td>
</tr>
<tr>
<td>Mathematical Confidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ability to do and understand maths</td>
<td>Overall maths was a negative experience for me at school and I found it irrelevant, boring and hard to do.</td>
<td></td>
</tr>
<tr>
<td>School Program Coherence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>capacity to influence teacher development</td>
<td>The influence of my school's maths program on the decisions I make about what, how and when I teach maths and how to develop as a teacher of maths is: HIGH</td>
<td></td>
</tr>
<tr>
<td>Teaching Confidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ability to teach mathematics</td>
<td>I am not very confident that I am an effective maths teacher. I know what to teach but am not sure that I am teaching it well and am unsure where to go to get the things I need to improve.</td>
<td></td>
</tr>
<tr>
<td>Mathematical Confidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ability to do and understand maths</td>
<td>I am not very confident in my capacity to 'do' and understand mathematics and my concerns about my teaching are linked to my maths content knowledge.</td>
<td></td>
</tr>
</tbody>
</table>
Pre-service Teacher Confidence

In the context of this study, Sue was one of four pre-service teachers (2%) out of 200 who completed a survey whose individual story reflects such a negative profile in relation to her low levels of confidence in herself as a mathematician and as a maths teacher. In Question 2 of the pre-service teacher survey, Sue recorded having an unambiguously negative experience of mathematics at school. Then, in Question 5, Sue indicated that she was not very confident of her ability to develop the listed higher-order mathematics skills in her students.

When looking at the internal consistency of Sue’s responses within the pre-service teacher survey, she also identified maths as one of the least enjoyable and easy curriculum areas to teach (Question 3). When given an opportunity to articulate a personal philosophy about teaching and learning mathematics, Sue chose instead to make a comment that indicated that she had suffered anxiety while studying teaching related to both her capacity to do and teach mathematics (Question 8—see Researcher’s Note below for full comment).

Fast forward two years and, as with Lucette, we meet Sue again in the latter half of her second year of teaching to interview her about her journey as a beginning teacher of primary mathematics.

The initial focus of the interview was to verify aspects of Sue’s individual pre-service teacher data and discuss it in light of the general thread of negativity that was identified as part of the collective pre-service teacher survey data analysis process (see The Pre-service Teacher, Chapter 4). At interview, Sue confirmed both her negative experience of mathematics at school, and her lack of confidence in herself as a teacher of mathematics, explaining that:

Maths was the subject I was most terrified of teaching when I graduated.
Beginning Teacher Confidence

As detailed in *The Beginning Teacher* (Chapter 5), overall teacher confidence was identified as being made up four separate confidence categories: curriculum; pedagogy; professional; and content area. An analysis of Sue’s beginning teacher survey and interview data confirmed that she was confident in only one of these four categories and was not very confident overall of her ability to both ‘do’ and teach mathematics. As such, Sue had maintained her low pre-service teacher levels of mathematical confidence during her initial teaching experience.

**Researcher’s Note**

I first met Sue in her final year as a pre-service teacher when I went to her university campus to administer the Pre-Service Teacher Survey. After Sue had completed her survey and handed it in she introduced herself to me and said she was very interested in being involved in my study. As she had written in response to Question 8 of the survey, Sue:

> ...had to work very hard with the support of a tutor to develop both the skills to pass maths at uni and the confidence to teach maths. It’s been a big journey that I’m glad to share.

While Sue’s stated ‘confidence to teach maths’ seemed at odds with her reported low confidence to develop students’ higher order maths skills and her low ranking of maths as an enjoyable and easy subject to teach, she seemed very positive about her university maths experience and was looking forward to teaching maths the following year.

Sue’s self-reported positivity about teaching maths continued in her responses in the Beginning Teacher Survey that she completed and returned to me at the end of her first year of teaching:

> I love teaching maths and am increasingly growing in my confidence to do this.
Sue also went on to report that she had completed professional development in maths, the Count Me In Too (CMIT) program, and was working in a very positive school context. During her interview in the second year of her teaching, Sue was confident that her overall maths program met set curriculum requirements because:

...last year my teaching partner planned our math program term by term...so I’ve got that as a resource...

and this year she and her current teaching partner get together to:

...work out our own term overview to ensure we cover all the areas of maths.

However, when discussing other aspects of teaching mathematics that fell into the other three categories of pedagogical confidence, professional confidence and content area confidence, Sue often displayed high levels of anxiety:

This is my second year of teaching...and I mostly taught quite good maths but I’ve had to work quite hard at it.

I still don’t feel really solidly confident doing CMIT (Count Me In Too)...I guess I do my best with it.

I’m sorry; I get really nervous talking about it (teaching mathematics) as if I’m doing something wrong.

I do term math reviews with my kids...only for myself...I need that for myself in case a parent comes.

My kids come into the (CMIT) group bouncing like they love to be here but I’m worried that if I had to justify what I’m doing using the CMIT framework [to others] that I would not be able to...that freaks me out.

[Matching maths games or other activities to the right concept] that’s the bit of CMIT that I don’t feel I’m there yet.

In addition to these comments at one point in the interview I paused the tape recorder as Sue was becoming very worried about discussing the implementation of the CMIT program at her school ‘on the record’. In the note I made after the interview and included at this point in the interview transcript I reported the following:
Sue…talked about some reservations she had about the Departmental expert from the Literacy and Numeracy team coming out and taking the names of teachers and talking about what they were doing wrong.

Her impression, given to her by other teachers who had attended this afternoon meeting at the school, was that some teachers were threatened by that and she felt lucky that she had had another commitment that afternoon and wasn’t in attendance. The thought of that process happening to her is causing her some level of stress as she is nervous that she is not implementing the program correctly and she is worried about being open about her lack of confidence.

At the end of the interview Sue indicated that she would be happy to be contacted again to participate in the next phase of the study. At the end of the interview I made the following note:

Sue had a very negative experience of maths at school and even though she describes her experience of teaching maths in the first two years of her career as being positive she is still lacking confidence in her own ability to justify what and how she teaches to others.

Fast forward another six months and we meet Sue again in Term 1 of her third year of teaching. Sue has agreed to meet with me to complete the ICAS Mathematics 2006 Paper D and arrange suitable times in the next semester for me to conduct some classroom observations.

Sue began the maths paper and at Question 2 she stopped, looked at me and said that she was feeling very uncomfortable about doing the test and that it was:

…pushing me way out of my comfort zone.

While Sue didn’t refuse to do the paper, she was obviously stressed as she continued so I called a halt to the process, letting her know that the main purpose of the visit was to touch base with her in her third year of teaching and not the test. I gave her the maths paper to keep along with her partially completed answer sheet (she attempted less than 10 questions before I stopped the test) and working out paper and kept no documentation related to the test administration. We then chatted for half an hour about her start to the year. At the end of half an hour I thanked Sue for her time and participation in the study so far and advised her that I would contact her at a later stage.
if she were required for the classroom observation phase of the study.

At this point, I contacted my Principal Supervisor to discuss what had occurred and we agreed not to contact Sue for further participation in the study in light of the anxiety she displayed in both face-to-face interviews she had with me. One month later I sent Sue an email thanking her again for her participation and advising her that she would not be required for the final data collection stage of the study.

School Context

In both the within and between analysis of Sue’s data from both surveys and interviews, there were a number of instances that suggested that there was a mismatch between Sue’s reported positive experience of teaching maths and her actual confidence as a teacher of mathematics. In light of this pattern of inconsistency in Sue’s data about teaching mathematics, it made sense to look more closely at her data relating to the school context to see if that was also the case. What role, if any, had the school played in Sue maintaining her low pre-service teacher levels of mathematical confidence during her initial teaching experience?

As detailed in Table 6.2 and shown in Figure 6.7, Sue reported that there had been a strong collegial influence on her mathematical decision making in her first years of teaching. She and her teaching partner planned together and this approach to programming mathematics was approved by the school executive and had some links to the professional development program. As such, the capacity of the school program to influence her mathematical decision making was deemed to be ‘high’. At no point in the re-analysis of Sue’s survey and interview data was there any indication that the school mathematics program at Sue’s school was anything other than what she reported.

For maths planning in general, the school promoted and supported teaching partners working together to devise teaching scope and
sequences and term overviews. Sue reported that this had happened in both years of her teaching career and that:

Planning in collaboration with a more experienced teacher has been great.

Sue also reported that she could call on members of the school executive:

...when I’m not sure and I have had our principal come (to my classroom) and model maths lessons.

The school executive had made a whole school commitment to implementing the Count Me In Too (CMIT) program. They had ensured that their staff, including Sue, had attended the relevant professional development course that supported the program. The school had also made sure they had the resources necessary for teachers to implement the program in their classrooms:

We have a well-resourced maths room and each classroom is fairly well provided with resources.

At a school level, there was a set time once a week for CMIT streamed maths groups to operate across the school. Groups were formed based on the results of the Schedule of Early Number Assessment (SENA), the pre- and post-assessment of the CMIT program that each teacher was given time off-class to complete one-on-one with all students in their class. On staff there was a teacher identified as a CMIT ‘expert’ who conducted on-going professional development and professional dialogue about the program to the whole staff. This expert teacher was also available for individual teachers to consult for advice about the CMIT program and its implementation at any time.

So, given that Sue was working in a school with a highly coherent school mathematics program where she was supported by her peers and school executive and felt:

...blessed about teaching here in this school where I feel I can go to other teachers when I need help...
why then was she still demonstrating such high levels of anxiety about her mathematical teaching three years into her career?

In looking closer at Sue’s survey and interview data, it would appear that what the school did not understand was that, given her high levels of maths anxiety, Sue would be in the initial ‘survival’ stage of teacher development longer than ‘normal’ when it came to teaching mathematics. As such, Sue would require the type of intensive support typically provided for beginning teachers very early in their transition for a longer period of time.

As previously reported, for the overall non-CMIT maths program, Sue worked with her teaching partner to:

…work out our own term overview to ensure we cover all the areas of maths.

However, in the first year of her teaching, in addition to Sue and her teaching partner planning together to ensure curriculum coverage, they would also:

…take it in turns, a week about, to prepare that week’s lessons and that worked really well.

This extra level of collegial assistance, where she and her teaching partner would discuss the week’s maths activities together both before and after they were taught, did not continue after Sue’s first year of teaching. Similarly, when planning for her CMIT group, Sue stated that she devised the learning program for that group on her own and then would:

…sometimes…go to our expert teacher…and say does this look alright?

The expert teacher did not initiate extra planning or classroom support for Sue (model lessons, conduct lesson observations, team teach, allow time for debriefing and professional discussion about her teaching experiences) in implementing the CMIT program.

And yet, it seems that Sue’s colleagues and school executive were aware that she was still struggling with her maths teaching past her
first year of teaching. Certainly, within five minutes of having more than a superficial discussion about teaching mathematics with Sue, it was obvious to the researcher that Sue was struggling. The language she used (“terrified”, “worried”, “nervous”, “I can’t”, “I don’t”, “I should”, “I’m sorry”, “I’m not”), her voice and body language and her obvious discomfort when talking about her teaching practice was very evident at both interviews. One can only assume that it would also have been evident to any of her colleagues and school executive with whom she would have had professional discussions about maths.

During her first interview, when the researcher stopped the audio taping of the interview as Sue was “nervous” that she was “doing something wrong” in implementing the CMIT program, Sue told how colleagues had approached her after the school visit of the Departmental Literacy and Numeracy Team’s officer and said that they were glad she hadn’t been there as they had felt “threatened” by the process. The implication was that these colleagues were aware that Sue was less confident than them about her maths teaching and therefore would have been more worried than they were after the school visit.

Similarly, at the end of that first interview, Sue mentioned that she might be moving from Year 3 to Year 6 in the following year. When asked by the researcher how she felt about that, Sue replied that she was “fine about it” but had asked the principal to “help her with her maths”. Obviously, this was not the first time she had approached the principal for assistance as the principal had modelled maths lessons in Sue’s classroom at her request.

In fact, Sue did not go to Year 6 the following year but to Kindergarten. It would be interesting to know if Sue’s maths anxiety, explicitly demonstrated in her response to the principal, played any part in that decision made by the school executive. Similarly, when Sue’s initial teaching placement at this school ended, she transferred to a P-2 (Preschool to Year 2 only) Early Childhood school. Again, it
would be interesting to know what, if any, Sue’s maths anxiety played in her decision to request a placement in an Early Childhood school.

So what more could the school have done to support Sue in her development as a confident and competent teacher of mathematics?

In her third year of teaching, Sue was still in the initial ‘survival’ stage as a beginning teacher of mathematics (Katz, 1972), even though this developmental stage is not normally expected to extend past the first year of teaching. Teachers in this stage of development need “support, understanding, encouragement, reassurance, comfort and guidance” (Katz, 1972, p. 51) and professional development needs to be mostly “on-site [and] in situ” (Katz, 1972, p. 51), focused on the day-to-day delivery of a learning program (in this case the mathematics program) in the beginning teacher’s classroom, and ideally delivered by colleagues, including members of the school executive (Katz, 1972). Many of these elements were provided to Sue through her school mathematics program, particularly in her first year of teaching at the school.

However, recognising that Sue needed this type of day-to-day, in-class, collegial support in her development as a mathematics teacher beyond her first year of teaching, and then providing opportunities for them to occur, may have helped her to develop the pedagogical, professional and conceptual confidence needed to be an experienced, independent teacher of primary mathematics in a shorter period of time.

As Katz (1972) noted in her seminal work on the developmental stages of teachers, “(e)xperience alone seems insufficient to direct a teacher’s growth and learning” and those responsible for professionally developing teachers “should try to make sure that teachers, especially beginning teachers, have informed and interpreted experiences” (p. 57).

Having said that, it is important to re-state that Sue is an ‘extreme’ example of maths anxiety in a beginning teacher. In the context of
this study, only 2% of the pre-service teachers surveyed on the eve of their transition into the classroom reported such high levels of anxiety about their capacity to both teach and do mathematics. In reality, few schools would have experience in supporting beginning teachers with such high levels of maths anxiety.

*Cross Case Analysis One: Lucette and Sue*

What do we learn when comparing the case stories of Lucette and Sue, two beginning teachers at either end of the pre-service teacher mathematical confidence continuum? The first thing that a comparison of these two case stories illustrates is the link between mathematical confidence and the time taken for a beginning teacher to progress though the early stages of teacher development in relation to their mathematics teaching.

In the context of this study, Lucette, a beginning teacher with high levels of confidence as both a teacher and doer of maths, progressed very quickly through the initial ‘survival’ stages of teacher development. More importantly however, when she came out the other side of the ‘reality shock’ of beginning teacher transition, her teaching was effective and consistent with the constructivist beliefs she espoused at the end of her pre-service training. While Lucette’s development as a teacher of mathematics occurred within a school that had a coherent, whole school mathematics program; the school did not have to provide any additional, specific, beginning teacher mathematical support to Lucette during her transition.

However Sue, who had high levels of anxiety about her ability to teach and do mathematics, was taking longer than ‘normal’ to progress through the initial stage of teacher development. Indeed, in her third year of teaching, she remained ‘stuck’ in the ‘survival’ stage of teaching mathematics and had been unable to appropriately resolve the inconsistencies between what she believed and what she was doing in the classroom to become a truly effective and confident teacher of mathematics. While Sue’s school also had a coherent, whole school mathematics program, they did not recognise that Sue
needed additional, specific, beginning teacher mathematical support well past the 'normal' survival timeframe in order to successfully develop as a teacher of mathematics.

From a school’s perspective, it is important to understand that, although rare, there will be beginning primary school teachers starting their teaching careers with extreme levels of either mathematical confidence or mathematical anxiety. It is also important for schools to understand that they are more likely to encounter someone like Sue, a primary school teacher who in her own words was "terrified" of teaching maths when she graduated from her teacher training (2% of this study’s pre-service teacher sample), than Lucette, a primary school teacher who was highly confident of herself as a mathematician and a teacher of mathematics on the eve of her transition into the teaching workforce (0.5% of this study’s pre-service teacher sample).

Certainly, from the perspective of the teaching partner or team, mentor and/or school executive team whose responsibility it is to support and guide a beginning teacher, to know from day one that this individual was either extremely confident or extremely anxious about their ability to teach and/or do mathematics would have a strong influence on the both the timing and type of support provided to them within the school context.

At a school level, just knowing what the likely developmental consequences of extreme maths confidence and anxiety are for the beginning teacher is valuable. This understanding, in turn, can lead to the provision of more effective school-based programs of mathematical professional development and support for these beginning teachers who fall out of the ‘normal’ range of experience.
As such, the following data statement can be reported:

Data Statement 6.3

**Beginning teachers with high levels of mathematical confidence** are more likely to:
- progress quickly through the initial stages of teacher development;
- resolve transition related inconsistencies between teaching beliefs and practice appropriately so they then;
- teach maths constructively as they espoused at the end of their pre-service training.

**Beginning teachers with high levels of mathematical anxiety** are more likely to:
- take longer than ‘normal’ to progress through the initial stages of teacher development;
- be at risk of not resolving transition related inconsistencies between teaching beliefs and practice appropriately; and
- need ongoing, intensive support from their school for a longer than ‘normal’ period of time to teach the maths they espoused at the end of their pre-service training.

It is important for schools to identify beginning teachers with extreme levels of maths confidence/anxiety as this has implications for the timing and type of support and professional development they need to deliver to meet the needs of these teachers.

**Data Check**

Having found that Sue’s high level of pre-service maths anxiety has prolonged the time it will take for her to develop as a teacher of mathematics, does this slowing down of the developmental process give us an opportunity to establish a model for the acquisition of the four mathematical confidence categories, i.e., is it hierarchical, sequential, simultaneous and/or iterative?

As previously reported in this study (see **The Beginning Teacher**, Chapter 5), we know that the results of data analysis confirmed the finding of other extant research (Frid & Sparrow, 2007) that there is a positive correlation between beginning teachers’ professional confidence and their pedagogical confidence. But what then is the significance that curriculum confidence is the only mathematical confidence category that Sue is confident in after three years of teaching? Is developing mathematical confidence similar to Maslow’s hierarchy of needs? For the three teaching confidence categories do you have to achieve curriculum confidence before you can achieve pedagogical and professional confidence?

What about beginning teachers’ mathematical content area knowledge? How does it affect the acquisition and development of
the other teaching confidence categories? And how does what beginning teachers are confident about with regards to the teaching of mathematics and content area knowledge affect the efficacy of their classroom practice?

As such, the following data check can be generated:

<table>
<thead>
<tr>
<th>Data Check: Mathematical Confidence Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial analysis data from the examination and comparison of the two extreme (outlier) case stories of beginning teacher mathematical confidence, Lucette and Sue, suggest that there may be a sequence involved in the acquisition of mathematical teaching confidence.</td>
</tr>
<tr>
<td>As a result of this finding, further investigation of the nature and relationship of the acquisition of mathematical confidence on the development of beginning teachers as teachers of mathematics has been identified as an ongoing issue of interest in the case study research and data analysis process.</td>
</tr>
</tbody>
</table>

**Stage 3: Analysing Additional Data For Extended Case Stories**

As shown in Table 6.2, in addition to Lucette and Sue being selected as individual case stories on the basis of being extreme, or outlier, cases, three other participants—Sally, Ally and Jackie—provided extended case stories for this study. Jackie, Sally and Ally were a convenience- and opportunistic-based sample in that they were both available and willing to participate in the supplementary data collection stage (convenient) and had “specific characteristics” within their cases that capitalised on “developing events occurring during data collection” (opportunistic) (Onwuegbuzie & Collins, 2007, p. 286).

In the context of this study, the specific characteristic of interest in all three cases was their mathematical content knowledge confidence. As pre-service teachers, all three participants—Jackie, Sally and Ally—were reported as being confident in their ability to do and understand mathematics. However, of the three participants, only Jackie conformed to the expectations derived from data patterns and maintained this level of confidence as a beginning teacher.

Of the 10 participants who were surveyed and interviewed as beginning teachers, most of them (80%) had no recorded change in
their pre-service levels of mathematical content knowledge confidence. The two participants (20%) who did have a change recorded in their mathematical content knowledge confidence from pre-service to beginning teachers were Sally and Ally. Even more interesting was the fact that the reported shift in their mathematical content knowledge confidence was a negative one, i.e., Sally and Ally seemed to have lost confidence as mathematical ‘doers’ as beginning teachers.

So, why did Sally and Ally ‘buck the trend’ and record a change in this confidence area when Jackie did not? And what, if any, affect did this have on the development of Jackie’s, Sally’s and Ally’s classroom practice?

Throughout this study, and based on the findings of other extant research and literature, the efficacy of identifying and investigating inconsistencies within and between data collected from beginning teachers to learn more about beginning teacher development is well established (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006). Therefore it was important to focus on Jackie, Sally and Ally as “confirming and disconfirming cases”, i.e., “cases that either verify or refute patterns in the data that have emerged…in order to further understand the phenomenon under study” (Teddlie & Tashakkori, 2009, p.175). And at this point in this study, one of the “phenomenon under study” was mathematical content knowledge and confidence and the part it played in the development of beginning teachers.

As participants in the third and final stage of data collection; Jackie, Sally and Ally were required to:

- complete a mathematical assessment to establish an external and independent baseline for each participant’s mathematical content area knowledge; and then
- allow the researcher to observe them teaching mathematics in their classrooms to establish an external and independent baseline for each participant’s classroom practice.
Once collected, the additional data were initially reduced, displayed and compared across and within cases in preparation for a more detailed comparative analysis to occur within the individual case stories of our three participants. The results of this initial analysis of the mathematical test instrument and lesson observations are reported below.

**The Mathematical Test Instrument**

The Australian Year 6 equivalent test instrument administered was comprised of 40 items—35 multiple choice and 5 free-response—that covered the mathematical content strands of Number, Space, Measurement and Chance and Data. A more detailed breakdown of each content strand as a total of the test instrument is provided in Table 6.3.

**Table 6.3: Mathematical Test Instrument—Items by Content Strand**

<table>
<thead>
<tr>
<th>Content Strand</th>
<th>Test Items /40</th>
<th>Percentage of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>17</td>
<td>42.5%</td>
</tr>
<tr>
<td>Space</td>
<td>10</td>
<td>25%</td>
</tr>
<tr>
<td>Measurement</td>
<td>8</td>
<td>20%</td>
</tr>
<tr>
<td>Chance and Data</td>
<td>5</td>
<td>12.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

All questions were awarded one score point for a correct answer and marks were not deducted from the total score for incorrect answers. Year 6 students who sat the test in 2006 received grades based on their raw score out of a possible total of 40 marks. The grade descriptors and score cut-offs are reported in Table 6.4 below.

**Table 6.4: Mathematical Test Instrument Grade Descriptors and Score Cut-offs**

<table>
<thead>
<tr>
<th>Grade Descriptor</th>
<th>Raw Score Range</th>
<th>Percentage Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation</td>
<td>≤25</td>
<td>≤62.5%</td>
</tr>
<tr>
<td>Credit</td>
<td>26 – 30</td>
<td>65% - 75%</td>
</tr>
<tr>
<td>Distinction</td>
<td>31 – 35</td>
<td>77.5% - 87.5%</td>
</tr>
<tr>
<td>High Distinction</td>
<td>36+</td>
<td>90%+</td>
</tr>
</tbody>
</table>
The results of the mathematical test for the three extended case story participants are reported in Table 6.5.

The results of the mathematical test for the three extended case story participants, as reported in Table 6.5, show that two participants achieved a credit result—Jackie and Ally—with scores of 29/40 (72.5%) and 26/40 (65%) respectively, and the other participant—Sally—received a participation result for this assessment with a score of 25/40 (62.5%).

Given that the testing instrument was designed to be administered to Year 6 students, and was administered to the participants under the same conditions used for students, it is not unreasonable to expect that qualified primary school teachers should be achieving very high Distinction or High Distinction results (85%+) in this assessment.

Certainly, a margin of error 15% to cover simple mistakes in selecting and/or completing a separate answer sheet in a multiple choice test format at this level of mathematics is very generous. As such, in the context of this study, these overall results seem to indicate that all three participants had fairly low levels of mathematical content area knowledge.

This result is generally consistent with the findings of other national and international research (Biddulph, 1999; Forrester & Chinnappan, 2011; Masters, 2011; Mewborn, 2001; Morris, 2001; Ryan & McCrae, 2006; Sullivan, Siemon, Virgona, & Lasso, 2002; White, Way, Perry & Southwell, 2006) that show that, when tested at the level of mathematics they are expected to teach, many pre-service and beginning primary school teachers do not achieve very high results.
Table 6.5: Mathematical Test Instrument Results—By Participant

<table>
<thead>
<tr>
<th>Item</th>
<th>Strand(1)</th>
<th>Descriptor(2)</th>
<th>Jackie</th>
<th>Ally</th>
<th>Sally</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N</td>
<td>Add two 3-digit numbers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>S</td>
<td>Identify the missing shape to complete a rotational pattern</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td>Recognise west on a plan with an unfamiliar orientation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>N</td>
<td>Identify the circle that has one-third of its area shaded</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>N</td>
<td>Divide a 2-digit number by a 1-digit number</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>Accurately add 6 numbers shown in 10s and 100s</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7</td>
<td>N</td>
<td>Solve a problem using 2-digit by 1-digit division</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>Add litres to millilitres and express answer in mL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>9</td>
<td>S</td>
<td>Select the correct image to complete a given picture</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>10</td>
<td>C&amp;D</td>
<td>Interpret a column graph to find the total of a sample</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>11</td>
<td>S</td>
<td>Identify the correct picture given its coordinates</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12</td>
<td>N</td>
<td>Subtract 3-digit numbers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>13</td>
<td>N</td>
<td>Develop and complete a number pattern from given shapes</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>14</td>
<td>C&amp;D</td>
<td>Interpret a divided bar graph in terms of fractions</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>15</td>
<td>S</td>
<td>Select a reflection that completes a picture using symmetry</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>16</td>
<td>M</td>
<td>Compare lengths expressed in mm, cm and m</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>17</td>
<td>N</td>
<td>Solve a complex problem using addition and multiplication</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>18</td>
<td>N</td>
<td>Multiply 2-digit numbers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>19</td>
<td>N</td>
<td>Find the missing numbers in an order of operations problem</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>20</td>
<td>N</td>
<td>Select the statement that satisfies a complex word problem</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>21</td>
<td>C&amp;D</td>
<td>Identify the spinner used to produce a given set of results</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>22</td>
<td>N</td>
<td>Find the total after an increase by a given percentage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>23</td>
<td>M</td>
<td>Calculate the total area of a shape from a given portion</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>24</td>
<td>N</td>
<td>Select the decimal number represented by the diagram</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>25</td>
<td>M</td>
<td>Use logic and visual clues to order mass—highest to lowest</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>26</td>
<td>C&amp;D</td>
<td>Calculate the number of objects given a probability</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>27</td>
<td>S</td>
<td>Compare areas of a shaded pattern</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>28</td>
<td>N</td>
<td>Count the possible multiples between two given numbers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>29</td>
<td>S</td>
<td>Select the shape that is exactly one-fifth of a five-point star</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>30</td>
<td>N</td>
<td>Use a rate calculation to find the time taken for a task</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>31</td>
<td>N</td>
<td>Find a number using a given pattern of multiplication</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>32</td>
<td>M</td>
<td>Convert between units of length</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>33</td>
<td>S</td>
<td>Identify the net of a given square pyramid</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>34</td>
<td>C&amp;D</td>
<td>Determine the possible totals from the first 5 odd numbers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>35</td>
<td>S</td>
<td>Use measurement &amp; visual clues to select half of a cylinder</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>36</td>
<td>M</td>
<td>Relate informal to formal units of measurement</td>
<td>✓</td>
<td>●</td>
<td>✓</td>
</tr>
<tr>
<td>37</td>
<td>M</td>
<td>Apply angles to the turn of a clock hand to measure time</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>38</td>
<td>N</td>
<td>Solve a complex problem using numeration, x and -</td>
<td>✓</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>39</td>
<td>S</td>
<td>Find the number of diagonals in a given polygon</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>40</td>
<td>N</td>
<td>Solve a money problem using arithmetic with fractions</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Score /40 (%)</th>
<th>Jackie</th>
<th>Ally</th>
<th>Sally</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>29</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>72.5%</td>
<td>66%</td>
<td>62.5%</td>
</tr>
</tbody>
</table>

Grade awarded by Test Authority to Year 6 students who achieved this result(4)

<table>
<thead>
<tr>
<th>Number /17 (%)</th>
<th>13 (76%)</th>
<th>10 (59%)</th>
<th>9 (53%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space /10 (%)</td>
<td>6 (60%)</td>
<td>7 (70%)</td>
<td>7 (70%)</td>
</tr>
<tr>
<td>Measurement /8 (%)</td>
<td>6 (75%)</td>
<td>5 (63%)</td>
<td>6 (75%)</td>
</tr>
<tr>
<td>Chance &amp; Data /5 (%)</td>
<td>4 (80%)</td>
<td>4 (80%)</td>
<td>3 (60%)</td>
</tr>
</tbody>
</table>

(1) N = Number, S = Space, M = Measurement, C&D = Chance and Data
(2) ✓ = Correct Response, ☐ = Incorrect Response, ◐ = Non-attempt
(3) CREDIT, CREDIT, PART.
(4) Cut-off for a Credit grade was 26/40 – lower marks were awarded a PARTICIPATION grade.
However, this growing body of research and literature also identify that there are two types of mathematical content knowledge: procedural or computational (“understanding the rules and routines of mathematics”); and conceptual (the “understanding of mathematical relationships”) (Forrester & Chinnappan, 2011, p. 263) with the general consensus being that, in most cases, teachers' procedural knowledge is stronger than their conceptual knowledge.

Certainly in the context of this test instrument, where the items increased in difficulty as the test progressed, participants were more successful in the first half of the paper than they were in the second half of the paper. In the first half of the paper items were simple, single step tasks and the number strand items involved straightforward computation using the four operations (addition, subtraction, multiplication, division). In the second half of the paper items were more likely to require the application of a range of mathematical knowledge to solve multi step problems.

For example, both the first and last questions of the paper were from the number content strand. Question 1 was a single step addition algorithm that required participants to add two 3-digit numbers without trading (575 + 324 = ?) and then identify the correct answer from a choice of four numbers (A. 898, B. 899, C. 909, D. 999). All three participants answered this item correctly.

On the other hand, Question 40 was a multi-step word problem that required participants to apply their knowledge of money, fractions and arithmetic to complete a calculation where no answer options were provided:

Paula is visiting Germany. In Germany the currency used is the Euro (€).

Paula took some money with her on a day trip. She spent a third of her money on a meal. She then spent a quarter of what was left on gifts for her friends. Paula then visited a museum and spent a fifth of the rest of her money. She then had €32.40 left. How many Euros (€) did Paula take on her day trip?

Two participants did not attempt this item. One, Ally, did not even read the item as, when she got to the final five free response
questions, she decided not to go any further in the assessment as she “had done enough to pass already”. For Sally, this question was one of the three free response questions she read but did not attempt to answer, i.e., there was no response on her answer sheet nor was there any identifiable attempt at working out a response on her working out paper. Jackie, the participant who did attempt this item, gave an incorrect response of €50 and the only working out for this question on her working out paper was the following unsolved algebraic algorithm that only dealt with the first step of the problem:

\[32.40 = x - \frac{1}{6}\]

This initial analysis of the overall mathematical test instrument results established that both the overall level (low) and nature (stronger procedurally than conceptually) of the extended case story participants’ mathematical content knowledge were generally consistent with the findings of extant national and international literature and research. Further analysis of participant performance in this assessment is provided as part of their individual case story narratives.

Classroom Lesson Observations

A total of five mathematics lessons were observed over a three-week period. The purpose of the lesson observations was to provide a snapshot of the participants’ mathematics teaching in the third year of their teaching careers. These snapshots, constructed from data collected as part of the lesson observation process, were organised in three sections: overview, episodes, and summary.

The overview lists basic information about who and what was taught and when the lessons occurred. The episodes break the lesson down into different component parts based on observed major changes in the lesson structure, organisation and/or activity. Each episode is coded and timed and also include data on teacher and student roles.
and resources/materials used. Details of the episode coding categories are provided as part of the data analysis reporting below.

The summary records information about the wider lesson context and includes brief elaborations of specific events of interest that occurred during the observed lessons. The classroom teaching snapshots are reported in Table 6.6 with an episode coding key.

As reported in Table 6.6, four distinct structural categories—introduction (I), main task (MT), review (R) and conclusion (C)—and three types of student organisation—whole class (WC), individual (I) and pairs (P)—were identified in the observed lessons.

Typically, lesson cycles began with a whole class introduction of the focus concept and/or activity. Introduction episodes were teacher directed with the teacher doing most of the talking. They linked the lesson/activity to previous lessons or experiences (LP), gave instructions (I), asked students questions (Q), provided worked examples (WE) of the set tasks and reviewed (RW) student contributions to worked examples and question responses.

In these episodes students were mainly expected to listen (L), understand what they were expected to do (UA), answer teacher questions (AQ) and assist in completing worked examples (WE) when called upon.

Following the introduction, students were then set to work completing a main task or activity. Most of the time, students were expected to work alone (WA) rather than with others (WO) although they often consulted with and/or helped other students around them (HO). While only one teacher explicitly directed students to work with a set partner (P), student collaboration occurred spontaneously at group desk arrangements and was not discouraged by the teachers.
### Table 6.6: Classroom Mathematics Teaching Snapshots—By Participant

<table>
<thead>
<tr>
<th>Jackie</th>
<th>Ally</th>
<th>Sally</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview</strong></td>
<td>Year 3 classroom Week 4, Term 2 L1: 11.47 – 13.00 Duration: 1h13m L2: 11.45 – 13.00 Duration: 1h15m</td>
<td>Kindergarten classroom Week 3, Term 2 L1: 10.00 – 10.47 Duration: 47m L2: 10.00 – 10.45 Duration: 45m</td>
</tr>
<tr>
<td><strong>Lesson Content</strong></td>
<td>L1: Addition, addition algorithm with trading L2: Problem solving with money &amp; addition</td>
<td>L1: Patterns with 2D Shapes L2: Patterns with 2D Shapes</td>
</tr>
<tr>
<td><strong>Classroom Plan</strong></td>
<td>W Board Floor</td>
<td>IWB Teacher Chair</td>
</tr>
</tbody>
</table>

#### Jackie

- **Episode 1**
  - **Lesson Structure**
    - WC I MT R MT
    - WC I WC WC I WC
  - **Activity**
    - WC I WC WC I WC
    - WC I WC WC I WC
  - **Materials**
    - WB HORM MB
    - WB HORM MB

- **Lesson Content**
  - L1: Addition, addition algorithm with trading
  - L2: Problem solving with money & addition

**Summary**

Jackie utilised cooperative learning strategies so students worked often with a partner sharing a coaching role. They were on task and transitioned quickly between activities. While Jackie reviewed work with the whole class, an individual who was off-task. No planned differentiation of activities, maths problems solving on the floor and completed it in their maths books. This work was reviewed on the board & students self-assessed. Participated in impromptu extra tasks related to L2 assessment item for fast finishers in L1 and an impromptu extra task related to L2 assessment item for fast-finishers (1st finished set task in 2min).

#### Ally

- **Episode 1**
  - **Lesson Structure**
    - WC I MT R MT C
    - WC I WC WC I WC
  - **Activity**
    - WC I WC WC I WC
    - WC I WC WC I WC
  - **Materials**
    - WB/IWB/HORM/GM/W/WS
    - WB/IWB/HORM/GM/W/WS

- **Lesson Content**
  - L1: Patterns with 2D Shapes
  - L2: Patterns with 2D Shapes

**Summary**

Ally utilised her IWB effectively in her whole class work. Large 2D shape blocks and plastic straws were used as student manipulatives. Straws were not particularly successful and idea had been adapted from one of the 2 EC Maths university textbooks used by Ally to inform the entirety of her program. Worksheet in L2 was teacher generated, based on IWB research project on mental computation and her class was being taught by a member of the Literacy and Numeracy Team with Sally assisting. The L&N member was not available on the day Lesson 1 was observed and Sally was willing to be observed on this day.

#### Sally

- **Episode 1**
  - **Lesson Structure**
    - WC I MT R MT C
    - WC I WC WC I WC
  - **Activity**
    - WC I WC WC I WC
    - WC I WC WC I WC
  - **Materials**
    - WB MB CB WS-TB G
    - WB MB CB WS-TB G

- **Lesson Content**
  - L1: Expressing equivalent common fractions as percentages

**Summary**

The lesson was part of a term-long focus on fractions. In previous lessons students had used paper folding and games to explore equivalence with common fractions. This lesson was designed to build on this experience by expressing common fractions as %. Intro to concepts linked to previous lessons & what students knew about % in the 'real world'. No manipulatives were used in this lesson. Students copied a partial visual representation off board and completed it in their maths books. This work was reviewed on the board & students self-corrected. Students completed a page in their maths textbook. 2-3 students supported by Sally in Episodes 2 and 4 while many other students were off task. No planned differentiation of activities, maths problems solving on the floor and 2 impromptu calculations set on board for students normally in a different maths group that had already completed the set textbook page.

#### Coding Key:

- **Lesson Structure**
  - HIntro: MT=Main Task, R=Review C=Conclusion
  - W=Whole Class, I=Individual, P=Pairs

- **Organisation**
  - WC=Whole Class, IF=Individual, P=Pairs, MB=Maths Book

- **Activity**
  - H=Introductory, MT=Main Task, R=Review, C=Conclusion
  - P=Procedural, C=Conceptual, PS=Problem Solve, I/Admin

- **Materials**
  - WB=Whiteboard, IWB=Interactive, WB=Whiteboard, CB=Copy Board

**Teacher Role**

- L=Listen, O=Answer Questions, T=Learner, D=Decision

- W=Work Alone, O=Work Others, R=Revisit Work

**Student Role**

- C=Comprehend, S=Support Individual, G=Group Work

- Q=Questions, WE=Work Examples, SD=Support Others, UA=Understand Activity

- HO=Help Others
In main task episodes teachers observed students (O) as they worked, supported individual students (SI) to complete the tasks successfully when required and answered student questions (AQ). Generally, main task episodes were deemed to be finished when the students were brought back together again in a whole class organisation by the teacher to either conclude the lesson/activity or review the work that had occurred in the episode.

Whether an episode was coded using a ‘C’ for conclusion or ‘R’ for review depended on what was observed to be happening in these whole class scenarios and where they were happening throughout the duration of the observed lesson.

Conclusion episodes occurred at the very end of the lesson and did not include activities that related directly to the mathematical content of either the lesson focus and/or a main task. They did include the whole class:

- packing-up and completing general administrative tasks (A) such as cutting, pasting, handing in sheets and/or books;
- playing general maths games (G) not related to the main task until the bell went; and in one case
- discussing whether students ‘liked’ one of the main tasks as opposed to discussing the strategies/maths involved in the task.

Review episodes were those where students were brought together as a whole class by the teacher with the specific purpose of reviewing (RW) the mathematical work done as part of a main task. On one occasion, a single episode was coded as having both a main task and review structure as it involved students solving multiple addition algorithms one at a time with a partner and then sharing their solutions with the whole class after each algorithm was done.

So, what do we learn from the classroom snapshots? Are our beginning teacher participants delivering the primarily constructivist mathematical learning spaces they imagined as pre-service teachers
Throughout their beginning teacher interviews, participants described classrooms that were pedagogically consistent with their pre-service understandings of a constructivist approach to teaching. They talked of lessons that included whole class introductions of mathematical concepts and followed by students working alone or with others with the teacher working specifically with groups or individual students. Certainly these basic structures and organisations were evident in the observed lessons.

Participants also identified that the tasks and activities they used in the classroom (games, worksheets, hands on manipulatives or open-ended opportunities for problem solving) were selected to engage student interest and maximise their enjoyment. Again, for the most part, students demonstrated high levels of enjoyment and engagement in the learning program. They were on-task, participated in all activities, collaborated with their peers, answered teacher questions and asked the teacher questions throughout the observed lessons. While there was one instance in Sally’s lesson where quite a few students were off-task for most of a main task episode, this could be attributed directly to factors of school context rather than Sally’s classroom practice (see summary section of Sally’s classroom snapshot reported in Table 6.6).

However, while there were many ‘constructivist’ ideals, beliefs and understandings being put into practice in the observed lessons, there were two important elements of a constructivist classroom that were missing or minimal: activity/task differentiation; and student explanation and discussion of their own and others mathematical thinking.

In all main task episodes, students were given and expected to complete exactly the same type and amount of work. When the teacher set extra work or challenges to students it was done in
response to them being fast finishers and the tasks were impromptu, i.e., unplanned and often unrelated to the main task. During the lesson episode coding process it also became apparent that while students were actively asking and answering teacher questions and talking to their peers they had very few opportunities to actually explain their mathematical thinking to others (EO). In fact, the EO code was only used once as part of a main task review episode that accounted for only 5% of the total lesson time.

An initial analysis of the lesson observation data would suggest that these elements were missing or minimalised in the observed lessons’ classroom practice, not because the participants did not believe they were important, but because their own levels of mathematical content knowledge impeded their ability to incorporate them in their classroom practice.

Firstly, the fact that there was no authentic differentiation in set tasks or activities was inconsistent with the self-reports of participants in the beginning teacher interviews that had indicated that the learning activities used in the classroom were differentiated based on student ability generally established through the use of pre- and post-assessments. However, the analysis of the beginning teacher interview data also identified that many participants were unsure of their ability to link maths activities and tasks to underlying maths concepts and that this uncertainty, in turn, was a product of low levels of participant mathematical content knowledge and confidence.

So, even though participants were administering assessments to establish students’ mathematical ability and understanding, they seemed limited in their ability to use this information to plan authentic, targeted differentiated student learning in the classroom.

Similarly, the minimal time allocated to student-led mathematical discussions and explanations during the observed lessons was at odds with existing data collected in this study. In the pre-service teacher survey, the ability of students to explain mathematics to
others was identified as one of four higher order mathematical skills. In that survey 91% of respondents rated it as being a very important skill for students to have and 74% of respondents were confident that they could help students develop this ability.

But do they help students develop this ability in the classroom? While our beginning teacher participants reported that their maths lessons included whole class discussions about how students completed set activities, the whole class interactions that occurred during the observed lessons were primarily teacher-led closed question and answer sessions rather than student-led sustained and substantial explanations and evaluations of their mathematics.

In a research study comparing the teaching of mathematics in Japanese and American primary school classrooms, Stigler, Fernandez, and Yoshida (1996) posited that the presence of very closely controlled, teacher directed question and answer sessions in maths lessons could be linked to lower levels of teacher mathematical competence and confidence. They felt that the idea of “[l]etting students influence the direction of the lesson…may provoke anxiety in…teachers who may not be sure themselves if children’s novel solutions to mathematical problems are justified” (Stigler, Fernandez, & Yoshida, 1996, p. 173).

Comparative Analysis of Extended Case Stories Additional Data

The initial analysis of both the mathematical test instrument and lesson observation data provide us with a deeper understanding of the link between beginning teachers’ mathematical content knowledge and confidence and their ability to realise the primarily constructivist classrooms they imagined as pre-service teachers and aspire to as beginning teachers.

Firstly, the results of the mathematical test instrument established that, like many beginning primary school teachers in Australia and internationally, our three extended case story participants had relatively low levels of mathematical content knowledge. Secondly,
the results of the classroom lesson observation process established that these low levels of mathematical content knowledge can impede the ability of beginning teachers to deliver the primarily constructivist mathematical learning spaces they imagined as pre-service teachers way beyond the initial ‘reality shock’ stage of beginning teacher transition and development.

As such, the following data statement can be reported:

**Data Statement 6.4**
Based on a comparison of mathematical testing and lesson observation data, low levels of mathematical content knowledge impede a teacher’s ability to successfully create the primarily constructivist, student-centred mathematical learning spaces they aspire to.

**Stage 4: Extended Case Stories**

After the initial analysis of the mathematical test instrument and lesson observation process data was completed it was used, in conjunction with data already collected via surveys and interviews, to conduct a more detailed comparative analysis within and between the individual beginning teacher developmental journeys of Jackie, Ally and Sally.

The cross case story comparative analysis focused on the three participants’ pre-service and beginning teacher mathematical content knowledge confidence and the impact it had on the development of their mathematical classroom practice. In conducting this analysis, aspects of the participants’ stories were interrogated and compared to identify a range of ‘variables of interest’ that might help to explain the development of beginning teachers as teachers of mathematics. The results of this more detailed analysis and the extended case stories are reported below.

**Biographical Details**

**Jackie**

Jackie was a school leaver entrant to university and was appointed as a full-time permanent teacher in the ACT public school system on
completion of her primary education studies. At the time the last data were collected for this study, Jackie was in the third year of her teaching career and had taught Year 3 and Year 3/4 composite classes in the same P-6 primary school since commencing her employment.

**Ally**

Ally was a school leaver entrant to university and was appointed as a full-time permanent teacher in the ACT public school system on completion of her primary education studies. At the time the last data were collected for this study, Ally was in the third year of her teaching career and was teaching a Kindergarten class. Since commencing her employment, Ally had taught at two P-6 primary schools. In her first year of teaching she taught a Kindergarten/Year 1 composite class; at her current school she had previously taught a year 1/2 composite.

**Sally**

Sally was a mature-age entrant to university and was appointed as a full-time permanent teacher in the ACT public school system on completion of her primary education studies. Prior to entering the teaching profession, Sally had worked for 17 years in business accounting and had worked for a few years as a teacher’s aide in the primary school setting. At the time the last data were collected for this study, Sally was in the third year of her teaching career and had been teaching in the same P-6 primary school since commencing her employment. For the first two years she had taught a Year 3 class and in her third year was teaching a Year 6 class.

**Variables of Interest: University Entrant Status and Year Level Taught**

In comparing the biographical details of our three extended case story participants, two possible variables of interest were identified: university entrant status (school leaver versus mature age); and year level taught (lower primary versus middle primary versus upper
primary). University entrant status was identified as a variable of interest as the effect of Sally’s post-school mathematical experiences on her pre-service teacher mathematical content confidence levels may help to explain her apparent loss of confidence in this area as a beginning teacher.

Year level taught was also identified as a variable of interest as it had been raised previously in this study as being a factor related to teachers’ mathematical content confidence (see The Beginning Teacher, Chapter 5, Table 5.22). In the beginning teacher interviews at least one participant directly attributed their lack of concern about their own level of mathematical content area knowledge as a teacher to the fact that they were teaching lower primary (Kindergarten) students.

Beginning Teacher Journeys

Jackie

As reported in Table 6.2 and shown in Figure 6.8, Jackie left her pre-service teacher training confident in her ability to do and understand mathematics and, in her second year of teaching, gave no indication that her level of mathematical content knowledge was a concern for her teaching. This result is consistent with overall data patterns reported earlier in this chapter in Data Statement 6.2 that indicate that:

Most beginning teachers who were confident in themselves as mathematicians as pre-service teachers maintained this confidence during their initial teaching experience.

As a pre-service teacher Jackie also reported that she was not very confident in her ability to develop higher-order math skills in her students. However, in her second year of teaching she was confident in herself as an effective teacher of mathematics. This change in Jackie’s teaching confidence occurred even though she reported that her school did not have a coherent mathematics program and had minimal influence on her development as a teacher of mathematics.
This result is consistent with overall data patterns reported earlier in this chapter in Data Statement 6.1 that indicate that:

Most beginning teachers who were not very confident as pre-service teachers developed confidence in the ability to teach maths during their initial teaching experience.

and that:

This change in mathematical teaching confidence occurred regardless of whether or not the participants identified that they were teaching at schools with highly coherent maths programs that had a strong influence on their development as teachers of mathematics.

**Figure 6.8:** Jackie Beginning Teacher Developmental Journey

<table>
<thead>
<tr>
<th>Pre-service Teacher</th>
<th>Initial Teaching Experience</th>
<th>Beginning Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Confidence ability to teach mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am not very confident of my ability to develop students’ higher-order maths skills.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematical Confidence ability to do and understand maths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall maths was a positive experience for me at school and I found it relevant, fun and easy to do.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>School Program Coherence capacity to influence teacher development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The influence of my school’s maths program on the decisions I make about what, how and when I teach maths and how to develop as a teacher of maths is:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching Confidence ability to teach mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am very confident that I am an effective maths teacher. I know what to teach, how to teach it and where and how to get the things I need to teach it well.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematical Confidence ability to do and understand maths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am very confident in my capacity to ‘do’ and understand mathematics and my maths content knowledge is not a concern for my teaching.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ally**

As reported in Table 6.2 and shown in Figure 6.9, as a pre-service teacher Ally, like Jackie, reported that she was not very confident in her ability to develop higher-order math skills in her students. However, in her second year of teaching she was confident in herself as an effective teacher of mathematics. This change in Ally’s teaching confidence occurred even though she reported, like Jackie, that her school did not have a coherent mathematics program and had minimal influence on her development as a teacher of mathematics. This result is consistent with overall data patterns...
reported earlier in this chapter in Data Statement 6.1 that indicate that:

Most beginning teachers who were not very confident as pre-service teachers developed confidence in the ability to teach maths during their initial teaching experience.

and that:

This change in mathematical teaching confidence occurred regardless of whether or not the participants identified that they were teaching at schools with highly coherent maths programs that had a strong influence on their development as teachers of mathematics.

However unlike Jackie, while Ally left her pre-service teacher training confident in her ability to do and understand mathematics, an analysis of her beginning teacher data indicated that in her second year of teaching her level of mathematical content knowledge was a concern for her teaching. This result is inconsistent with overall data patterns reported earlier in this chapter in Data Statement 6.2 that indicate that, like Jackie:

Most beginning teachers who were confident in themselves as mathematicians as pre-service teachers maintained this confidence during their initial teaching experience.

![Figure 6.9: Ally Beginning Teacher Developmental Journey](image-url)
Sally

As reported in Table 6.2 and shown in Figure 6.10, as a pre-service teacher Sally reported that she was confident in her ability to develop higher-order math skills in her students and in her second year of teaching she was confident in herself as an effective teacher of mathematics. This result is consistent with overall data patterns reported earlier in this chapter in Data Statement 6.1 that indicate that:

In their second year of teaching most beginning teachers are confident of the overall efficacy of their mathematics teaching.

and that:

Beginning teachers who were confident as pre-service teachers maintained this confidence during their initial teaching experience.

However like Ally, while Sally left her pre-service teacher training confident in her ability to do and understand mathematics, an analysis of her beginning teacher data indicated that in her second year of teaching her level of mathematical content knowledge was a concern for her teaching. This result is inconsistent with overall data patterns reported earlier in this chapter in Data Statement 6.2 that indicate that:

Most beginning teachers who were confident in themselves as mathematicians as pre-service teachers maintained this confidence during their initial teaching experience.
Variables of Interest: Mathematical Confidence and School Program Coherence

It has been previously identified that a major focus of the cross case comparative analysis of the extended case stories was to better understand the effect of initial teaching experience on participants’ mathematical content confidence levels. The first step in investigating this relationship was to check the veracity of the pre-service and beginning teacher mathematical content confidence classifications. This check was conducted by re-interrogating participants’ data collected from surveys, interviews and the administration of the mathematical assessment data.

**Pre-service Mathematical Confidence Ratings**

As previously reported in Table 6.2, all three extended case story participants were classified as having had an ‘overall positive experience of maths at school’. This classification was based on their responses to Question 2 and, to a lesser degree, Question 8 in the pre-service teacher survey.

In Question 2, participants were asked to record their own experience of mathematics at school on three semantic differential 7-point bipolar rating scales. The three scales looked at how
easy/difficult, fun/boring and relevant/irrelevant participants had felt maths to be at school.

Each of the three rating scales were presented as number line continua with seven possible response values; ‘1’, ‘1.5’, ‘2’, ‘2.5’, ‘3’, ‘3.5’, ‘4’. As such, for the combined scales, a total score of ‘3’ was the most positive response, ‘12’ was the most negative response and ‘7.5’ was the neutral mid-point. To be given an ‘overall positive’ classification a participant’s combined responses on the rating scales had to score less than ‘9’ out of a possible ‘12’ points.

This question was subsequently re-asked at the beginning teacher interview, giving participants an opportunity to comment on their school experience of mathematics while checking the reliability of their responses over time.

While Question 8 of the pre-service teacher survey asked participants to articulate their personal philosophy of teaching and learning mathematics, some participants used the free response format to include comments relating to their own experience and confidence as mathematical ‘doers’. When a response indicated that a participant may have some anxiety related to teaching and/or understanding mathematics, a note was made for follow-up.

So, were the initial classifications of our three participants’ pre-service confidence levels accurate?

Jackie

In her pre-service teacher survey Jackie rated her school experience of mathematics as an ‘8’ out of ‘12’, which is very close to the ‘7.5’ neutral midpoint of the scale used. Also, in her free response statement, Jackie did not make any comments that would indicate that she was suffering from any manifestation of maths anxiety.

In her beginning teacher interview Jackie rated her school experience of mathematics as a ‘7’ out of ‘12’, which is both very close to her pre-service teacher rating of ‘8’ and the ‘7.5’ neutral
midpoint of the scale used. Aside from acknowledging the general consistency of her rating, Jackie did not elaborate on her school experience of mathematics and did not indicate that her ability to understand and ‘do’ mathematics had been a concern for her.

**Ally**

Like Jackie, in her pre-service teacher survey Ally rated her school experience of mathematics as an ‘8’ out of ‘12’ and did not make any comments that would indicate that she was suffering from any manifestation of maths anxiety in her free response statement.

In her beginning teacher interview Ally’s rating of her school experience of mathematics was identical to her pre-service rating. Also, like Jackie, aside from acknowledging the consistency of her rating, Ally did not elaborate on her school experience of mathematics and did not indicate that her ability to understand and ‘do’ mathematics had been a concern for her.

As such, the initial classification of both Jackie and Ally as being confident of their ability to understand and do mathematics on the eve of commencing their teaching careers was deemed to be correct.

**Sally**

In her pre-service teacher survey Sally rated her school experience of mathematics as a ‘7.5’ out of ‘12’, which is the neutral midpoint of the scale used. In her free response statement, Sally did not make any comments that would indicate that she was suffering from any manifestation of maths anxiety. In her beginning teacher interview, Sally’s rating of her school experience of mathematics was identical to her pre-service rating.

However, unlike Jackie and Ally, while Sally was completing her rating scales she verbalised her thinking behind her ratings and these elaborations seemed to indicate that Sally’s post-school experience of mathematics moderated both her definition of what maths was and her perception of herself as a mathematician.
During the beginning teacher interview, Sally made a range of statements that suggested her school experience of mathematics was quite negative and that it was her subsequent post-school ‘success’ with maths, which lifted her overall pre-service rating:

I found it very boring.

There were times when I found it really difficult…on the whole it wasn’t too bad though it seemed hard at the time.

I was hit by a nun for not knowing that 7 x 8 is 56 when I was 14…that was really off-putting so it didn’t help.

And for relevance…well I became an accountant bookkeeper so I guess it was very relevant to my life that I had those basic number skills.

At interview, Sally also indicated that her definition of mathematics as a field of study had broadened since she had commenced teaching and that this seemed to impact on her confidence to ‘do’ and understand mathematics:

You know it’s the concepts. I can add and subtract and do division and multiplication…it’s the concepts like algebra and symmetry and isosceles triangles and all those other things [that make] you go…arrgghh.

I was quite good at number but even then I still say to myself that I don’t know my tables yet when someone asks me something I think, oh, I do know that one. I mean, I suppose I do but it’s not an instant recall.

Sally’s post-school accountancy/bookkeeping experience of mathematics had a narrow focus on maths as number calculated and manipulated using a set of standard operational procedures. It was this type of procedural mathematics that Sally had experienced success in and was confident of as a pre-service teacher. As such, based on her own definition of mathematics at that time, Sally’s initial classification of being confident of her ability to understand and do mathematics as a pre-service teacher was deemed to be correct.

However, what Sally’s case does show is that when using school experience of mathematics as a general indicator of an individual’s confidence in their ability to ‘do’ and understand mathematics it is important to acknowledge that, particularly for those individuals who are mature-age entrants to their studies, post-school experiences
and indeed the passage of time, can moderate the individual’s evaluation of that experience.

Having checked and confirmed the veracity of the participants’ pre-service mathematical content confidence classifications, the process was repeated to check the veracity of their beginning teacher mathematical content confidence classifications.

Beginning Teacher Mathematical Content Confidence Ratings

As reported in Table 6.2, participants were classified as being either ‘confident/very confident’ or ‘not very confident’ of their ability to ‘do’ and understand mathematics after their initial teaching experience. This classification was based on the analysis of beginning teacher survey and interview data (see The Beginning Teacher, Chapter 5) that indicated whether participants were either confident or concerned about their maths content knowledge and capacity in general, relative to the year level they taught and/or in relation to selecting appropriate classroom learning activities.

Jackie

During her beginning teacher interview, Jackie did not make any statements that seemed to indicate that she was anything less than confident in her ability to ‘do’ and understand mathematics. Indeed, Jackie’s mathematical content knowledge did not factor into her data at all as she was very focused on, and positive about, the development of her mathematical teaching pedagogy in line with her constructivist beliefs and understandings. As such, the initial classification of Jackie as being confident in her ability to understand and ‘do’ mathematics as a beginning teacher was deemed to be correct.

Ally

Like Jackie, Ally was generally very positive about how her mathematics pedagogy was developing. However, during her beginning teaching interview Ally made a number of statements that
seemed to indicate that her general understanding of maths was impeding her ability to select appropriate classroom learning activities.

Still finding difficulties with how to link the concept with activities.

I just go to the resource room and say right what's here [CMIT maths games and activities]. OK, I'll use that one…but I don't feel like I'm planning.

I went to a course about the SENA testing…but I'm still struggling with…how to use it to inform your teaching.

Ally then confirmed that her difficulty was in using students’ individual assessment data to identify their current understanding of a particular number concept so she could select activities designed to develop students’ understanding of that particular number concept.

So, while Ally did not make any direct statements saying that she had difficulty doing or understanding mathematics, based on the type of concerns she raised about her mathematics teaching, the initial classification of Ally as being not very confident of her ability to understand and ‘do’ mathematics as a beginning teacher was deemed to be correct.

Sally

Like Jackie and Ally, Sally was generally very positive about her mathematics teaching. However, as reported above when verifying Sally’s pre-service mathematical confidence rating, during her beginning teaching interview Sally made a number of statements that seemed to indicate that her concerns about her mathematics teaching were related to her own ability to understand and ‘do’ maths at a conceptual rather than procedural level. As such, based on her own broadening definition of mathematics, the initial classification of Sally as being not very confident of her ability to understand and ‘do’ mathematics as a beginning teacher was deemed to be correct.

Having checked and confirmed the veracity of the participants’ pre-service and beginning teacher mathematical content confidence
classifications, the next step in the process was to compare the participants’ mathematical content confidence levels against their performance in the mathematical test instrument.

**Mathematical Content Knowledge: Confidence versus Test Results**

Based on the participants’ reported confidence in their ability to understand and ‘do’ mathematics as beginning teachers it was to be expected that, when the mathematical test instrument was scored:

- Jackie would have the highest test score of the three participants—self-reports as mathematically confident and existing data does not suggest any inconsistency exists;
- Ally would have the second highest test score and that her score would be closer to Sally’s than Jackie’s score—some suggestion in existing data that there is an inconsistency between self-reports of confidence and actual level of conceptual understanding; and
- Sally would have the lowest score—participant self-identifies a general lack of conceptual understanding of the mathematics she is teaching but is confident in her procedural understanding of maths particularly with regards to working with number.

As previously reported in this chapter (see Table 6.5), the results of the mathematical test show Jackie and Ally (with scores of 29/40 (72.5%) and 26/40 (65%) respectively) achieved a credit result while Sally received a participation result for this assessment with a score of 25/40 (62.5%).

While these scores overall were lower than expected, it was also reported that this result is generally consistent with the findings of other national and international research that show, when tested at the level of mathematics they are expected to teach, many pre-service and beginning primary school teachers do not achieve very high results. However, the ranking order of participants’ based on their comparative scores was as expected.
Jackie did achieve the highest score, followed by Ally and then Sally, with the gap between Ally and Sally’s scores smaller than the gap between Ally and Jackie’s scores.

As such, the following data statement can be reported:

<table>
<thead>
<tr>
<th>Data Statement 6.5</th>
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<tbody>
<tr>
<td>Based on a comparison of mathematical testing results and survey and interview data:</td>
</tr>
<tr>
<td>• while the confidence of a beginning teacher in their ability to ‘do’ and understand mathematics after their initial teaching experience can be generally indicative of their level of mathematical content knowledge;</td>
</tr>
<tr>
<td>• when tested on the mathematical concepts they are expected to teach, their actual mathematical performance is lower than expected based on reported confidence levels.</td>
</tr>
</tbody>
</table>

So, what else can be learned from a comparative analysis of the participants’ reaction to their relatively low test performance and how it affected their mathematical confidence ratings?

**Jackie**

When asked to complete the mathematical test instrument as part of this study, Jackie showed no hesitation or concern about participating in the process or about her performance in the test. Jackie completed the mathematical test instrument in 28 minutes and answered all 40 questions.

Jackie worked through the questions sequentially and only left one multiple-choice question unanswered. After she had gone through the test once, she checked her answer sheet for missing responses and answered the missed question at this time. Although aware that she had one hour to complete the test, Jackie did not use any of her extra time to check her responses. This was despite the fact that for at least one of the five free-response, multi-step questions on the paper she had guessed the answer based on partial completion of the task after saying “I give up!”

During the marking of the test, Jackie did not look very closely at her errors to see where she had gone wrong and attributed individual errors to either carelessness:
That was a silly mistake.

or forgetfulness:

Oh…of course that’s how you do that one.

Overall, despite the fact that the test was designed for Year 6 students, Jackie was pleased that she had achieved a high credit grade as she:

…doesn’t do that well in exams.

At no stage in the marking process did Jackie make any connection between her relatively poor understanding of the mathematics she is expected to teach as a primary school teacher, as highlighted by her test results, and her capacity to teach this mathematical content to students. This result is consistent with the findings of other research relating to the reaction of pre-service and qualified teachers to mathematical content knowledge testing (Meaney & Lang, 2001; Morris, 2001) and with Jackie’s survey and interview data where mathematical content knowledge was not raised at all by her as a factor in her development as a teacher of mathematics.

Ally

Like Jackie, Ally showed no hesitation about completing the test or concern about her performance. Ally completed the mathematical test instrument in 22 minutes but only attempted 33 of the 40 questions. Ally worked through the questions sequentially and left two multiple-choice questions unanswered. When she got to the last five free-response, multi-step questions on the paper, Ally put her pencil down and said:

I don’t need to do those…I’ve already passed [the test].

Although aware that she had one hour to complete the test, Ally did not check her answer paper for missing responses nor review any of her answers.
During the marking of the test, Ally did not reflect on any individual questions and/or incorrect responses. When told the overall mark, Ally was satisfied that she had ‘passed’ the test, as she had predicted, and commented that she felt her mathematical content knowledge was sufficient to teach Kindergarten level maths. This comment was interesting in light of the fact that, even as a Kindergarten teacher, the analysis of Ally’s survey and interview data identified that her relatively low levels of mathematical content knowledge was impeding her ability to connect student assessment data to learning activities designed to develop student understanding of mathematical concepts.

Sally

Unlike Jackie and Ally, Sally did raise some concerns about her performance in the mathematical test instrument. While she wasn’t concerned about completing the test or making mistakes:

...because I now have the confidence to do it and think...well if I go wrong I'll just go and learn it. It will tell me what I have to learn.

she wanted to make sure that her results would not shared with anyone else at the school:

...as long as you don’t tell anyone else the results.

Sally completed the mathematical test instrument in 25 minutes and attempted 37 of the 40 questions. The three questions she did not attempt, i.e., no response on the answer sheet, no working out on the paper provided and no working out observed by the researcher, were all free-response questions at the end of the test.

Like Jackie and Ally, Sally worked through the questions sequentially and left five multiple-choice questions unanswered. When she got to the end of the multiple choice questions, Sally went back and made responses for the five she had missed the first time around. Then Sally moved on to the five free-response, multi-step questions on the paper, and of the two questions she attempted she got one correct.
Sally was aware that she had one hour to complete the test and, while she checked her answer sheet for missing responses in the multiple choice a second time, she did not review any of her answers. As soon as the test had been marked, Sally immediately commented that her overall result was:

Not a distinction then!

and then, while reviewing her incorrect responses, commented:

This is sad…I have to teach this.

These observations would seem to suggest that, unlike Jackie and Ally, Sally’s overall expectation was that she should achieve at least a distinction grade in a Year 6 maths test, and that there was a link between her level of mathematical content knowledge and her capacity to teach this mathematical content to students.

Sally was also the only participant who reviewed any of her incorrect responses in-depth post-marking. While she declined to review the five free-response questions at the end of the test:

I don’t even want to talk about them!

Sally did examine all of the 11 multiple choice questions she got wrong. When Sally was unable to independently identify why the correct response was correct she worked with the researcher to solve the items. During this review process, Sally attributed most (six out of the 11) individual errors to carelessness, either in reading the question stem or choosing the wrong distractor:

I just read the question wrong.

I got the right numbers but the wrong names.

and forgetfulness in relation to the procedural steps required to solve the set problem:

I forgot all about order of operations and was confused when two of the choices gave the right answer.
For the remaining five errors, Sally identified that she was unable to correctly recognise and/or interpret the visual, spatial and/or number patterns provided in either the questions or response choices:

You see, I could not see the differences between those pictures until you pointed them out.

I know the pattern in those numbers should have helped me work out the answer but I used the wrong bit of the pattern to guess.

However, despite Sally’s willingness to review her test performance at the individual test item level and her acknowledgement of a weakness in her conceptual understanding of some mathematics, overall she still attributed her relatively low achievement level to being in a test situation.

Spatial skills aren’t my forte and I just go blank, especially in a test situation with time restraints.

I normally wouldn’t make those silly errors if it wasn’t a test. If I was at home and had time to work it out I know I would have worked out how to do things.

As such, the following data statement can be reported:

<table>
<thead>
<tr>
<th>Data Statement 6.6</th>
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<tbody>
<tr>
<td>Based on a comparison of participants’ post-test reactions, when beginning primary school teachers are tested on the mathematical concepts they are expected to teach and their test results are relatively low (&lt;85%), they are more likely to either:</td>
</tr>
<tr>
<td>• be satisfied with their results (50%+), i.e., I passed and this is evidence that my knowledge of the mathematical content I am expected to teach is fine; and/or</td>
</tr>
<tr>
<td>• attribute some of their lower score to the fact that they were in a test situation, i.e., these lower results are evidence of a procedural issue with testing not a conceptual understanding issue</td>
</tr>
<tr>
<td>rather than question their existing beliefs about their own level of mathematical content knowledge and how that impacts on their capacity to teach this content in the classroom.</td>
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</table>

Challenging Mathematical Content Knowledge Confidence: The Role Of School Context

Jackie, Ally and Sally all reported that on the eve of their transition into their teaching careers they were confident of their ability to do and understand mathematics. Subsequent analysis of mathematical test results and classroom observations that occurred in the participants’ third year of teaching would indicate that these pre-service confidence levels were somewhat misplaced in relation to the
mathematics the participants were expected to teach as primary school teachers.

However, as beginning teachers, were the participants aware of this mismatch? Was evaluating and/or improving mathematical content knowledge part of their developmental journey as teachers of primary mathematics? Had their initial teaching experience challenged their pre-existing beliefs about themselves as mathematicians? If yes, how? If not, why not?

Certainly for Sally and Ally a shift had occurred in their mathematical content knowledge confidence as beginning teachers. Although it is interesting to note that while Sally was aware of the shift, Ally was not as yet identifying content knowledge as the root cause of her ongoing concerns for her mathematics teaching. On the other hand, Jackie reported no shift in her mathematical confidence over time.

So, what were the experiences that Sally had that made her question the link between her level of mathematical content knowledge and her effectiveness as a teacher of mathematics and how was her initial teaching experience different and/or similar to that of Jackie and Ally? What is the role of school context, or more specifically that of mathematical school program coherence, in the development of mathematical content knowledge awareness in beginning teachers?

School Program Coherence

Jackie

Jackie was the only one of the three extended case story participants whose confidence in herself as a mathematician remained unchanged over the two and a half years of her initial teaching experience. This would seem to suggest that nothing had occurred in those two and a half years that caused her to question her own level of mathematical content knowledge and whether or not it had a bearing on her classroom practice. Certainly, her positive reaction to her relatively low test results indicated that this experience on its own
did not in any way challenge her pre-teaching beliefs and perception of herself as a mathematician.

So, what was Jackie doing when reflecting on her experiences as a teacher and in order to develop as a teacher of primary mathematics? As detailed in Table 6.2 and shown in Figure 6.8, Jackie reported that there had been minimal whole school or collegial influence on her mathematical decision making in her first year of teaching.

At the whole school level, Jackie identified that all teachers were directed to teach numeracy in the session between recess and lunch (literacy was taught in the morning session), that there was a numeracy committee that met about twice a term mostly to buy resources, and that a school-wide scope and sequence chart had been created but then folded halfway through the year without anyone really ever seeing it.

Jackie also identified that there had been a preferred textbook program nominated for teachers to use, but not all the resources were readily available, and that the program was pulled halfway through the year as well. This decision was made as teachers were advised to adopt a Count Me In Too/Counting On approach, although not everyone was able to access the related professional development program in order to implement it.

Not only was the mathematics program incoherent and very ad-hoc at the whole school level, Jackie also reported that there was no common approach to programming, planning, assessment or report moderation at the individual teaching team level. As such, the capacity of the school program to influence Jackie’s mathematical decision making was deemed to be ‘low’.

However, despite this rather rocky start, by the time Jackie was interviewed in her second year of teaching she was able to demonstrate that she was confident in her overall mathematical teaching in the following areas: curriculum, pedagogy, and
professional. This confidence was gained primarily as a result of changes initiated within Jackie’s teaching team at the beginning of the year to better address the administrative and procedural needs of mathematical programming and teaching.

These changes included a commitment from all teachers in the team to use a common scope and sequence for the year, select and moderate common assessment items, team teach across classes during the numeracy block, use the same main textbook program as a starting point for lesson and unit planning and implement Kagan™ cooperative learning strategies in their classrooms.

Therefore, as Jackie reflected upon and evaluated her mathematics teaching into her third year of teaching, her focus was still very much on addressing and refining the administrative whole class planning issues (what to teach, when to teach it, how long to teach it for, how to teach it and how to report on it) that she identified as ongoing concerns for her teaching in her first year beginning teacher survey.

As a result, in her third year of teaching, Jackie had not even got to a point where she even considered that her mathematical content knowledge would be an area of concern for her mathematical teaching. Her primary attention was still on the development of effective procedural and administrative systems and pedagogical frameworks and she didn’t focus on mathematical content when evaluating her classroom practice.

Ergo, Jackie’s initial experience of teaching did not provide her with opportunities to challenge her pre-existing beliefs about her own level of mathematical content knowledge and how it could be affecting her development as an effective teacher of primary mathematics. Little wonder then that, when presented with her relatively low test results, Jackie did not consider them to be an issue for her mathematical teaching.
Ally

Unlike Jackie, Ally’s confidence in herself as a mathematician was deemed to have changed over the two and a half years of her initial teaching experience. However, this drop in confidence was not directly identified by Ally herself, rather it came from the external analysis of the concerns Ally raised about her mathematics teaching as a beginning teacher and was subsequently supported by both her test results and classroom observations.

This would seem to suggest that, while the mathematical teaching concerns Ally was identifying in her third year of teaching could be attributed to her level of mathematical content knowledge, she had yet to make that conscious connection herself. Certainly, Ally believed that achieving a traditional pass mark of 50% in the Year 6 mathematics test was an acceptable result based on the fact that she was only teaching Kindergarten. And, as Ally achieved the very low bar she set for herself without having to even attempt the last five questions of the test, this would indicate that she did not use either the test experience or results to challenge her existing beliefs and perception of herself as a mathematician.

Like Jackie, and as detailed in Table 6.2 and shown in Figure 6.9, Ally also reported that there had been minimal whole school or collegial influence on her mathematical decision making in her first year of teaching. At the whole school level, Ally identified that all teachers were directed to teach numeracy from 10.15 am to 11 am daily and that there was a numeracy committee that met once a term but it had been without a leader from Term 1 and had not produced anything to assist teachers.

Ally also reported that there was a numeracy task centre coordinator who could provide teachers with primarily Count Me In Too games and activities from a central store that they maintained. However, this coordinator did not provide any other assistance regarding mathematical professional development to teachers.
Again, like Jackie, Ally reported that not only was the mathematics program incoherent and very ad hoc at the whole school level, there was also no expectation that teaching partners would plan their mathematics programs together. As such, the capacity of the school program to influence Ally’s mathematical decision making was also deemed to be ‘low’.

However, by the time Ally was interviewed in her second year of teaching she, like Jackie, was able to demonstrate that she was confident in her overall mathematical teaching in the following areas: curriculum, pedagogy, and professional. This confidence was gained primarily as a result of Ally withdrawing from a collegial, school model of professional development and working independently as much as possible to address the administrative and procedural issues of mathematical programming and teaching that she found lacking within the school program.

This process involved locating two key texts relating to the teaching of early childhood mathematics and using these exclusively as the basis for her classroom mathematics program. Recommended to her by a colleague in her first year of teaching, these books were Ally’s mathematical lifeline:

They’re like my bibles and I struggled until I found them.

And, regardless of the fact that Ally had since changed schools, she still used these books and planned her program independently while her two Kindergarten colleagues planned together. The only time she really interacted with her colleagues in relation to programming maths was to ensure that they were covering the same topics over a term so that their reporting was consistent.

So, in her third year of teaching, unlike Jackie, Ally had addressed to her own satisfaction the administrative whole class planning issues (what to teach, when to teach it, how long to teach it for, how to teach it and how to report on it) that she identified as ongoing concerns for her teaching in her first year beginning teacher survey.
Therefore, as Ally reflected upon and evaluated her mathematics teaching in her third year of teaching, she was beginning to identify concerns that could be attributed to her level of mathematical content knowledge. Although she still had faith in the efficacy of her ‘bibles’, Ally identified that she was having difficulty linking activities to mathematical concepts. Unfortunately, her self-imposed exile from her colleagues and general disengagement with the school mathematics program as a whole meant that she did not have an easily accessible avenue where she could discuss, further explore and/or resolve these issues. Little wonder then that Ally was very reluctant to acknowledge that anything other than external factors could be negatively affecting her development as an effective teacher of primary mathematics.

Sally

Like Ally, Sally’s confidence in herself as a mathematician had changed over the two and a half years of her initial teaching experience. However, unlike Ally, Sally was aware of this change in that she clearly identified that her definition of mathematics had broadened as a result of her initial teaching experience. The consequence of Sally developing this more comprehensive definition of mathematics was that she began to identify both her mathematical strengths and weaknesses to first challenge, and then modify, her existing beliefs and perception of herself as a mathematician. These modified, more measured beliefs were subsequently supported by both her test results and classroom observations.

This would seem to suggest that there were a number of experiences in those initial two and a half years of teaching that caused Sally to question her own level of mathematical content knowledge and how it affected her classroom practice. Certainly, Sally’s understanding that she should, as a qualified primary school teacher, achieve at least a distinction level pass in the Year 6 test administered and her decision to review errors made in the test would indicate that she
was in the habit of using her experiences to better understand herself as a teacher of primary mathematics.

So, what is the role of school context in Sally’s development as a teacher of primary mathematics? As detailed in Table 6.2 and shown in Figure 6.10, Sally reported that there had been a strong whole school and collegial influence on her mathematical decision making in her first years of teaching. Her school was implementing a new textbook-based program across multiple year levels and teaching staff had participated in a professional development program at their school that was delivered by one of the program’s co-authors.

Sally and her teaching team also had access to all the available student and teacher program resources which included teacher handbooks that incorporated unit tests that could be used pre- and post-teaching, and a sequential plan of teaching activities that supported the development of students’ conceptual understanding. Sally and her teaching partner and mentor planned together using these resources and, as a teaching professional within a learning community of teachers, Sally appreciated the professional dialogue she had with her peers across the school regarding the implementation and evaluation of the prescribed textbook based program. As such, Sally was the only one of our three extended case study participants for whom the capacity of the school program to influence mathematical decision making was deemed to be ‘high’.

It was also apparent that, in this highly coherent school context where there was a strong focus on the school mathematics program, Sally was able to acquire her mathematical teaching confidence (curriculum, pedagogy and professional) relatively quickly as a beginning teacher. Therefore, as Sally continued to reflect upon and evaluate her mathematics teaching in this supportive, collegial and dynamic context, and because she was confident that she was meeting these more administrative and immediate needs of her mathematical programming and teaching, it allowed her to look
beyond them when assessing her own development as a teacher of primary mathematics.

Sally had also taken on a number of mathematics related roles at her school as a beginning teacher that provided her with rich and varied mathematical experiences and opportunities to ‘test’ her ideas and beliefs about mathematical teaching and learning. As a result, by the time Sally entered the third year of her teaching career she had used her initial teaching experience to broaden her own, narrow pre-service teacher definition of mathematics as a field of study and identified that she had ‘gaps’ in her own conceptual understanding of mathematics that affected her classroom practice.

Not only had Sally identified her mathematical content knowledge as an area of concern for her mathematical teaching, but her willingness to take on extra roles and professional development in mathematics demonstrated that Sally was also actively seeking to address these concerns as part of her ongoing development as an effective teacher of mathematics.

As such, the following data statements can be reported:

**Data Statement 6.7**
At schools with highly coherent school mathematics programs, once they have acquired initial mathematical teaching confidence in the areas of curriculum, pedagogy and professionalism, beginning teachers are more likely to:
- look beyond these areas and question the link between their own levels of mathematical content knowledge and any continuing identified inconsistencies between their primarily constructivist teaching beliefs and their developing classroom practice; and
- have access to a range of situations and experiences that can assist them to discuss, further explore and/or resolve mathematical content knowledge issues in order to develop as effective teachers of primary mathematics.

**Data Statement 6.8**
At schools without highly coherent school mathematics programs, once they have acquired initial mathematical teaching confidence in the areas of curriculum, pedagogy and professionalism beginning teachers are less likely to:
- look beyond these areas and question the link between their own levels of mathematical content knowledge and any ongoing inconsistencies between their primarily constructivist teaching beliefs and their developing classroom practice; and/or
- have access to a range of situations and experiences that can assist them to identify, discuss, further explore and/or resolve mathematical content knowledge issues in order to develop as effective teachers of primary mathematics.
Stage 5: Integrating the Case Story and Profiling Data

Once the extended case stories were developed; the Beginning Teacher Development Model (BTDM) profiling data and case story data were integrated and reduced in the final stage of the data analysis process. The purpose of data integration and reduction was to form a cohesive picture of the total data collected in order to better understand the relationship between the development of teacher mathematical confidence, classroom practice and school context. The results of this process are displayed in Figure 6.11 and discussed below.

Teacher Confidence, School Context and Classroom Practice

The analysis of profiling and case story data in the final data collection stage of this study showed that the acquisition of teaching confidence is the first priority for beginning primary school teachers in their development as effective teachers of mathematics. Being confident that they can develop and deliver a mathematical teaching program that satisfies the curriculum, pedagogical and professional expectations of ‘others’ (colleagues, school executive, parents and the wider community), as well as their own primarily constructivist beliefs, is an important first step for beginning teachers.

A sound knowledge of curriculum, pedagogy and professional expectations allowed teachers to establish classrooms where students were engaged, having fun and using hands-on manipulatives and real world connections to investigate mathematical concepts. However, the analysis of profiling and case story data also showed that to be able to develop and deliver teaching programs that are truly student-centred, i.e., where there was differentiation based on the learning and behavioural needs of individual students and multiple opportunities for students to lead mathematical discussion and inquiry, beginning teachers also need to have a sound knowledge of the mathematical concepts they are expected to teach in the primary school setting.
Unfortunately, not only do many beginning primary school teachers not have a sound knowledge of the mathematical concepts they are expected to teach, many teachers: a) are not aware that their mathematical content knowledge is lacking; b) don’t really recognise their level of mathematical content knowledge may affect their teaching; or c) are not really sure about what to do about their own mathematical content knowledge if they are aware of it as a potential issue for their teaching.

However, the analysis of case story data suggests that providing a positive school context—one where there is a coherent school mathematics program that includes a common approach to mathematics teaching and programming that is linked to a professional development program with a strong focus on collegial planning and discussion—can assist beginning primary school teachers to acquire the mathematical content knowledge confidence they need to fully realise the student-centred, constructivist mathematics classrooms they envisioned.
Conclusion

This chapter provided a full description of the third stage of this study, from the Beginning Teacher Development Model (BTDM) profiling data, to case story participant selection and the design and selection of the mathematical assessment instrument and lesson observation schedule through to the presentation of the data analysis results.

The goals outlined in the chapter introduction have been achieved as the results of the data analysis have:

- described and compared the development of individual participants as teachers of mathematics at the beginning of their teaching careers using the BTDM;
- identified points of contradiction and congruence within the participant-generated data (participant self-reports via survey and interview responses) and researcher-generated data (mathematical testing results and the observation of mathematics teaching); and
- integrated the data from all stages of the study and presented it as an interesting and convincing story that demonstrates the development of beginning primary school teachers as teachers of mathematics, to better understand the relationship between teacher confidence, school context and classroom practice.

In keeping with the data analysis framework of the overall research design, the results of the data analysis presented in this chapter will be integrated with the data collected and analysed from the first and second stages of this study. The result of this integration process will be presented in Chapter 7 of this report where all the study data will be integrated to address the research questions and produce the findings of the study.
Chapter 7: Findings

Introduction

The purpose of this final chapter is to “address clearly each of…[the]…research questions” (see Box 7.1) and to provide “sufficient, convincing, and defensible evidence for each…research finding and recommendation” presented (Johnson & Christensen, 2012, p. 578). As such, the presentation of the findings will combine the use of direct, descriptive data (e.g., vignettes and participant quotes) and links with related research and literature to support the “meta-inferences” (i.e., integrative inferences or conclusions) made based on the integration of all qualitative and quantitative data collected in this mixed methods study (Johnson & Christensen, 2012, p. 577).

In keeping with the core characteristics of the mixed methods research design selected as the methodological framework of this study, the presentation of the findings will reflect an “emphasis on continua” and a “reliance on visual representations (e.g., figures, diagrams)” (Teddlie & Tashakkori, 2012, p. 775).

Box 7.1: The Research Questions

Research Question 1
How does an individual’s experience of mathematics as a school student and as a pre-service teacher influence their beliefs and attitudes about mathematical teaching and learning on the eve of their transition into the primary school classroom?

Research Question 2
How does the first year experience and factors of school context reinforce and/or change beginning primary school teachers’ pre-existing beliefs and attitudes about teaching and learning mathematics?

Research Question 3
To what extent is a beginning primary school teacher’s classroom practice an artefact of their beliefs and attitudes formed as a result of their experiences as:
- a school student;
- a pre-service teacher;
- a beginning teacher;
- a teacher within a particular school context; and
- part of developing an individual teacher identity?

Research Question 4
Can we use these understandings of the links between teacher beliefs, attitudes and practice to construct a model that allows schools to provide more targeted and effective support for beginning primary teachers to develop as effective teachers of mathematics?
Research Question 1: The Pre-service Teacher—Beliefs and Attitudes

How does an individual’s experience of mathematics as a school student and as a pre-service teacher influence their beliefs and attitudes about mathematical teaching and learning on the eve of their transition into the primary school classroom?

On the eve of their transition into teaching, pre-service primary school teachers are most likely to imagine the mathematics classrooms they want to create as being learning spaces that reflect the basic tenets of the constructivist teaching and learning theory that they have learnt during their formal primary education studies. At the same time, however, many pre-service teachers’ own school experience of mathematics and their subsequent understanding of mathematics as a field of study and themselves as mathematicians either contradicts parts of a constructivist approach to mathematics teaching and learning and/or undermines their confidence in their ability to teach mathematics ‘constructively’.

In this study, contradictions were identified in areas such as mathematics content, teaching orientation and learning theory, and pre-service teachers’ ideas about ‘good’ teachers of mathematics and students as learners of mathematics. These contradictions were framed as a tension between what pre-service primary school teachers ‘knew’ as a result of their studies and what they ‘knew’ from their own school experience of mathematics. This interpretation of the data as a mismatch between the teaching, learning and classroom ‘ideal’ and the personal ‘real’ experiences of respondents as students and student teachers is consistent with the findings of other research and literature (Brady, 2007; Grootenboer, 2003; Haylock, 2001; Marland, 2007).

The research and literature also suggests that while teacher education courses ‘challenge’ the “durable and powerful”, “personal and highly subjective” theories that pre-service teachers have when
they commence their formal study (Marland, 2007, pp. 27-28), these ‘tensions’ are not always resolved appropriately at the completion of their study (Brady, 2007; Grootenboer, 2003; Haylock, 2001).

In this study, it was found that these tensions were heightened when the ‘real’ mathematical experiences of participants were not positive. Indeed, in this study, pre-service primary school teachers about to begin their teaching careers were more likely to remember their own school experience of mathematics as being negative i.e., more boring than fun, difficult rather than easy, and not really relevant to real life. They were also more likely to believe that mathematics would be one of the hardest and least enjoyable curriculum subjects to teach. And in turn, pre-service primary school teachers who expected mathematics to be either the most, or one of the most, difficult subjects to teach were less confident of their capacity to develop students’ higher order mathematical abilities than those who did not.

So, not only did these pre-service teachers need to believe that learning maths could be fun, engaging, relevant, meaningful and attainable despite their own experience to the contrary, they also needed to believe that they could teach mathematics so it was all these things to students. And, as illustrated in Figure 7.1, the more negative the ‘real’ mathematical experience of these pre-service teachers was, the longer and more difficult the developmental journey they had to make to resolve these tensions appropriately and reach their constructivist ‘ideal’.

As one participant in this study noted:

I think the hardest problem…[for me as a teacher]…is getting rid of at least 20 years of ingrained negative attitude towards maths and trying to turn it around…and make it enjoyable and engaging for kids.
Research Question 2: The Beginning Teacher—Beliefs and Attitudes

How does the first year experience and factors of school context reinforce and/or change beginning primary school teachers’ pre-existing beliefs and attitudes about teaching and learning mathematics?

Having survived their first year of teaching, all beginning teachers in this study reported that the experience of teaching maths had been more positive than they had thought it would be as pre-service teachers (see Figure 7.2). For six of the seven beginning teachers in this study who did not believe in their capacity to teach mathematics effectively as pre-service teachers, this positive experience of teaching mathematics was accompanied with a change in their belief about their own capacity in that they were now ‘confident/very confident’ of the overall efficacy of their mathematics teaching after their first year.

At the same time however, when re-asked a range of questions that had been posed to them as pre-service teachers, beginning teachers at the end of their first year of teaching recorded little or no change in their pre-existing beliefs and attitudes about mathematics as a field of study, its teaching and learning, or themselves as mathematicians.
This finding is not surprising in light of the fact that we know that the main focus of beginning teachers in their first year of teaching is on surviving the initial ‘reality shock’ of teaching and what beginning teachers do to survive has major implications for the way in which they teach mathematics and subsequently what they believe effective mathematics teaching and learning is (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006).

Having already established that many pre-service primary school teachers leave their formal education studies with unresolved tensions between their ‘real’, and often traditional, experience of mathematics and their constructivist ‘ideal’, what does this mean for them?
In the first instance we know from the findings of other research and literature about the first year teaching experience that beginning teachers initially teach in ways that are at odds with what they believe, or say they believe, about teaching mathematics (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006). Instead of using a constructivist, student-centred approach in the classroom, they use traditional and teacher-directed pedagogy to quickly gain control of the classroom and be seen by others (parents, students teaching peers and school executive) as a competent professional (Sparrow & Frid, 2006).

As a result, and as demonstrated in this study, the beginning teacher initially feels validated for using these methods because they were used successfully in establishing themselves as a 'good' teacher and giving them control in the classroom (Sparrow & Frid, 2006), hence their self-reports of teaching maths declares it a more positive experience than they originally believed.

In this scenario, the “durable and powerful”, traditional and teacher-centred theories (Marland, 2007, pp. 27-28) about teaching mathematics that many beginning teachers are still ambivalent about after completing their formal study are initially reinforced by the first year experience. As such, these inconsistencies between traditional and constructivist beliefs are not always resolved quickly, appropriately or indeed at all in the first year of teaching (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Raymond, 1997; Sparrow & Frid, 2001, 2002, 2006).

So, given that surviving the first year of teaching doesn’t necessarily equate with beginning teachers appropriately resolving inconsistencies within their mathematical beliefs and moving quickly and/or effectively through the initial ‘reality shock’ stage of teacher development, what does?

We know, from the findings of extant research and literature spanning the last four decades, that the early development of beginning teachers follows a fairly predictable course that can be
characterised by a shift in the focus of the teacher from being teacher-centred to being student-centred (Frid & Sparrow, 2007; Fuller & Bown, 1975; Katz, 1972; Sparrow & Frid, 2001, 2002, 2006). In this study, and as shown in Figure 7.3, this shift in beginning teacher focus was conceptualised as the teacher moving through a continuum where they were developing first teaching confidence and then mathematical confidence.

In the first instance, beginning teachers need to develop teaching confidence. Teaching confidence consists of three parts: curriculum confidence (knowing what maths topics to teach and when to teach them); pedagogical confidence (knowing how to teach); and professional confidence (confidence in their professional role as teachers of mathematics within the wider school context).

Once beginning teachers were confident that they were effective teachers of mathematics, they could begin to focus on how the more personal factors of mathematical confidence (how they perceive themselves as mathematicians, how they view mathematics as a
field of study and their own level of content knowledge) impact on how they teach to meet the individual learning needs of students.

So what, if any, is the role of school context in supporting beginning teachers through this continuum so that their mathematical beliefs and attitudes are consistent with the tenets of the constructivist ‘ideal’ that they espouse as pre-service and beginning teachers?

When looking at the role of school context in shaping the beliefs and attitudes of beginning teachers in the first years of their teaching careers, this study found that schools with a coherent school mathematics program that met the individual developmental needs of beginning teachers and strongly influenced the decisions they made about teaching mathematics had a positive effect on teacher development.

In schools such as these—where there is a common approach to mathematics teaching and programming that is linked to a professional development program with a strong focus on collegial planning and discussion—beginning teachers were able to demonstrate appropriate curriculum, pedagogical and professional teaching confidence which allowed them to move quickly through the reactionary ‘reality shock’ phase of teacher development. Having acquired initial mathematical teaching confidence they were then more likely to:

- look beyond these areas and question the link between their own levels of mathematical content knowledge and any continuing identified inconsistencies between their primarily constructivist teaching beliefs and their developing classroom practice; and
- have access to a range of situations and experiences that can assist, encourage and support them to discuss, further explore and appropriately resolve these issues in order to develop as effective teachers of primary mathematics.
Research Question 3: The Beginning Teacher—Influences on Classroom Practice

To what extent is a beginning primary school teacher’s classroom practice an artefact of their beliefs, attitudes and experiences as:

- a school student;
- a pre-service teacher;
- a beginning teacher;
- a teacher within a particular school context; and
- part of developing an individual teacher identity?

This study found that the mathematical classroom practice of beginning primary school teachers, post their first year of teaching, was most strongly influenced by the primarily constructivist beliefs they acquired as pre-service teachers. The study also found that inconsistencies between beginning teacher beliefs and classroom practice were more likely to be caused by “durable and powerful”, traditional and teacher-centred theories (Marland, 2007, pp. 27-28) about teaching mathematics that beginning teachers formed as a result of their own experiences of learning mathematics and initial experiences of teaching mathematics, rather than their experience of being a teacher in a particular school context.

As reported in Table 7.1, beginning teachers’ classrooms were organised to encourage student interaction and collaboration and a wide range of general and maths-specific resources and hands-on manipulatives were made available to students during maths lessons. The tasks and activities beginning teachers used in the classroom (games, worksheets, hands-on manipulatives) were selected to engage student interest and maximise their enjoyment and students demonstrated high levels of both throughout the lessons observed in this study. At the same time, however, there were some aspects of beginning teacher classroom practice that were inconsistent with their stated constructivist beliefs.
Table 7.1 Factors that Influence Beginning Teacher Classroom Practice—Individual Teacher and School Context

<table>
<thead>
<tr>
<th>Practice Component</th>
<th>Major Factor of Influence (with elaborations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum</td>
<td>School Context</td>
</tr>
<tr>
<td>Coverage (content and sequence)</td>
<td>what topics teachers taught and when they taught them across a school year were negotiated with teaching colleagues based on a school directive or policy document and/or a textbook program or syllabus document chosen by the team to follow.</td>
</tr>
<tr>
<td>Timetabling</td>
<td>when to teach maths and how long to teach maths on a daily/weekly basis was based on a school directive or policy and could involve being told how many hours per week, time per day, an allocated block (after recess) or when to have streamed classes.</td>
</tr>
<tr>
<td>Pedagogy</td>
<td>Individual Teacher</td>
</tr>
<tr>
<td>Classroom Organisation</td>
<td>designated areas for whole class instruction with access to white board (static or interactive) for visual instruction and student desks arranged in clusters to allow students to sit and work together in small groups of 4 to 6.</td>
</tr>
<tr>
<td>Lesson Structure (with % of total lesson time)</td>
<td>whole class introduction of concept/topic/main task activity (20-40%), then students go to desks to work on main task (50-70%), then students move back to designated area for whole class review to end lesson (10-15%).</td>
</tr>
<tr>
<td>Student Role</td>
<td>during lessons, student talk centred around answering teacher questions and helping each other during the main task. *inconsistent with stated importance of students explaining maths to others—can indicate low levels of teacher mathematical confidence.</td>
</tr>
<tr>
<td>Learning Activities/Resources</td>
<td>learning activities and hands-on maths resources and general manipulatives were mostly used successfully to engage students. However, often selection not based on robust and/or clear link to main task/maths concept being covered. *inconsistency identified in pre-service teachers who focused on making maths fun and engaging rather than content. Also linked to inconsistency identified in beginning teacher concerns about matching activities to math content—linked to low levels of teacher mathematical confidence.</td>
</tr>
<tr>
<td>Differentiation</td>
<td>no authentic or planned differentiation observed, all students given same type and amount of work. Any extra tasks or challenges set were for fast finishers and the tasks were unplanned and often unrelated to the main task. *inconsistent with beginning teacher reports of using pre- and post-assessment to identify student needs—linked to low levels of teacher mathematical confidence.</td>
</tr>
<tr>
<td>Lesson Evaluation</td>
<td>end of lesson reviews were typically no more than 15% of total lesson time and were focused on student engagement/enjoyment and rarely gave students opportunities to discuss their mathematical solutions or strategies. *inconsistent with stated importance of students explaining maths to others—linked to low levels of teacher mathematical confidence.</td>
</tr>
</tbody>
</table>

* Indicates possible inconsistency within and/or between teacher beliefs and classroom practice and attempts to identify the nature and source of the inconsistency.

These aspects were more reflective of traditional and teacher-centred theories about mathematics and its teaching and learning and/or beginning teachers own mathematical content competence and confidence.
Again, as reported in Table 7.1, an observer of the beginning teachers’ mathematical classroom practice in this study would see a lot of student interaction and hear a lot of student talk during the lesson. However, when looking and listening more closely at what was happening and being said this study found that students were not actually doing a lot of explaining their mathematics to others. Not only was minimal time allocated to reviewing the mathematical focus of the lesson, the whole class interactions that occurred were primarily teacher-led closed question and answer sessions rather than student-led sustained and substantial explanations and evaluations of their mathematics.

Research shows a link between the presence of teacher directed question and answer sessions in maths lessons and lower levels of teacher mathematical competence and confidence as the idea of “[l]etting students influence the direction of the lesson…may provoke anxiety in…teachers who may not be sure themselves if children’s novel solutions to mathematical problems are justified” (Stigler, Fernandez, & Yoshida, 1996, p. 173).

Similarly, while students were engaged by, and enjoyed, the set activities and resources, some of the activities themselves (or the way in which students were instructed to complete them) were not fully aligned with the stated conceptual focus of the lesson. As beginning teachers in this study acknowledged that they had difficulty matching learning activities to mathematical concepts, so ‘fun’ rather than ‘content’ became the primary driver in their activity selection.

When further investigating this issue of ‘fun versus content’ (first raised as an area of interest in pre-service teachers’ beliefs and again as an feature of beginning teacher classroom practice), this study found that the mismatch between conceptual focus and activity selection was linked to lower levels of mathematical confidence in beginning teachers. In particular, it suggested that beginning teachers did not necessarily possess a deep understanding of the mathematical concepts they were required to teach.
This finding was further supported by the absence of task differentiation in any of the observed lessons.

That there was no authentic differentiation in set tasks or activities was inconsistent with the self-reports of beginning teachers who had indicated that the learning activities they used in the classroom were differentiated based on student ability generally established through the use of pre- and post-assessments. So, even though participants were administering assessments to establish students’ mathematical ability and understanding, they seemed limited in their ability to use this information to plan authentic, targeted differentiated student learning in the classroom.

As such, this study found that the classroom practice of beginning teachers in their second and third year of teaching, while largely reflective of their pre-service beliefs of the constructivist ‘ideal’, is moderated by their ‘real’ experience of mathematics learning and teaching, regardless of their particular school context.

Research Question 4: Supporting Beginning Teacher Development as Effective Teachers of Mathematics

Can we use these understandings of the links between teacher beliefs, attitudes and practice to construct a model that allows schools to provide more targeted and effective support for beginning primary teachers to develop as effective teachers of mathematics?

This study found that, in order to fully realise the ‘ideal’ constructivist classrooms that they imagined as pre-service teachers, beginning teachers need both teaching confidence and mathematical confidence. The study also found that the acquisition of teaching confidence—being confident that they can develop and deliver a mathematical teaching program that satisfies the curriculum, pedagogical and professional expectations of ‘others’ (colleagues, school executive, parents and the wider community)—is the first
priority for beginning primary school teachers as they transition into their teaching careers.

Having a sound knowledge of curriculum, pedagogy and professional expectations of others (as well as their own primarily constructivist beliefs) allowed teachers to establish classrooms where students were engaged, having fun and using hands-on materials and real world connections to investigate mathematical concepts. However, this study also found that to be able to develop and deliver truly constructivist and student-centred teaching programs, i.e., where there was differentiation based on the learning and behavioural needs of individual students and multiple opportunities for students to lead mathematical discussion and inquiry, beginning teachers also need to have a sound conceptual understanding of mathematics.

Unfortunately, this study also found that well into their second and third year of teaching, many beginning teachers had yet to acquire mathematical confidence. In fact, not only do many beginning primary school teachers not have a sound knowledge of the mathematical concepts they are expected to teach, many beginning teachers: a) are not aware that their mathematical content knowledge is lacking; b) don’t really recognise that their level of mathematical content knowledge may affect their teaching; or c) are not really sure about how to improve their mathematical content knowledge if they are aware of it as an issue for their teaching.

However, the findings of this study suggest that providing a positive school context—one where there is a coherent school mathematics program that underpins a beginning teacher support model that can be tailored to identify and meet the needs of the individual—can assist beginning primary school teachers to acquire both the teaching and mathematical confidence they need to fully realise the student-centred, constructivist mathematics classrooms they envisioned.

As shown in Figure 7.4, using the understandings of the links between teacher beliefs, attitudes and practice identified as part of this study, we can list eight ‘top tips’ that schools can action to
construct a targeted and effective mathematical support model for beginning primary school teachers’ mathematical development. The first five actions listed in the support model, and outlined below, are designed to assist beginning teachers to progress quickly through the initial ‘survival’ stage of teacher development through the early acquisition of teaching confidence.

1. **Provide beginning teachers with all mathematical program structure documentation.**

   **What:** Scope and sequence documents (full year and term programs) and expected daily/weekly timings.

   **Why:** Providing this information to beginning teachers helps them to quickly acquire the first level of teaching confidence—curriculum coverage. Knowing that they are using the same documents as their teaching peers to schedule their mathematics program, beginning teachers can be confident that they are meeting the curriculum expectations of their school, their colleagues and parents and the wider community.

2. **Provide beginning teachers with all required resources and materials.**

   **What:** For at least the first term, provide beginning teachers with detailed unit plans for math topics outlined on scope and sequence and term programs and make sure any resources and/materials mentioned are provided to them. This includes providing them with their own copy of all books associated with specific commercial programs (teacher resource, student workbooks, blackline masters), and/or any particular games, resources, manipulatives and assessment materials that are listed in the planning documentation.

   **Why:** Beginning teachers are time poor and having everything they need on hand will allow them to focus on teaching and using resources effectively rather than sourcing and/or creating them.
Figure 7.4: Beginning Teacher Mathematical Support Model

TOP TIPS
(for supporting beginning primary school teachers to develop as effective teachers of mathematics)

DEVELOPING TEACHING CONFIDENCE

Curriculum Confidence—knowing what to teach when.
1. Provide beginning teachers with all mathematical program structure documentation.

Pedagogical Confidence—knowing how to teach.
2. Provide beginning teachers with all required resources and materials.
3. Facilitate easy and ongoing access to teachers and classrooms.
4. Provide beginning teachers with multiple opportunities for shared lesson/unit planning and evaluation.

Professional Confidence—knowing their professional role as a teacher of mathematics within the wider school context.
5. Establish a cohesive school mathematics program and learning community.

DEVELOPING MATHEMATICAL CONFIDENCE

6. Focus on the mathematics—concepts versus procedures.
7. Focus on the student—content versus fun/learning versus teaching.

*************************************************************************** MOST IMPORTANT OF ALL ****************************

8. TAILOR THE SUPPORT PROGRAM TO THE INDIVIDUAL TEACHER
Beginning teachers will start their teaching careers at various points along a range of mathematical continua:

<table>
<thead>
<tr>
<th>Maths anxiety</th>
<th>Maths confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative maths experiences</td>
<td>Positive maths experiences</td>
</tr>
<tr>
<td>Maths as procedures/rules</td>
<td>Maths as conceptual ‘big ideas’</td>
</tr>
</tbody>
</table>

Teacher-directed pedagogy | Student-led pedagogy

| Low levels of mathematical content knowledge | High levels of mathematical content knowledge |

As a general rule of thumb, the more ‘left’ a beginning teacher is on any particular maths continua, the longer it will take for them to fully realise the ‘ideal’ constructivist classroom. As such, they will need more time and/or scaffolded beginning teacher pedagogical and mathematical support to progress through the early stages of mathematical teacher development.

ASK questions about their mathematical experiences and concerns; LISTEN to them speak about their maths content and pedagogy; and LOOK at their programming and planning documentation and their classroom practice so you can tailor a support program to help them develop as effective teachers of mathematics.
3. **Facilitate easy and ongoing access to other teachers.**

**What:** Schedule regular and targeted opportunities for beginning teachers to observe and talk to other teachers about teaching mathematics. This includes modelling lessons for beginning teachers in their classrooms, team teaching with them and observing them as well as organising for them to observe other teachers teach. Areas to target during these observations include how to use particular games, resources and manipulatives to teach different concepts, and how to run whole class discussions, activities and reviews, and small group activities.

**Why:** Initially, beginning teacher professional development should be closely linked to the day-to-day operation of the classroom and be delivered on site as much as possible. Learning from their colleagues in their own classroom assists time poor beginning teachers and helps them feel confident that they are meeting the pedagogical expectations of their school, their colleagues and parents and the wider community.

4. **Provide opportunities for shared lesson/unit reflection and evaluation.**

**What:** Schedule regular and targeted opportunities for beginning teachers to reflect on and talk to others about what is happening mathematically and pedagogically in their classrooms. This includes reflecting on individual lessons within a maths unit as well as regular discussions before, during and after the implementation of maths units.

**Why:** Just surviving the experience of teaching mathematics does not automatically mean that beginning teachers are confident that they are teaching mathematics effectively, or indeed are actually teaching mathematics effectively. Targeted discussion and critique of their teaching allows beginning teachers to critically reflect on the mathematical and pedagogical efficacy of their classroom practice.
5. Establish a cohesive school mathematics program and learning community.

**What:** Provide a positive school context where there is a coherent school mathematics program. This includes having a common approach to mathematics teaching and programming across the school that is linked to a whole school professional development program with a strong focus on collegial planning and discussion.

**Why:** Beginning teachers who teach at schools with a coherent mathematics program have greater access to a range of situations and experiences that can assist them to identify, discuss, explore and resolve mathematical and pedagogical issues in order to develop as effective teachers of primary mathematics. These five actions are also consistent with the suggestions made by study participants of various ways that schools could better support beginning primary school teachers to teach mathematics:

- Providing really good support and a great syllabus...with a beginner’s resource pack...as my arrival here coincided with the introduction of the dedicated program it was a shared experience with my colleagues.

- You really need to pull the school together for maths...having a skeleton program to support you and let your new teachers sit and watch other teachers.

They are also consistent with the generally held understanding that the most effective professional development for beginning teachers in the initial ‘survival’ stage of teacher development was that which provided them with “on site support and technical assistance” and “colleague advice” (Katz, 1972, p. 3)

The next two actions listed as part of the beginning teacher mathematical support model (see Figure 7.4) and outlined below, are designed to assist beginning teachers to develop their mathematical confidence by focusing on the mathematics within their classroom practice and how their own mathematical understandings influence their teaching and student learning in the classroom.
6. **Focus on the mathematics—concepts versus procedures.**

**What:** Ensure that all planning and programming documentation, discussions and other professional development focus on the mathematical concepts, the ‘big ideas’, that we want students to know and understand and not just a particular procedure and/or skill.

**Why:** To challenge the traditional view of maths as a set of procedures and skills to be learnt that many beginning teachers have based on their own experience of school maths and/or were reinforced by their initial teaching experiences.

7. **Focus on the student—content versus fun/learning versus teaching.**

**What:** Ensure that all planning and programming documentation, discussions and other professional development explicitly link the teaching of maths to student learning outcomes. This includes:

- looking beyond levels of student engagement and fun as the sole consideration when planning activities for, and evaluating the effectiveness of, maths lessons and units and focusing instead on the mathematical understandings of students; and
- differentiating mathematical activities and learning based on the assessed individual academic needs of students.

**Why:** To be able to develop and deliver teaching programs that are truly student centred, beginning teachers need to have a sound knowledge of the mathematical concepts they are expected to teach in the primary school setting. We know from the results of this study that many beginning teachers do not have a sound conceptual understanding of mathematics and that this manifests itself in their classroom practice as a difficulty in matching learning activities to mathematical concepts and authentically differentiating student learning.
By constantly focusing on the conceptual understanding of student mathematical learning and catering for their individual needs when planning, it raises teacher conceptual understanding as an ongoing issue for discussion and beginning teacher development.

The final action listed as part of the beginning teacher mathematical support model (see Figure 7.4) and outlined below is a reminder to schools that for any support program to work it has to be flexible enough to identify and cater for the individual needs of each beginning teacher.

8. **Tailor the support program to the individual teacher.**

**What:** It is very important that the colleagues and mentors of beginning teachers take the time and effort to engage them at every opportunity in a rich and ongoing professional dialogue about their mathematical beliefs and attitudes and their classroom practice. Ask beginning teachers questions about their mathematical experiences and concerns; listen to them speak about their maths content and pedagogy; look at their programming and planning documentation; and observe their classroom practice so an individualised support program can be created to help them develop as effective teachers of mathematics.

**Why:** Beginning teachers will start their teaching careers at various points along a range of mathematical beliefs, attitudes and experiential continua that will either contradict parts of a constructivist approach to mathematics teaching and learning and/or undermine their confidence in their ability to teach mathematics ‘constructively’. This study found that, as a general rule of thumb, the more distance there was between what an individual ‘knew’ as a result of their studies and what they ‘knew’ from their own experience of mathematics, the longer it would take for them to fully realise the ‘ideal’ constructivist classroom.
As such, some beginning teachers will need more time and/or different scaffolded beginning teacher support to progress successfully through the early stages of mathematical teacher development than others based on their individual needs.

This reminder to schools to tailor beginning teacher support programs is consistent with the findings of this study that established that the mere existence of mathematics and/or beginning teacher support programs at a school does not automatically mean that it will meet the needs of individual teachers nor have a major impact on their classroom practice. Rather, it is the school ‘program coherence’, a “measure of integration of the different elements in the school as an organisation” (DEST, 2004, p. 15) that is the critical factor in supporting teacher development as effective teachers of mathematics (DEST, 2004; Newmann, King, & Youngs, 2000; Newmann et al., 2001).

**Implications of the Research**

The results of this study, as reported previously in this chapter to answer the four research questions, contribute to our understandings of the developmental journey of beginning primary school teachers as effective teachers of mathematics. It identifies links between beginning teacher confidence, school context and classroom practice—and articulates how schools can use these understandings to better support the mathematical development of beginning primary school teachers.

This study conceptualised the development of beginning teachers as a journey to acquire both the teaching confidence and mathematical confidence necessary to become effective teachers of mathematics. It also found that the acquisition of teaching confidence was the first priority of beginning teachers, which limited their focus on the actual mathematics being taught to ensuring adequate curriculum coverage and high levels of student engagement and enjoyment.
This study also identified that, having acquired teaching confidence, it was not automatic that beginning primary school teachers then went on to acquire the levels of mathematical confidence required to be an effective teacher of mathematics and this was impeding their ability to fully realise constructivist teaching and learning of mathematics in their classrooms.

Therefore, this study found that it is imperative that beginning teacher professional development and support programs are tailored to the individual needs of the beginning teacher and focus on them achieving the timely acquisition of teaching confidence and the effective acquisition of mathematical confidence required to ensure that there is robust mathematical learning and teaching occurring in beginning teacher classrooms.

In addition to answering the research questions, one of the most interesting aspects of this research was the identification of the link between lower levels of beginning teacher mathematical content knowledge and some aspects of classroom practice. This study identified that, in the classroom of the beginning teacher with low levels of mathematical content knowledge:

- while you may hear a lot of student talk, it does not necessarily mean that students discussing and explaining their mathematical solutions and understandings to others;
- while you might observe high levels of student engagement and enjoyment, it does not necessarily mean that the learning activities selected actually develop the mathematical concept focus of the lesson or are linked to each other; and
- while teachers say that they use assessment to differentiate learning activities based on individual student abilities, it does not mean that you will see that in the classroom.

These findings suggest that targeted classroom observations can assist school and teachers to identify areas of classroom practice teachers need to develop to become more effective teachers of mathematics. They also suggest lower levels of mathematical
content knowledge as a probable root cause of these inconsistencies within and between mathematical beliefs and practice that must be addressed as part of improving these aspects of beginning teacher classroom practice so as to appropriately resolve these inconsistencies.

Therefore, it is imperative that in general there is a greater focus on the rigor of mathematical content in school and classroom programs, professional development, planning discussions, activity selection, lesson evaluations and student assessment in order for beginning teachers to develop as effective teachers of primary mathematics.

Limitations of this Study and Implications for Further Research

One of the strengths of this study was that it was longitudinal and tracked beginning primary school teachers over a four-year period. This allowed for the investigation of the effect of initial teaching experiences on beginning teachers’ mathematical beliefs and attitudes and the development of their classroom practice. However, this research design feature also decreased the size of the study sample at each phase of the study and that, in turn, affected the decisions made regarding the methods of data collection and analysis used at each phase.

The fact that this study was conducted by a lone, part-time researcher (working full-time as a primary school teacher at the same time) was also a limiting factor in determining the geographical location of the sample, the amount and type of participant contact required and the time taken to collect data at each phase of the study.

Knowing that this study would need to track participants over four years from their final year of university study and then into their first three years employment as full-time, permanent primary school teachers, it was determined that a large initial sample size would be required.
Although a large initial sample was achieved in this study \((n=200)\), had a greater amount of pre-service teacher surveys been administered there may have been an opportunity for the identification of more than just the two ‘extreme’ cases of beginning teacher mathematical development model detected in this study.

This, in turn, could have given an opportunity to further test the findings about the ‘ideal’ case and the ‘cautionary tale’ (see Lucette and Sue’s stories in Chapter 6) and achieve a greater understanding of how these extremes affect beginning teachers’ mathematical development and classroom practice.

This study also identified a link between lower levels of beginning teacher mathematical content knowledge and some aspects of classroom practice that would benefit from further investigation. Testing mathematical content knowledge at each phase of a similar, longitudinal study would allow for comparisons over time to be made to determine if, and how, the initial teaching experience affected beginning teacher performance in this type of testing.

Finally, this study was observational in nature. Its purpose was to document the lived reality of beginning teachers in order to identify what schools could do to provide more targeted and effective support for them to develop as effective teachers of mathematics. However, having now identified eight ‘top tips’ that schools can action to construct a targeted and effective mathematical support model for beginning primary school teachers’ mathematical development, the next step is to design an interventionist study that tests the effectiveness of these eight ‘top tips’.
Conclusion

The goals outlined in the chapter introduction have been achieved as the analysis of all the study data collected has been integrated to both address the research questions and produce the findings of the study.

In keeping with the core characteristics of the mixed methods research design selected as the methodological framework of this study, a range of continua and visual representations were used to support the presentation of the study findings.

This chapter also identified some limitations of the study and the implications these had for further research in investigating and supporting the development of beginning primary school teachers as teachers of mathematics.
References


perspectives and agendas (Proceedings of the 2007 Australian Teacher Education Association national conference). Wollongong, NSW: ATEA.


Appendix A – Information Sheet

This research aims to extend our understandings of how the first year teaching experience and school context affects what beginning teachers think and believe about teaching mathematics and how this is reflected in their classroom practice. Using a combination of research methods – surveys, focus groups and case studies – data will be collected from beginning teachers in the final year of their undergraduate degree studies and the first two years of their teaching careers.

You have been approached as a potential participant for this study as you are about to complete your preservice primary teacher training and begin your teaching career. The information you provide will help us to understand what we need to do in our schools and school systems to better support beginning teachers and to assist them in becoming effective teachers of numeracy.

This research is part of a PhD study and will be conducted by Judy Geeves, the Principal Researcher. Miss Geeves is enrolled in her postgraduate study at Charles Sturt University, Wagga Wagga Campus and is currently employed as a Level 1 Teacher in the ACT. The findings of this study will be published as a PhD thesis. Contact details for both The Principal Researcher and her PhD Supervisor are provided on the back of this page.

Participation in this study is purely voluntary and participants may withdraw from the research project at any time. All completed surveys, consent forms, observation records and audio tapes will be stored securely and separately and treated confidentially by the Principal Researcher. Any participant information or personal details gathered in the course of this research are confidential and neither names nor any other identifying information will be used or published without the participant’s prior written permission.

Participants in this project will be required to:

**Complete a survey in the last year of their university study** that records their beliefs and understandings of mathematics teaching and learning. At the same time they will be asked to read and sign the Consent Form. The Consent Form is not permanently attached to the survey so it can be stored separately to ensure that the survey responses cannot be identified after they have been received.

**Complete a survey at the end of their first year of teaching** that provides information about their school context and professional experience as well as re-asking questions about their beliefs and understandings of mathematics teaching and learning. This data will be compared to that collected in the first survey to see if there have been any changes.
Only participants who are working fulltime at one school for this period and who provided Miss Geeves with their contact details at the time of the initial survey will be targeted to complete the second survey.

For most participants, this will be the extent of their involvement in this study. Data collected from these surveys will be analysed and used to inform the future directions of the study and provide the framework for the presentation of the research findings.

Volunteers who have completed both surveys will be asked to participate in an interview in their second year of teaching to discuss the survey and research questions and the findings of the data analysis. These interviews will be audio taped.

Volunteers from the interviews (no more than three) will be asked to participate in an in-depth case study of their mathematics teaching in their third year of teaching. This will involve the Principal Researcher visiting the participants' schools and classrooms as an observer. These observations will then be used in conjunction with the survey and interview data as a focus to investigate how factors of school context and the first year experience informed participants practice in the subsequent years of teaching.

Please Note:

For participants who agree to complete the second survey, your survey will be numbered with the same number as your first survey so some of your responses to similar questions can be compared to see if changes occur as a result of your first year teaching experience. You will not be individually identified in the presentation of these results in the final report.

For participants who agree to participate in interviews and/or case studies, your responses in these forums may be compared to your survey responses to see if changes occur as a result of your teaching experiences. Pseudonyms for you will be used in the final report.

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Principal Supervisor
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WAGGA NSW 2678
(02) 69332441

NOTE: Charles Sturt University’s Ethics in Human Research Committee has approved this project. If you have any complaints or reservations about the ethical conduct of this project, you may contact the Committee through the Executive Officer:

The Executive Officer
Ethics in Human Research Committee
Academic Secretariat
Charles Sturt University
Private Mail Bag 29
Bathurst NSW 2795
Tel: (02) 6338 4628
Fax: (02) 6338 4194

Any issues you raise will be treated in confidence and investigated fully and you will be informed of the outcome.
Appendix B – Consent Form

Project Title
First Year and Beyond: Beginning Primary School Teachers and Teaching Mathematics.

CONSENT FORM

• I have read and understood the information sheet given to me about this research.
• I understand the purpose of the research project and my involvement in it.
• I understand that I may withdraw from the research project at any time, and that if I do I will not be subjected to any penalty or discriminatory treatment.
• I understand that any information or personal details gathered in the course of this research about me are confidential and that neither my name nor any other identifying information will be used or published without my written permission.

Charles Sturt University’s Ethics in Human Research Committee has approved this study.

I understand that if I have any complaints or concerns about this research I can contact:

Executive Officer
Ethics in Human Research Committee
Academic Secretariat
Charles Sturt University
Private Mail Bag 29
Bathurst NSW 2795

Phone: (02) 6338 4628
Fax: (02) 6338 4194

Name: ...........................................................................................................

Signature: ........................................... Date: ..............................

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Appendix C – Pre-service Teacher Survey

PRE-SERVICE TEACHER SURVEY

1. Are you □ Male or □ Female

2. Use the scales below to record your own experience of MATHEMATICS at school:
   a. 1 2 3 4
      Fun Boring
   b. 1 2 3 4
      Easy Difficult
   c. 1 2 3 4
      Relevant to My Life Irrelevant to My Life

3. Using the numbers 1-6 (where 1 is the most and 6 is the least) rank the following curriculum areas according to how enjoyable and then how easy you think they are to teach:

   Enjoyable Easy
   SOSE / HSIE □ □
   Science/ Technology □ □
   The Arts □ □
   PDHPE □ □
   English □ □
   Maths □ □

4. How important are the following aspects of mathematics learning for primary school students?

   The learning of:
   □ □ □ □ □
   mental methods of calculation
   □ □ □ □ □
   mathematical facts (eg multiplication tables)
   □ □ □ □ □
   methods of problem solving
   □ □ □ □ □
   standard written procedures for carrying out calculations

   The ability to:
   □ □ □ □ □
   apply known mathematics in unfamiliar contexts
   □ □ □ □ □
   undertake open-ended mathematical investigations
   □ □ □ □ □
   explain mathematics to others
   □ □ □ □ □
   improvise mathematical approaches to solving problems

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5. Please indicate how confident you feel about developing students' abilities in the following areas taken from the list above (tick 1 choice only)

<table>
<thead>
<tr>
<th>Ability of students to:</th>
<th>Very Confident</th>
<th>Confident</th>
<th>Not very confident</th>
<th>Not at all confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>apply known mathematics in unfamiliar contexts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>undertake open-ended mathematical investigations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>explain mathematics to others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>improvise mathematical approaches to solving problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Please indicate what you think of the following statements about students attitudes to mathematics (tick 1 choice only)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>most students cannot be expected to like mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>learning mathematics is hard work for most students</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to be good at maths you have to like it</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>maths is training in logical thinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>most students do not understand mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>only a few students are capable of understanding early algebraic ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Please indicate what you think about the following factors as possible impediments to improving student abilities

<table>
<thead>
<tr>
<th>Factor</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>time devoted per day to mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>textbooks and other written resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>availability and nature of other learning materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>type of classroom organisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>required style of teaching</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is your philosophy about teaching and learning mathematics and how do you think it will inform your classroom practice?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

THANK YOU FOR COMPLETING THIS SURVEY
Appendix D – Beginning Teacher Survey

BEGINNING TEACHER SURVEY

SECTION A: BACKGROUND INFORMATION

1. Are you □ Male or □ Female

2. Is your school □ Public Sector or □ Non-Government / Private Sector

3. Where is your school located?
   □ ACT □ NSW □ QLD □ VIC
   □ SA □ WA □ NT

4. What year level are you teaching?
   (Please tick more than one option if teaching a composite class)
   □ K □ 1 □ 2 □ 3 □ 4 □ 5 □ 6

SECTION B: PROFESSIONAL DEVELOPMENT

5. Are you a member of the Australian Association of Teachers of Mathematics and/or a state/territory maths teachers association? □ Yes □ No

6. As a beginning teacher, did you participate in a formal induction program external to your school? □ Yes □ No

If YES, briefly describe this induction program and include information on how often you had to attend, how long the program went for, what type of topics were covered and whether or not the program included any explicit curriculum-based activities and directly related to mathematics.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

7. As a beginning teacher, did you participate in a formal induction program at your school? □ Yes □ No

If YES, briefly describe this induction program and include information on how often you had to attend, how long the program went for and what type of topics were covered.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
8. As a beginning teacher, did you have an assigned in-school mentor? □ Yes □ No

If YES, briefly describe how you worked with your mentor and include information about the type of assistance they provided to you, how often you met and what benefit you received from this relationship particularly in relation to your maths teaching.

9. In the last 12 months have you participated in any professional development activities or taken courses about mathematics concepts or teaching? □ Yes □ No

If YES, briefly describe these courses/activities.

10. In the last 12 months have you participated in any professional development activities or courses not directly related to your induction as a beginning teacher? □ Yes □ No

If YES, what were these courses/activities?

11. In the last 12 months have you participated in the following activities?

- Observational visits of mathematics teaching at another school □ Yes □ No
- Individual or collaborative research on a topic related to your maths teaching □ Yes □ No
- Regularly scheduled collaboration, relating to teaching maths, with other teachers □ Yes □ No
- Participation in a mathematics related teacher network (eg one organised by an outside agency or over the internet) □ Yes □ No
- Attending workshops, conferences or training about mathematics education □ Yes □ No

12. In the last 12 months:

- How frequently is your maths teaching observed by other teachers in your school? Never □ Once □ 2-3 times □ Often □

- How frequently do you receive feedback on your maths teaching from other teachers in your school? □ □ □ □
SECTION C: SCHOOL CONTEXT

13. Does your school have any of the following:

- dedicated numeracy blocks (where the whole school/stage teaches mathematics at a set time) □ Yes □ No
- streamed maths classes (where students move rooms to go to ability-based classes) □ Yes □ No
- designated maths curriculum contact person □ Yes □ No
- school-wide mathematics curriculum committee □ Yes □ No
- maths scope and sequence chart that shows what has to be taught term by term □ Yes □ No
- prescribed textbook-based maths program □ Yes □ No
- prescribed maths assessment items and diagnostic tests □ Yes □ No

If you answered YES to any of the above, briefly describe how these things are implemented in your school (including information about who is involved, what happens, when do things happen, how often committees meet, when are numeracy blocks etc)

14. To what extent are the following statements about conditions for maths teaching true for your classroom and school?

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all</th>
<th>To a minor extent</th>
<th>To some extent</th>
<th>To a major extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>quality computer software is available for maths teaching and learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>calculators are readily available for student use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quality concrete materials are available for maths teaching</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quality maths resources are able to be purchased easily</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>support is readily available from school system people external to the school</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
15. How often do you have the following types of interactions with other teachers?  

<table>
<thead>
<tr>
<th>Type of Interaction</th>
<th>Rarely</th>
<th>Monthly</th>
<th>Weekly</th>
<th>Almost daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>discussions about how to teach a maths concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>working together on preparing maths teaching materials</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>visits to other teachers' classrooms to observe their maths teaching</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>working together to assess your own and other students' work in maths</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>informal observations of your maths lessons by other teachers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. What types of interactions with other teachers would you like to have and which interactions would be of greatest benefit to your mathematics teaching?

17. How much does each of the following influence **HOW** you teach maths in your classroom?  

<table>
<thead>
<tr>
<th>Influence</th>
<th>Not at all</th>
<th>To a minor extent</th>
<th>To some extent</th>
<th>To a major extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>student interest in mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>student ability level in mathematics</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>class size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>class organisation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>behaviour management issues</td>
<td></td>
<td></td>
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<tr>
<td>time devoted everyday to teach maths</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>access to maths resources</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>textbooks purchased by the school</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>guidelines set by the maths curriculum committee/contact person in your school</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>advice, discussion and sharing ideas with other teachers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>parent and community expectations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
18. How much does each of the following influence WHAT you teach in maths?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>To a minor extent</th>
<th>To some extent</th>
<th>To a major extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>the maths curriculum framework in your state or territory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>state maths tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>textbooks purchased by the school</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>guidelines set by the maths curriculum committee/contact person in your school</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>state education department/employer guidelines</td>
<td></td>
<td></td>
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<tr>
<td>your understanding of what motivates your students</td>
<td></td>
<td></td>
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<tr>
<td>parents and community expectations</td>
<td></td>
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</tr>
</tbody>
</table>

19. Please indicate how strongly you agree or disagree with each of the following statements.

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>my job provides me with professional stimulation and growth</td>
<td></td>
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<tr>
<td>I can get good advice from other teachers in this school when I have a maths teaching problem</td>
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<tr>
<td>most teachers in this school are seeking and learning new ideas about maths teaching</td>
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<td></td>
<td></td>
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<tr>
<td>this school seldom evaluates its maths programs and activities</td>
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</tbody>
</table>

SECTION D: MATHEMATICS TEACHING PRACTICES

20. In teaching maths in your classroom, how often do you explicitly teach:

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>mental methods of calculation</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>knowledge of mathematical facts (eg multiplication tables)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>different methods of problem solving</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>standard written procedures for carrying out calculations</td>
<td></td>
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<td></td>
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</tbody>
</table>
21. In teaching maths in your classroom, how often do your students get to:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>apply known mathematics in unfamiliar contexts</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>improvise mathematical approaches to solving problems</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>explain mathematics to others</td>
<td></td>
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</tr>
<tr>
<td>undertake open-ended mathematical investigations</td>
<td></td>
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</tr>
</tbody>
</table>

22. What is your philosophy about teaching and learning mathematics and how does it inform your classroom practice?

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Appendix E – Interview Guide

Introduction
- Thank you for taking the time
- Introduce self with regards to current student and work status

Reorient to research study
- Research objectives
- You have previously completed 2 surveys for me
- Revisit the information sheet and cover:
  o Informed consent – I have a signed consent form....
  o Data use and storage
  o Pseudonym – ask participants if they want a particular one used
  o Next stage of research
  o Voluntary participation

Begin questions
- School experience of mathematics
  o Participant to respond to copy of Q2 from preservice teacher survey and rate experience on the 3 semantics differential scales
  o Compare responses to preservice survey responses
  o Discuss school experience of maths in relation to their development as a teacher of primary mathematics
  o Discuss results of whole sample in general
- Preservice expectation of teaching maths compared to other curriculum subjects
  o Participant to respond to copy of Q3 from preservice teacher survey and rank 1-6 how enjoyable and easy mathematics is to teach compared to other curriculum subjects
  o Compare responses to preservice survey responses
  o Discuss preservice expectation of teaching maths in relation to their development as a teacher of primary mathematics
  o Discuss results of whole sample in general
- The first year experience
  o Participant to clarify, explain, describe etc responses to 1st year professional development
  o Participant to clarify, explain, describe etc responses to 1st year school context
  o Participant to classify 1st year experience as negative or positive and then clarify, explain, describe etc responses
- **Teaching mathematics**
  - Participant to clarify, explain describe etc **preservice responses vs 1st year responses** to classroom practice – textbooks, curriculum, pedagogy, resources, planning
  - Participant to clarify, explain describe etc **preservice responses vs 1st year responses** to teaching mathematical aspects
  - Participant to clarify, explain describe etc **preservice responses vs 1st year responses** to philosophy of teaching and learning mathematics

- **The current state of play**
  - Participant to clarify, explain describe etc **where are you now?**
  - Participant to clarify, explain describe etc **where would you like to be? Or where are going in relation to your maths teaching?**
  - Participant to clarify, explain describe etc **what do you think ACT DET and schools should be doing to support beginning teacher development as teachers of maths?**

**Conclude interview**

- Thanks again for your participation
- Next stage of the study timeline
- Is it OK for me to contact you closer to the time to check availability etc?
- Leave business card for contact purposes
END OF PAGE

What is the number on your answer sheet?

Write the number (the digits)

How many squares does it have?

When is the hour hand closest to the minute hand of the clock?

6:30

Writing for a test, write the time on the clock.

1:15

The number on the clock is 12.

What is the number on your answer sheet?