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Multiple Perspectives on the Education of Mathematically Gifted and Talented Students

**A dissertation presented in partial fulfilment of the requirements
for the degree of Doctor of Philosophy in Education
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ABSTRACT

This study examines multiple perspectives on the education of a group of fifteen Year 6 and Year 8 students identified as mathematically gifted and talented. The students' mathematical experiences, both past and present are examined using evidence from school policy documents; student, teacher, and parent interviews; questionnaires; and classroom observations. The purpose of this case study was to seek understandings about awareness of the characteristics of mathematically gifted and talented students, the identification of and educational provisions for mathematically gifted and talented students, parental involvement, and school transfer.

The group of fifteen students consisted of ten Year 6 students who transferred from primary school to a new school for Year 7, and five Year 8 students who moved to secondary schools for Year 9. These students had been identified by their school and teachers as gifted and talented in mathematics.

This predominantly qualitative study is underpinned by an interpretive paradigm and influenced by a sociocultural philosophy of learning and teaching. The literature review presents the dilemmas, similarities, and differences that prevail in the field of gifted education. A more specific focus is given to the education of mathematically gifted students to highlight gaps in the field. This two-year study tracking a group of students provides a cohesive approach to understanding the educational provisions for students identified as mathematically gifted and talented in the New Zealand setting. The multiple case studies included interviews, questionnaires, documents, and observations.

The research findings show that there is not a comprehensive understanding by schools and teachers about the characteristics of mathematically gifted students. Despite the documentation of a range of identification processes in school policies, a multiple method approach is not practised in many schools. Provision of appropriate programmes is variable and determined by factors such as school organization, identification, teacher knowledge and expertise, and resources. Parents play a key role in their children's mathematics education as motivators, resource providers, monitors, mathematics content advisers, and mathematical learning advisers. Schools, teachers, parents, and peers all contribute to the success of a student's transfer from one phase of schooling to another; they support a student's social and emotional well being and influence curriculum continuity in mathematics.

This study provides insights into the various determinants of the development of mathematical talent. For New Zealand schools and teachers, it provides evidence that understanding the characteristics of mathematical giftedness is important and that identification processes must reflect this understanding. Provisions must be well considered and evaluated; the role of parents should be understood and valued; and home-school communications strengthened. Together, all stakeholders share a critical role in the education of mathematically gifted and talented students.

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CHAPTER ONE:

INTRODUCTION

1.1 Introduction

Claims have been made in clichéd form that our gifted students are an invaluable resource. The translation of that claim into practice has been sporadic and at times barely visible. This is in part due to the perception that to identify and provide for gifted students, firstly through policy and then into practice, is perceived as elitist. The concept of varying intellectual abilities creates a conflict with our country's democratic principles of equal opportunities. The emphasis on inclusion that has pervaded our schooling in recent times has been skewed towards those students who have performed poorly in academic areas such as literacy and numeracy rather than those who show promise in these domains. Other factors such as funding, cultural bias, and ideological differences further complicate the issue. The definition, identification, and educational provisions for gifted and talented students are therefore varied and complex.

Despite the challenges, it is timely to question this treatment and to give greater consideration to the situation of gifted and talented students in this country. Instead of examining this issue in general, this study focuses on the mathematically gifted and talented in particular. The main purpose of this study is to examine those factors that contribute to a mathematically gifted and talented student's sustained interest and achievement in mathematics.

A case study approach was used to find out more about the learning experiences of a group of mathematically gifted and talented students. The focus was on their early mathematics learning experiences and mathematics education in previous and current years. These experiences were examined from the perspectives of the students, their teachers and parents. The students were also followed through a transfer from one school to another.

In this chapter, background information is presented to contextualize, justify, and explain the study. This is followed by a personal justification, research aims and objectives, and an outline of the structure of the thesis.

1.2 International Background

There has been a wealth of literature published in gifted education, but a paucity of studies that have focused on the teachers and students who have participated in gifted programming (Matthews & Kitchen, 2007). Much of the research has also been directed towards administration concerns with the key voices of students, teachers, and parents missing (Callahan, 2000).

There have been extensive longitudinal studies conducted in the United States on students described as mathematically promising (see, for example, Lubinski & Benbow, 2006; Stanley, & Benbow, 1986; Swiatek & Benbow, 1991). This research is based on students who have been involved in talent searches (an initiative devised by Stanley in 1971). Much of the international research conducted with mathematically gifted and talented students focuses on provision in specialized programmes (such as Stanley's Study of Mathematically Precocious Youth (SMPY)), rather than on issues associated with identification, policy, and practice. Many descriptive articles are written about policy (see, for example, House, 1999; Sheffield, 2006) and best practice in the general area of provision for gifted education. There are reports on provision for mathematically gifted students, but they are presented usually from teachers' or students' perspectives, only occasionally parents, but rarely are they corroborated through multiple perspectives. Closer to home, Diezmann and Watters (2002a) commented on the paucity of Australasian research on mathematically gifted and talented students. From their literature review, they concluded that there was a "need for a concerted research effort on the education of mathematically gifted students particularly, in relation to commonly held views and practices" (p. 224).

1.3 New Zealand Background

In 2001, a Ministry of Education Working Party on Gifted Education was established to identify strengths and gaps in identification and provision of gifted education in New Zealand schools. There was an acknowledgement of a somewhat limited research base and the need for commissioned research to guide future initiatives in policy, practice, and research. On 8 March 2004, The Honourable Trevor Mallard, Minister of Education, released the first comprehensive research study into gifted education in New Zealand that was aimed at helping schools and teachers to better support their gifted and talented students in the classroom. He stated:

This government is committed to ensuring that we meet the needs of every single student. We want to make sure all our students have the opportunity to reach their full potential. This new research is a practical tool for schools, which I am sure will help them meet the needs of their gifted and talented students.

The research, conducted by researchers at Massey University (Riley, Bevan-Brown, Bicknell, Carroll-Lind, & Kearney, 2004), showed that there was a wealth of international literature outlining what works in gifted education, but in the New Zealand setting, there was limited evidence as to what are effective programmes for 'kiwi kids' in 'kiwi classrooms'. Minimal funding has been targeted at research in this area and there is limited expertise in New Zealand universities to initiate and conduct this research.

At the same time as the release of the report, the Minister announced changes to the National Administration Guidelines so that from Term One 2005, schools were required to identify their gifted and talented learners and to develop and implement teaching and learning strategies to address their needs. This was to reflect what they were currently required to do for students who were not achieving, were at risk of not achieving, or had special needs. Essentially, the change to the National Administration Guidelines formally recognized that the diverse learning needs of all students, including gifted and talented students, in New Zealand schools must be addressed.

This was the first formal recognition for gifted and talented students in New Zealand and follows an international trend where gifted education is emerging as a strong and visible field in education. With a national policy statement in place, this specific legislation should mean that the special needs of gifted and talented students no longer go unrecognized. The historical battle between beliefs pertaining to elitism and egalitarianism can hopefully be put to rest and the focus can shift to identification, provision, and evaluation for gifted and talented students.

Specifically, New Zealand research on mathematically gifted and talented students has been limited to case studies on identification tools, students' perspectives, and types of provisions (see, for example, Allan, 1999; Curran, Holton, Marshall, & Haur, 1991/1992; Niederer, 2001; Rawlins, 2000). There are gaps in the field of the education of mathematically gifted and talented students that will be highlighted in greater depth in the literature review presented in Chapter Two.

1.4 Personal Perspective

The focus of this study is specifically on mathematically gifted and talented students. Since beginning teaching in the mid-1970s, I have been interested in gifted education and specifically in providing challenging programmes for mathematically gifted students. I began my teaching career with the privilege of having in my class a student with an amazing capacity for mathematical thinking. His behaviour frustrated many teachers in the school, but I was fascinated by his logical thinking and interest in mathematics. I was fortunate to be able to teach this lad for three years and have recently renewed acquaintances with Matthew (pseudonym). Matthew provided me with a challenge, a desire to know more about giftedness in mathematics, and a sense of justice, for in the 1970s neither attention nor funding was given to the identification and education of gifted and talented students. This situation aggravated my sense of equity and on the few occasions when I had an opportunity to make my case, I voiced my concerns. At the time I felt like a lone voice and so within my class I endeavoured to convey my passion for mathematics and to 'feed' those few exceptional mathematical minds with whom I had the privilege of teaching. This

study has provided me with further opportunities to gain insights into the lives and experiences of young people with gifts and talents in mathematics.

1.5 Research Aims and Objectives

This study aims to address some of the gaps acknowledged in the literature and to examine the mathematical experiences, past and present, for a group of students identified by their teachers as gifted and talented in mathematics. These experiences are examined from multiple perspectives—those of the students, teachers, parents, and the researcher as observer.

To meet the aims of the study, the following research questions were posed:

1. What are the characteristics of mathematical giftedness recognized by school policies and procedures, students, teachers, and parents?
2. How are mathematically gifted and talented students identified?
3. What provision for the students' education in mathematics has been made within the classroom and school contexts?
4. What are the characteristics of an effective teacher of mathematically gifted and talented students?
5. What roles have parents played in their child's mathematical development?
6. How is a school transfer managed for a mathematically gifted and talented student?

1.6 Structure of the Thesis

The thesis begins with a review of the literature relevant to the field both nationally and internationally (Chapter Two). This is followed in Chapter Three by a

description of the methodology and a justification for the research methods in relation to the questions posed. The following chapter (Chapter Four) describes the research design and is supported by information about the sample, settings, data gathering tools, and analysis. The ethical considerations encountered prior to and during the project are presented to support the claim that the research was conducted with integrity. The results combined with supporting discussions follow in Chapters Six to Nine. The final chapter (Chapter Ten) presents a summary in relation to the research questions, limitations, conclusions, contribution to the field, and suggestions for further research.

CHAPTER TWO:

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of the literature that relates to the aims of the research. The objective is to situate the study in the broader historical and scholarly context and to meet criteria advocated by Cresswell (1994): “to present results of similar studies, to relate the present study to the ongoing dialogue in the literature, and to provide a framework for comparing the results of the study with other studies” (p. 37). It shows how the questions posed for this study relate to this previous research and identifies some of the gaps in the field.

Beginning with the main concepts and theories from the general field of gifted education, consideration is then given to key material in the specific context of the education of mathematically gifted and talented students. First, an outline is provided of the nature of definitions of giftedness and the types of gifts and talents exhibited by students. This is followed by a description of the characteristics of the mathematically gifted and talented and critique of the identification process. In the context of mathematics, relevant theories of learning and teaching are briefly outlined. Provisions for mathematically gifted students are discussed along with an examination of classroom strategies and school-wide options. This chapter includes a discussion on the teacher of the gifted, resources, and the role of parents in their children’s education. It concludes by highlighting the issue of school transfer.

In ‘mining’ the literature, the researcher applied criteria in order to make decisions about what to include and what to exclude. From an extensive data base, developed through various search mechanisms and records in EndNote, decisions were made about the suitability and quality of materials. The criteria used were: topicality and relevance, currency (although significant historical material is included), authority, and context. Another issue taken into consideration was age variables. Ziegler and

Raul (2000) state: “if age-dependent identification criteria are employed, then one needs to seriously question the generalization of the results from one age group to another” (p. 115). Literature was also considered in light of the methodologies and techniques used in the field.

2.2 Definitions and Conceptions of Giftedness

The problems associated with terminology, definition, and conceptions of giftedness have attracted copious discussion at all levels: policy-makers, academics, teachers, parents, and students. In New Zealand the term ‘Children with Special Abilities’ (CWSA) is still in use, albeit not as prevalent; in Britain the nomenclature changed from ‘able’ to ‘gifted and talented’; and in America ‘gifted’, ‘talented’, and ‘gifted and talented’ are used. Since the Ministry of Education implemented relevant policy in New Zealand in 2004, the term ‘gifted and talented’ has become more prevalent. In this dissertation, the terms ‘gifted’ and ‘talented’ are often used co-jointly to reflect current practice in New Zealand (Ministry of Education, 2000, 2002; Riley et al., 2004). At other times they are used synonymously, reflecting the use of terminology in reported studies. However, it is not the terminology or label that is of concern, but how it is defined and what is meant by giftedness.

Sternberg (2004) stated that “just as people have bad habits, so can academic fields have bad habits. A bad habit of much of the gifted field is to do research on giftedness or worse, identify children as gifted or not gifted without having a clear conception of what it means to be gifted” (p. xxiii). The two main types of definitions of giftedness, according to Moon (2006), are conceptual and operational. Conceptual definitions are based on theories of giftedness and consider giftedness in the abstract whereas operational definitions “provide specific guidance on how a conception of giftedness will be assessed and identified in a particular context, for a specific purpose” (p. 24).

If we start from the 1920s, we can trace the initial term ‘gifted’ from Terman’s (1925) study where giftedness was measured by intelligence and the recognition that early promise of intellectually gifted students in the elementary school was likely to

culminate in relatively outstanding achievement in adulthood. Hollingworth (1926), at a similar time, added the view that the gifted child, who is more educable than the general child, may be gifted in the arts, mechanics, or literacy. She encouraged consideration for all forms of giftedness. In the 1940s the limitations of intelligence testing for giftedness was explored. For example, Parkyn (1948) reflected these early views that giftedness was based on intelligence, but noted the importance of social, emotional, and moral domains. These areas later became a focus for Parkyn (1984), stimulating the consideration of a broader concept in the New Zealand setting. Renzulli (1978) explained that definitions were to become more liberal or inclusive. For example, Renzulli proposed a definition that included three components—above average ability, task commitment, and creativity.

Giftedness consists of an interaction among three basic clusters of human traits—these clusters being above-average general abilities, high levels of task commitment, and high levels of creativity. Gifted and talented children are those possessing or capable of developing this composite set of traits and applying them to potentially valuable area of human performance. Children who manifest or are capable of developing an interaction among the three clusters require a wide variety of educational opportunities and services that are not ordinarily provided through regular instructional programs.

(Renzulli, 1978, p. 261)

Renzulli (1978) believed that this definition was defensible and would prove to be useful to practitioners. He used the term ‘gifted and talented’ and referred to general abilities. This definition raised questions about the gifted and talented students who had demonstrated outstanding ability in a specific domain whilst others did not appear to be highly motivated in developing potential—the gifted underachiever. The presence of creativity added a further notion worthy of contention; some might argue that creativity is not necessarily a factor in all domains of giftedness. Renzulli modified the interpretation over time. In redefining the concept in 1986, Renzulli acknowledged that each cluster played an important role in contributing to the display of gifted behaviour. He also used the term “gifted behaviour” rather than giftedness and added “and/or specific abilities” (p. 73).

Another widely recognized definition of giftedness and talent was that of Gagné (1985) in which he differentiated between giftedness and talent. He identified four major domains of giftedness—intellectual, creative, socio-emotional, and sensori-

motor. Gagné also left the door open for the identification or differentiation of other domains of ability. In the centre of his model he placed variables that act as catalysts for the development of specific fields of talent. These catalysts were defined as intrapersonal or environmental. He acknowledged the multidirectionality between giftedness on one side and talents on the other. Gagné and Renzulli offered contradictory positions on the importance of creativity. For Renzulli, creativity was an essential component of giftedness whereas in Gagné's model it was one general ability domain.

In 1983, Gardner proposed a theory of Multiple Intelligences. This was a theory that called for a conception of human abilities that included multiple areas of intelligence (logical-mathematical was one of these). The original seven were later updated to eight and possibly nine (1993, 1999) with the addition of 'naturalistic' and the unconfirmed 'existentialist' intelligence. More recent developments in concept development have reflected an awareness of cultural and multicultural values (for example in the New Zealand setting, see Bevan-Brown, 1993, 1996, 2003).

Definitions can also be viewed as conservative or liberal (McAlpine, 2004a), the former based on one criterion such as intelligence and the latter on broad ranging criterion and a more inclusive approach. Definitions may rely on demonstrated performance or potential. In the context of this study, it is not useful to negate or dispute the contrasting definitions of Renzulli, Gagné, and Gardner, but the value is in acknowledging and appreciating their contributions to the field. It is their definitions and models that stimulate discussion about, who is gifted? Who is talented? How are giftedness and talent manifested?

New Zealand has shifted to a multicategory concept of giftedness (Ministry of Education, 2000) and not provided a national definition. In this study, it was important to acknowledge some of the literature and contrasting views about definitions and concepts and to thereby place this study in context. The focus of this study is on the specific academic domain of mathematics which resides within the multicategorical concept of giftedness. The operational definition underpinning this study has drawn on the concepts of Renzulli, Gagné, and Gardner, that is, gifted and talented students in mathematics are those who have above-average ability and

‘display’ specific interests, aptitudes (including problem solving ability and logical reasoning), and achievements in this area. This operational definition is supported in the next section by a description of important characteristics commonly associated with mathematical giftedness.

2.3 Mathematically Gifted

There is no commonly accepted single definition of mathematical giftedness. The literature suggests that mathematically gifted students could be thought of as those who have special mathematical abilities or those who engage in qualitatively different mathematical thinking. Most studies on students who are gifted in mathematics have drawn on the work of a Russian psychologist, Krutetski, who originally published his findings in 1968. His comprehensive investigation of mathematical ability during a twelve-year period was designed to explore the nature and structure of mathematical abilities. He defined ability as a personal trait that enables one to perform a given task rapidly and well, and contrasted this to a habit or skill, which relates to the qualities or features of the activity a person is carrying out. According to Krutetski (1976), “mathematical giftedness” is the name given to “a unique aggregate of mathematical abilities that opens up the possibility of successful performance in mathematical activity” (p. 77).

Krutetski (1976) investigated the development of these mathematical abilities by comparing the problem solving abilities of different students at different ages; some students were studied for several years. The students were presented with a range of arithmetic, geometric, algebraic, and logical problems of grade difficulty that would allow for mathematical creativity, would be somewhat familiar, and would also allow the investigator to gain insight into the processes being used in solutions. Krutetski’s work has stood the test of time for a number of reasons. Firstly, the principal research is on the structure and formation of mathematical abilities and instead of extracting information primarily from tests and using factor analysis, Kruteski designed a variety of rich mathematical tasks for students to perform. Students were required to think aloud as they solved the problems. Secondly, instead of students being pre-selected as gifted in mathematics, Krutetski investigated the development of abilities by comparing different ages and different abilities. Finally, some groups of students

were studied for several years so that longitudinal comparisons could be made. The extended studies included special lessons, classroom observations, and home visits.

Some of Krutetski's reports were received with scepticism because of the lack of empirical testing. However, his notions of differences in mathematical thinking and his rich tasks (like Piaget's), which could be adapted and used by teachers and researchers, have broadened conceptions of mathematical giftedness. It is unlikely that there will ever be a fixed definition of mathematical giftedness, but Krutetski tried to address the questions of the specificity and the structure of mathematical abilities, and typological differences. Students gifted and talented in mathematics tend to view the world through a mathematical lens. Krutetski used the term a "mathematical cast of mind" (p. 302) to describe this characteristic. He identified three key types of mathematical cast of mind—analytic, geometric, and harmonic.

The analytic type tends to think in verbal-logical terms. This is the student who operates confidently in the abstract and does not rely on visual supports for visualizing objects or patterns in problem solving. In contrast, geometric thinkers strive to solve a problem using visual supports; they feel a need to interpret abstract mathematical relationships visually. These students tend to relate problem solving to the analysis of diagrams, drawings, and graphs. They display a very high development of spatial concepts. The harmonic type displays the characteristics of both the analytic and geometric types. These students are successful at using both approaches to solving problems.

Gardner (1983) also sought to identify the characteristics of those with mathematical gifts by examining Piaget's (1969) development of logical mathematical thought and the thinking of eminent mathematicians. Students may engage in other curriculum activities using mathematical skills and predictive logic as described by Gardner's Multiple Intelligences. These students choose to represent information in a mathematical or quantitative way. Some of these characteristics resemble those identified by Krutestki. Gardner described abilities such as using mathematical notation, sustaining long chains of reasoning, abstracting general features from mathematical material, and using mathematical reasoning. There were also features of Gardner's 'Spatial Intelligence' that reflected capacities described in Krutetski's

‘geometric mind’. Tests of spatial ability included items such as choosing shapes that represented a target shape after rotations and visualizing three-dimensional shapes (made from cubes) from different perspectives. Problems that used spatial capacities were also expressed verbally such as: “Take a square piece of paper, fold it in one half, then fold it twice again in half. How many squares exist after this final fold?” (Gardner, 1983, p. 171).

Published lists of indicators of mathematical giftedness support those characteristics provided by the research cited above. The basis of the development of these lists is not always clear, but further to Krutetski’s work a useful contribution is made from the writings of Johnson (1983) and House (1987). Their lists of characteristics reflect similarities. The usefulness of such lists is as a tool for teachers and parents to help with identification and subsequent provisions. House (1987, p. 9) suggested the following characteristics, some of which, but not necessarily all, are indicators of mathematical giftedness:

- “Early curiosity and understanding about the quantitative aspects of things
- Ability to think logically and symbolically about qualitative and spatial relationships
- Ability to perceive and generalize about mathematical patterns, structures, relations, and operations
- Ability to reason analytically, deductively, and inductively
- Ability to abbreviate mathematical reasoning and to find rational, economical solutions
- Flexibility and reversibility of mental processes in mathematical activity
- Ability to remember mathematical symbols, relationships, proofs, methods of solution, etc.
- Ability to transfer learning to novel situations
- Energy and persistence in solving mathematics problems
- Mathematical perception of the world”.

Children may display some of those characteristics from an early age and be “highly focused and obsessive” (Diezmann & Watters, 2000a, p. 9) in a particular domain such as mathematics. When the focus is on very young children, Straker (1983) suggested that one should look for the following behavioural indicators:

...a liking for numbers including use of them in stories and rhymes; an ability to argue, question and reason using logical connectives: if, then, so, because, either, or...; pattern-making revealing balance or symmetry; precision in positioning toys, e.g. cars set out in ordered rows, dolls arranged in order of size; use of sophisticated criteria for sorting and classification; pleasure in jigsaws and other constructional toys. (p. 17)

Ablard and Tissot (1998) found that academically gifted students were quite different from one another in their advanced reasoning abilities. They reported, on a study using above-level testing with 150 academically talented students, that performance levels were up to four grade levels higher than the norm. Their results showed differences among various mathematical concepts and that proficiency in particular concepts may help to identify those mathematically gifted students who are ready for more challenging and abstract concepts such as the study of algebra. This difference among mathematically gifted students was also found in a review conducted by Sowell, Bergwall, Ziegler, and Cartwright (1990) of empirical research of the 1970s and 1980s on identification and descriptions of mathematically gifted students. These authors showed that there were at least two types of mathematically gifted students: those precocious students able to complete mathematics in advance of their years, and those able to solve demanding problems using qualitatively different methods. This research suggested that gifted students may be overlooked if there is reliance on test results rather than on a characteristic such as problem solving ability. This is an area that should be further explored with “future research focus on the identification of these students and on the contributions of home environments and spatial abilities” (p. 147), aspects explored in this study.

Mingus and Grassl (1999) used a naturalistic inquiry approach to validate a description of mathematically gifted students based on House’s (1987) characteristics. Their description, also included natural mathematical ability as represented by Krutetski’s characteristics, as well as non-mathematical ones such as a willingness to work hard (focused, committed, energetic, persistent, confident, able to withstand stress, and distraction) and creativity (as acknowledged by Renzulli). These authors explored who influenced mathematically gifted students and how to create a nurturing environment that would encourage their growth. The study involved multiple perspectives, but was limited to interviews with four students, one teacher, and one parent. The interview data was supplemented with questionnaire

data. The findings raised some of the issues addressed in this study: the challenge of regular class work; parental guidance and support; teacher concerns; and the teacher's knowledge of mathematics. This thesis is based on a larger sample size and has the added dimension of classroom observation.

Benbow and Minor (1990) compared verbally and mathematically gifted and talented students (n=144) on a variety of tests. They found that the verbally precocious students scored higher on verbal and general knowledge type of tests, and the mathematically precocious students scored higher on tests of nonverbal reasoning, spatial ability, and memory. This is probably not surprising although it is interesting that enhanced memory and speed appear to be associated more strongly with mathematical rather than with verbal talent. The presence of high verbal ability also appeared to increase the likelihood of high mathematical ability. The study is based on a relatively small sample, but contributed to the constructs of different types of giftedness and the view that giftedness is comprised of multiple talents rather than one general ability. Giftedness is therefore not a unitary construct and mathematical talent relates to a "different mix of cognitive abilities, personality traits, and environmental circumstances than verbal talent" (p. 24).

The mathematically able, argued Damarin (2000), constitute a "marked category" or "category of deviance" within the context of popular culture (p. 70). This notion of deviance is in relation to some larger functional group. In the media and societal contexts, success in mathematics is at times portrayed as a marking of deviance; failure in mathematics is not viewed as an occasion for embarrassment. This acceptance is contrary to the notion of economic empowerment and the contribution of mathematicians and scientists to an advanced technological society. Damarin also suggested that mathematically gifted women are "doubly marked" (p. 69) as society encourages and gives less recognition to women in the field. There are studies that report support for mathematically gifted and talented women (see, for example, Reis & Graham, 2005), but there is not a comprehensive picture of what "contributes to decisions of some women to develop their mathematical abilities in spite of the marking entailed" (Damarin, 2000, p. 76).

An approach that regarded mathematical giftedness as “involving special ways of looking at and attempting to solve mathematical problems” was proposed by Wiczerkowski, Cropley, and Prado (2000, p. 415). Similarly, Winner¹ (1996) asserted that gifted children insist on “marching to their own drummer” (p. 3). These children, she claimed, independently invented rules of the domain such as mathematics and devised novel, idiosyncratic ways of solving problems. This reflects a more qualitative conceptual view of mathematical giftedness. Cropley (1994) argued that a combination of quantitative² and qualitative approaches defined true mathematical giftedness. Varying conceptions of mathematical giftedness underpin the studies reported here. However, definition determines the identification of mathematically gifted and talented students; there must be a direct link between definition and identification (Callahan, Hunsaker, Adams, Moore, & Bland, 1995).

2.4 Identification

How giftedness is defined or conceptualized provides the theoretical rationale underlying identification (Renzulli, 2004). This rationale guides the selection criteria for identification instruments and the ways in which they are used for identification. Reis (2004) suggested that the first question to be asked in the process of identification is “identification for what?” (p. xii). In this study, the focus is on the process for identification of giftedness and talent in mathematics for particular classes and programmes. Mathematically gifted students can be identified through a variety of methods. These include observation, conversation, classroom activities (particularly mathematical problem solving), tests, portfolio assessment, parent nomination, peer nomination, and self-nomination. Ideally the combination of methods is the best strategy as long as the data collected is directly related to the concept of giftedness and talent, and the information is inter-related (Davis & Rimm, 1998). “Fair identification systems use a variety of multiple assessment measures that respect diversity, accommodate students who develop at different rates, and identify potential as well as demonstrated talent” (Reis, 2004, p. xii). The

¹ Winner provided a reliable synthesis and evaluation of the best scientific research in a variety of domains including mathematics.

² The quantitative approach suggests mastering mathematical knowledge and skills at an early age.

identification procedures, according to Moon (2006) should reflect four key elements: a comprehensive approach, student characteristics, objective and subjective tools, and defensible and inclusive criteria. Identification should also happen early (Clark, 2002; McAlpine, 2004b), prior to primary school (Clarke, 2001), and be an on-going process (Davis & Rimm, 1998; McAlpine, 2004b).

Identification of mathematically gifted and talented students is not necessarily an easy task. These students may or may not display those characteristics outlined in the previous section. They may or may not show interest in things mathematical, get excited during a mathematics lesson, or score well on mathematics tests. Teachers who have a limited background in mathematics or little experience in identifying gifted students often mistake hard work for promise. Students who complete many written tasks efficiently and quickly are not necessarily those who are gifted and talented in mathematics. Mathematically gifted and talented students may be identified through their high levels of reasoning (Sheffield, 1999), but if teachers focus on teaching rules and formulae, they may not give opportunities for mathematically gifted children to demonstrate the thinking processes that set them apart from the hard workers (Hoeflinger, 1998). As high achievers, they are usually identified by their abilities to attain high test results. Other mathematically gifted students with unique ways of thinking about and doing mathematics may be overlooked unless, as more recent research shows, identification includes aspects of problem solving, creativity, and spatial development (Diezmann & Watters, 1997; Niederer, 2001; Watters & English, 1995). Spatial ability has recently been given more attention; it has now been recognized as a neglected dimension, for example, in the American Talent Searches for Intellectually Precocious Youth (Webb, Lubinski, & Benbow, 2007). These researchers believe, based on an extensive study, that a focus on spatial ability could uncover a neglected pool of mathematical-science talent.

Another issue deserving attention is that of the identification of at-risk populations such as the economically disadvantaged, culturally diverse, and twice-exceptional students. These are the students who are under-represented in gifted programmes (Reis, 2004). There has been a failure to respond to society's diversities especially students from ethnic minorities (see, for example, Bevan-Brown, 1993; Borland &

Wright, 1994, 2000; Keen, 2001; McKenna, Hollingsworth, & Barnes, 2005). Borland and Wright (1994) showed that an identification process based on methods such as observation, dynamic assessment, and examples of best performance could be used successfully to identify economically disadvantaged students for gifted programmes. This was further validated in later studies in which economically disadvantaged minority students were identified early in their schooling and appropriate provision made for their education in gifted programmes (Borland, Schnur, & Wright, 2000).

Twice-exceptional students³ are those considered to be both gifted and to have disabilities (Baum, 2004). These students may suffer from syndromes such as “dyslexia (reading disability), dysgraphia (writing disability), Asperger’s Syndrome (severe impairment of social interaction), or combinations of symptoms that do not clearly fit a specific diagnostic category” (Silverman, 2003, p. 533). According to Silverman, these students have gone unrecognized due to the long-held perception that giftedness equates with academic achievement. These students face barriers to identification and provision (Baum, 2004) and such students are likely to be labelled underachievers (Silverman, 2003). Neihart (2000) proposed characteristics that differentiate ordinary gifted children from gifted children with Asperger’s Syndrome such as the inability of these children to cope with change and difficulty in understanding the perspectives of others. Where gifted students understand that others do not share their knowledge of particular topics, the child with Asperger’s Syndrome assumes others understand their references. Limited studies have been reported on gifted individuals with Asperger’s Syndrome; despite interest and considerable research on this disability, giftedness is rarely mentioned.

Traditionally, in mathematics there has been a recognized gender gap, but by the end of the century the situation had improved. Underlying the problem of achievement of gifted females were certain cultural and environmental factors (Reis, 1987). Despite improvements in mathematics achievement test scores, a gender gap continued within the gifted (Gallagher, 1996). Gallagher wrote that the gender gap had been

³ One student in this study could be categorized as twice-exceptional: gifted and Asperger’s Syndrome.

reconceptualized as gender differences in solving complex mathematics problems, the identification of external forces, and how these might be contributing to the problem. Exploring gender differences is beyond the scope of this study, but women have been recognized as under-represented in higher levels of mathematics (Gavin, 1996) and “many gifted females continue to reject mathematics and directly related fields, such as computer science and engineering as courses of study” (Gavin & Reis, 2003, p. 34).

The identification of students gifted and talented in mathematics is the mediating link between concept and characteristics, and provision. It should be seen as “a means to an end and not an end in itself” (Ministry of Education, 2000, p. 27). Gubbins (2006) identified four attributes that define high-quality identification procedures: a comprehensive approach, uses objective and subjective tools, has defensible and inclusive criteria, and includes student characteristics. Some of the characteristics of mathematical giftedness, previously described, are not as easily measurable as others and so more than one method of identification should be considered. The methods most relevant to the identification of mathematically gifted students will be given further attention. These are: observations, tests, and problem solving.

2.4.1 Observations

Teacher observation can be an effective means of identifying gifted and talented students if the teacher is aware of what to look for such as the student’s problem solving strategies, communication of mathematical ideas, attitude and interest towards mathematics, and application of mathematical understandings. Teachers should take notice of those ‘significant moments’, that is, when the student displays some of those characteristics identified by Krutetski (1976). Krutetski argued that the way to identify mathematically gifted students was by observing them as they worked on problems designed to elicit the abilities that he identified. However, no one has found a way to organize his work so that it can be used as an identification tool in schools (Wertheimer, 1999). Indicators of the mathematically gifted may be observed across the curriculum. It may be the way in which the student organizes data and tables in a science experiment, the logic and reasoning articulated in a

debate, the processing and interpretation of information through a mathematical lens, or the student's view of what constitutes a problem (Hoeflinger, 1998).

In the New Zealand setting, teacher observation and nomination has been strongly favoured (Keen, 2001; McAlpine, 2004b; Riley, 2003; Riley et al., 2004). However, teacher nomination is not the most reliable of identification tools. According to Kissane (1986) teachers overlooked many students in the identification process. It is important to use a variety of identification strategies to minimize the place of teacher opinion. Due caution is also needed to guard against teacher bias and stereotyping (Davis & Rimm, 1998). Practical considerations may also prohibit the effectiveness of this method in identifying the mathematically gifted. These include aspects such as time, teacher expertise, teacher professional development, and school policy. The literature on teacher identification was relevant to the general academic area; hence it raises questions about the effectiveness of this method and associated issues in the specific context of mathematics. So what other methods are commonly used in mathematics? National research on gifted education (Riley et al., 2004) found that in the intellectual and/or academic domain the use of teacher observation (94.1%) was the most commonly used identification method closely followed by tests (89.7%).

2.4.2 Tests

New Zealand teachers commonly use the results from the Progressive Achievement Test (PAT) to identify students as gifted and talented in mathematics. The high achieving students are usually identified as those that scored above the 95th percentile (Reid, 1993). The 'Progressive Achievement Test in Mathematics' is a standardized national test published by the New Zealand Council for Educational Research (Reid, 1993; revised by Darr, Neill, & Stephanou, 2006). These tests assess a student's recall, computational skills, aspects of understanding, and application. The student's raw score is based on the number of correct items answered in a limited timeframe. This result may then be converted into class and age percentile rankings. The particular value of this piece of information is that it gives a reasonably accurate indication of the student's performance in mathematics relative to his or her peers nationwide. However, the items are multiple-choice where students may have guessed the answer, may not have understood the question, and possibly used

inappropriate means to find a solution. The more able students may also experience a ceiling effect where a student may be capable of high test results on a test designed for class levels one or more years ahead. The re-designed PAT: Mathematics (Darr, et al., 2006) is more useful than its predecessor. Although students' results can still be reported normatively, they can also be reported formatively. It is suggested that the specific PAT is selected so that the level of difficulty is appropriate for the student. There should not be a ceiling effect in which a student achieves perfect or near perfect scores. It is important that a teacher knows what type of tests are appropriate and useful for providing information for an individual student profile (Assouline, 2003).

Some schools in New Zealand use their own tests based on material from Assessment Tools for Teaching and Learning (asTTle), or tests from the Australian Council for Educational Research. Instead of a written test, Years 1 to 8 students in New Zealand are being assessed on number knowledge and strategies using a diagnostic interview, the Numeracy Project Assessment (NumPA) (Ministry of Education, 2005). Concerns have been raised about the use of this tool with gifted students, but to date, there is no published research focused on this issue. The important factor when using tests and diagnostic interviews is that, if they are being used to identify mathematical giftedness, they must have the potential to differentiate between those students who are excellent at their grade level from those whose abilities are far beyond the current grade level. Otherwise, when students reach this ceiling, there is no recognition of how much more that student knows.

A New Zealand study showed that, independent of any chosen percentile, the PAT was 78% accurate in identifying mathematically gifted and talented students and included errors of commission and omission (Niederer, Irwin, Irwin, & Reilly, 2003). The researchers believed that such a degree of accuracy would lead to many mathematically gifted students being overlooked or being mistakenly identified as gifted. Niederer and Irwin (2001), in another report, concluded that the use of problem solving tasks was a more reliable indicator of giftedness than the standardized test.

Krutetski (1976) condemned the use of tests if only scores are focused on without studying the process. Teachers cannot obtain much about mathematical thinking by

analyzing test results alone. Multiple-choice tests such as the PAT are limited in that the results tend to only be considered summatively. Students may give the same solution to a mathematical problem, but the solution could be obtained in different ways. There is no opportunity for students to answer except by the selection of a predetermined response choice. According to Krutetski (1976), an emphasis on examining the result instead of the process gives students a false conception of mathematics. Ideally, a test of mathematical reasoning should be a power test, in the sense that a student's score would not differ substantially if more time to respond to test items was allowed. A test that focuses more on reasoning than on content knowledge can also help identify a younger child who has not yet been exposed to curriculum content at higher levels, but can easily master it conceptually (Matthews & Foster, 2005).

The most recognized test for identifying mathematically gifted students in the United States is the Scholastic Aptitude Test⁴ (SAT), a test of developed verbal and mathematical reasoning ability. The strength of the test according to Stanley and Benbow (1986) was in its “simplicity and elegance” (p. 361). The proclaimed advantages were that it was unlikely to have a ceiling effect because of the target group (older students); it was focused on mathematical reasoning; and had established validity for predicting the likely ability of young students benefiting from acceleration. However, a study conducted in 1986 in Australia, found that younger and older students responded to SAT items in qualitatively different ways (Kissane, 1986). At Stanford University, a Mathematical Aptitude Test (SEMAT) was developed because it was felt that no satisfactory test was available that had been normed for the gifted population (Paek, Holland, & Suppes, 1999). The goal was to address this issue of gifted students banding in top percentiles of tests normed for general populations. These tests were designed to assess mathematics ability with non-curriculum specific items that were challenging, but age specific. “These items do not require deep mathematical knowledge to solve. Instead, they require the ability to apply insightfully basic mathematics-related skills” (Paek et al., 1999, p. 339).

⁴ Formerly Scholastic Aptitude Test and Scholastic Assessment Test—a standardized test for college (university) admissions in the United States.

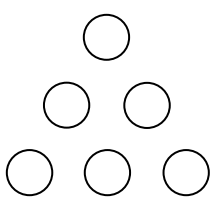
Efforts have been made in the United States to use a variety of above-level tests such as the SAT Reasoning Test to identify mathematically gifted students (Rotigel & Lupkowski-Shoplik, 1999). The above-level test contained more difficult items and allowed students to demonstrate their mastery of more advanced concepts. The above-level tests spread out the scores of the able students so differentiation could be made between the talented and exceptionally talented students. Although the use of above-level testing is advocated, comprehensive research from Lupkowski-Shoplik, Sayler, and Assouline (1994) using T-tests on tests taken by third and fourth grade students in mathematics programmes for gifted students found that they performed better on conceptual tasks than computational tasks. Explanations for this included:

- an underlying cognitive construct;
- talented students may be bored with repetitive computation tasks which may lead to speed;
- the differential effect of classroom instruction on opportunities to learn concepts and computational skills; and
- conceptual material is easier for students to understand intuitively—it requires less direct instruction than computational material.

These findings were also supported in Rotigel’s (2000) doctoral study (cited in Assouline & Lupkowski-Shoplik, 2003). This means that mathematically gifted and talented students may perform relatively poorly on computational tasks; therefore tests with problem solving tasks would be a more useful identification tool.

2.4.3 Using Problem Solving as a Means of Identification

A problem can be defined as a mathematical question that you are not immediately sure how to solve (Pólya, 1957). For example, the following question (Figure 2.1) about the six circles is almost certainly a problem (Holton & Lovitt, 1998, p. 48).



Six circles are placed symmetrically along the sides of an equilateral triangle as shown. Place each of the numbers 1 to 6 in a different circle. Is it possible to do this so that the sets of three numbers from each side of the triangle have the same sum? If so, in how many ways can it be done?

Figure 2.1. The six circles problem.

After a certain amount of thinking, experimenting, and perhaps guesswork you will find that the answer is “yes”, and that there are just four ways to do this. A mathematician would want to then prove that this was the case and this would require the application of more processes. The problem can thus be generalized and extended.

Problem solving is the means of using mathematical tools and ideas to solve problems. Valuable insight into a student’s mathematical understanding and ability can be gained from problem solving and problem posing. The teacher should select problems that can be solved using a variety of strategies. The student’s response to a problem may be quite creative and the chosen strategy quite sophisticated. The tenacity and determination to solve the problem may be surprising and the conversation that accompanies the explanation may indicate mathematical promise. The student should be encouraged to show the teacher how they organized the relevant information, to explain their conjecture, and provide justification for their solution. “With younger students, teacher observation of the process, and the surrounding discussion is the most accurate and reliable tool for distinguishing truly gifted students” (Hoeflinger, 1998, p. 245). Many of the characteristic behaviours previously outlined are evident when the student is engaged in problem solving (Niederer & Irwin, 2001). A teaching experiment, based on several years work in one Montreal bilingual school (n=238), focused on an enriched programme in mathematics for young children (Freiman, 2006). Analyzing students’ responses to mathematical problem solving tasks and their different approaches to numbers and patterns led to recognition of differences and the identification of mathematical talent. This approach is supported in examples reported by Callahan (2001), Diezmann and English (2001), Greenes (1997), Hoeflinger (1998), Kennard (2001), Krutetski (1976), and Sheffield (1999).

Consider the story of Gauss (Boyer, 1991), one of the greatest mathematicians and how he very quickly solved the computation for the sum of consecutive numbers to 100. Whilst the rest of the children in the class methodically added (incorrectly) $1+2+3+4+5\dots$, Gauss immediately recognized the efficient way of finding the sum by regrouping and recognizing the sum as the product of 101×50 . Using a routine task such as finding sums of two digit numbers is “one dimensional” (Sheffield,

1999, p. 47) and would not give opportunities for teachers to identify students, like Gauss, who displayed a ‘mathematical cast of mind’ at a young age. The value of open-ended and challenging tasks for purposes other than identification will be explored later in the chapter.

There could be opportunities, if teachers have adopted Renzulli’s Enrichment Triad Model (Renzulli, 1977, 1994), to use Type I, II, and III activities as part of the identification process. These activities can include problem solving and mathematical applications. An underlying principle is that identification can be embedded within the responsive classroom environment, be unobtrusive, and naturally set in the everyday learning and teaching environment (McAlpine, 2004b; Ministry of Education, 2000). An open-ended model of identification is advocated that uses a variety of methods of identification (Ministry of Education, 2000).

2.4.4 Other Methods of Identification

Parent nomination can be an effective form of identification. Parents may recognize mathematical talent at a young age and advocate for their children to be challenged mathematically (Lupkowski-Shoplik & Assouline, 1994). In New Zealand, a study by Allan (1999) found that parents were reliable in identifying specific gifted behaviours in young children. Niederer et al. (2003) reported (also from a New Zealand study) that parents were more likely than teachers to nominate their children as having special abilities in mathematics. Freeman (1998) found that most of the children presented by parents as gifted to the National Association for Gifted Children (UK) were indeed gifted and this was in discord with teachers’ views. Rogers (2002) proposed a questionnaire (Parent Inventory for Finding Potential) to help parents identify their child as gifted or talented, and to assess their child’s strengths (her work is based on Gagné’s (1985) views). Rogers followed this inventory with interest and attitude inventories in specific learning domains such as reading and mathematics⁵. The aim was to provide a measure of motivation in the subject area (this supports Renzulli’s (1986) concept of giftedness). It is believed that children’s interests and leisure activities can provide clues and serve as a reliable

⁵ Used as a tool in this study

predictor of future high achievement in that area (Freeman, 2000). The information can be also be used by teachers and parents to support educational planning.

Other possible methods include self nomination, peer nomination, teacher recommendation, checklists, rating scales, and portfolios. There are alternative views about identification and whether such procedures are really necessary.

2.4.5 Is Any Identification Procedure Necessary?

Birch (1984) posited that if students were accommodated through individualized adaptive education there would be no need for a separate identification scheme. This would mean that the content, pace, and teaching style would have to be matched to each student's interests, abilities, and potential. The identification would be "curriculum-imbedded" (p. 157) and regular assessment would guide and optimize learning opportunities. Similarly, Freeman (1998) suggested that the best way to identify the very able was by provision. This implied offering a consistent challenging education, but required teachers to have specific training in differentiation and identification. This view was also strongly supported by Gardiner (2008) who viewed early diagnosis as a "medical model" imported into classrooms to subject children to "spurious identification rituals" (p. 1). This viewpoint, whilst worthy of consideration, is not held in the mainstream.

Teachers require specialized knowledge and competence in providing challenging and differentiated programmes (see, for example, Croft, 2003; Hansen & Feldhusen, 1994; Leppien & Westberg, 2006). There is no evidence in countries such as Australia, England, the United States, or New Zealand to move away from the development of identification policies and practices. Some New Zealand schools, in response to NAG changes, have focused on developing identification procedures (Education Review Office, 2008). The most recent research in New Zealand (Education Review Office, 2008; Riley et al., 2004) reported on identification of general intellectual abilities, but not on a specific learning domain such as mathematics. This study seeks to address this gap on identification practices in mathematics.

Once schools have established conceptions and definitions of giftedness, and policies and practices for identification, then options for providing for gifted and talented students should be considered. However, before a synthesis and critique of the different types of provisions is presented, influential philosophies about the teaching and learning of mathematics are briefly considered. These philosophies have influenced the reality of classroom experiences for the mathematically gifted and talented students in the study and the researcher's view of what constitutes mathematics teaching and learning.

2.5 Teaching and Learning Mathematics

What does it mean to do and think mathematically? Views in response to this question vary, but more recently there has been an acceptance of mathematics as dynamic and exploratory (Romberg, 1994). This is in contrast to a traditional view of mathematics as a system of facts, procedures, and concepts. The National Research Council (2001) in the United States suggested that proficient students are those who have not only conceptual understanding, procedural fluency, and strategic competence, but adaptive reasoning and a productive disposition. These notions built on Schoenfeld's (1994) earlier claims that student learning in mathematics were about the process of acquiring a "mathematical disposition" or "mathematical point of view" (p. 60). Mathematics is also a result of a cultural process and therefore the learning of mathematics is influenced by cultural developments. Consider, for example, the influence of graphic calculators, computers, and technology in general. There is growing use of such tools and technologies in mathematics classrooms; this in turn has led to an increasing body of research in the field (see, for example, Martin & Pirie, 2003; Penglase & Arnold, 1996;). Through the use of technology, students can be aided in generating powerful mathematical ideas in number, problem solving, and in mathematical connections (Jones, Langrall, Thornton, & Nisbet, 2002).

To examine the gifted student's capacity for thinking, learning, and reasoning mathematically is beyond the scope of this thesis; instead questions related to the characteristics of mathematically gifted students have been addressed. It is necessary, however, to examine the conditions under which the individual processes of mathematics learning takes place; mathematics learning is embedded in a social

context. Underpinning this study is a sociocultural perspective of mathematics learning and teaching as theorized by Vygotsky (1986). Mathematics learning is essentially a process of active individual construction and a process of enculturation (Cobb, 1994). It is a cultural product, but it takes place within a social group; the discourses and learning conditions within the group are central elements of the learning process. “Analyses of learning developed within this theoretical tradition therefore account for learning by focusing on the process by which people become increasingly substantial participants in various cultural practices” (Cobb, 2006, p. 151). In this thesis, the learning and teaching contexts are not examined specifically from a sociocultural perspective, but from theories and models regarding appropriate provision in gifted and talented education. However, the researcher acknowledges the influence of sociocultural theory on current practice in mathematics classrooms.

2.6 Provisions for the Mathematically Gifted

In a New Zealand national survey (Riley, et al., 2004), the preference reported for gifted and talented students’ educational provisions was for a combination of acceleration and enrichment. Of those schools (n=765) reporting school-based provisions for intellectually and/or academically gifted and talented students, withdrawal grouping was the most frequently reported approach (68%). This was followed by competitions (54%), cross-age grouping (53%), and external examinations (51%). There are a wide range of provisions to be considered in gifted education. The Ministry of Education (2000) recommended a continuum of approaches, but the first pragmatic question to be asked concerns what is ‘intentionally’ provided for mathematically gifted and talented students. This question can be answered by an examination of what is documented in school policy documents.

2.6.1 Policy, Practice, and Evaluation

A school’s policy should indicate how it attends to the educational requirements of its gifted and talented students. The documents should include a rationale, purposes, definitions, identification methods, programme design, professional involvement and development, community and parent involvement, resources, and evaluation

processes (Riley, 2000). The policy documents should be based on good theory as a starting point (Teare, 1997). However, even with a policy in place, schools may not be able to provide adequate identification and provision for mathematically gifted students. Teare (1997) suggested that “the needs of able students have to be understood so that they will be served genuinely by the policies and practices undertaken by the school” (p. 17). A policy should allow for adaptations to be made to the curriculum and flexibility to meet an individual student’s needs. Without a policy, there is little chance of consistency, but on the other hand, a policy does not guarantee consistency. A policy should, at least, promote a shared purpose. Ultimately, despite sound policy documents, it is what happens in a classroom that is important.

Gifted and talented students should not experience the same subject matter as their average ability peers. They should experience mathematics at a different pace and scope. “All children, including the most able, have a right to a challenging and appropriate education. There have been far too many instances of able and talented children being left unfulfilled, bored, underchallenged or frightened to use their abilities...” (Teare, 1997, p. 7). Sternberg (2004) suggested that if student aptitudes were carefully defined, systematic creative instruction was provided, and there was powerful assessment, then students would achieve. Continuous evaluation was also suggested as a crucial element of successful programmes (Tomlinson & Callahan, 1994). Tomlinson and Callahan (1994) provided a detailed explanation and plan for programme evaluation (see also, Callahan 2004, 2006).

Schools should be interested in the connections between using identification effectively and provisions (Robinson, 1996). Provisions were classified within a two-dimensional matrix by Wiczerkowski, et al. (2000, p. 421). This matrix is shown in Figure 2.2. One dimension addresses instructional settings (in-school versus out-of-school) and the other, the special approach to provision (acceleration and enrichment). The authors added the grouping aspect for this may be applied to either provision.

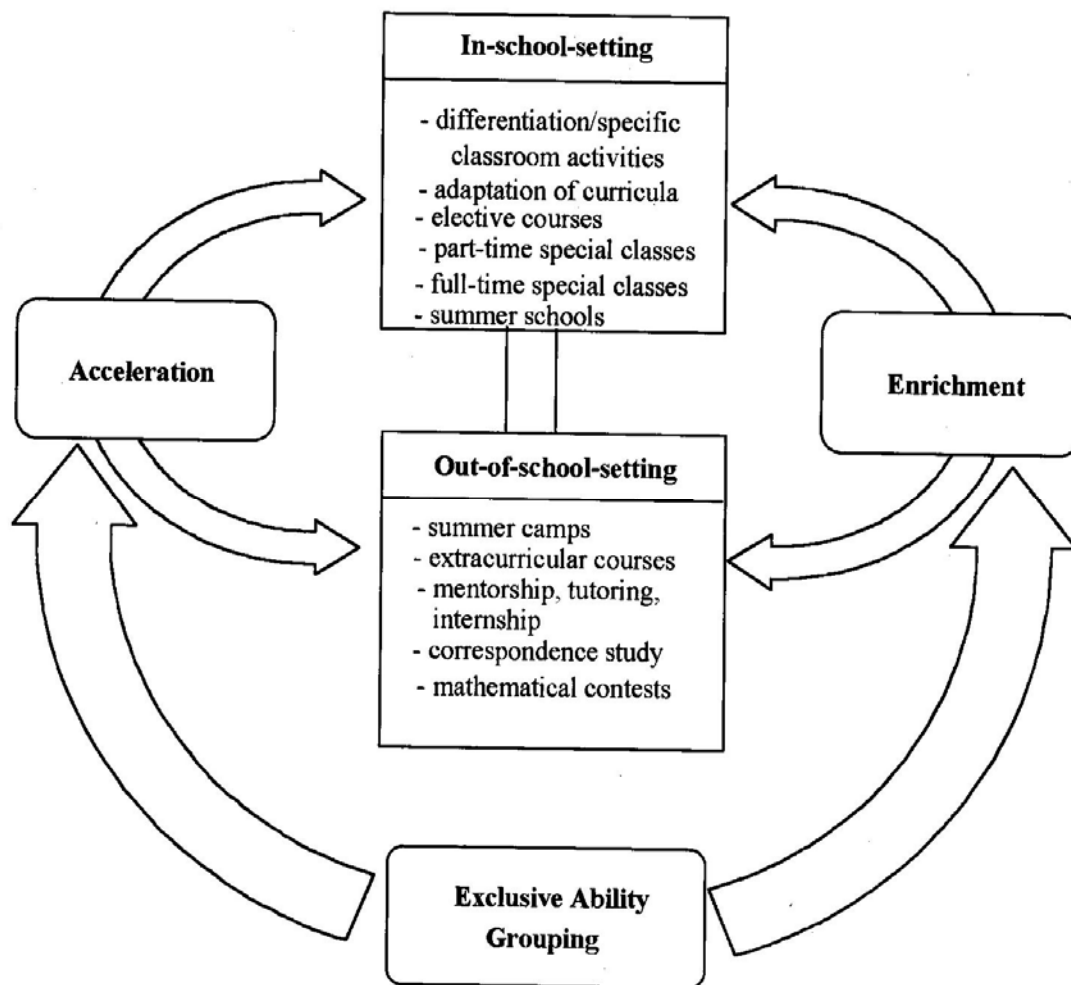


Figure 2.2. Strategies for special provision for the mathematically gifted.

2.6.2 Acceleration

Acceleration is usually interpreted as a means by which students are introduced to concepts earlier and cover conventional material at a faster rate than usual. Feldhusen (1989) asserted that acceleration is a process of “bringing gifted and talented youth up to a suitable level of instruction commensurate with their achievement levels and readiness so that they are properly challenged to learn new material’ (p. 8). A review of empirical research of the 1970s and 1980s (Sowell, 1993) showed that mathematically precocious students profited by participating in accelerated mathematics programmes. The rationale for acceleration was summarized by Southern and Jones (1991) as increased efficiency, increased effectiveness, recognition of accomplishments, increased time for careers, increased productivity,

increased options for academic exploration, exposure of the student to a new peer group, and administrative economy.

There is a relatively large body of research on the acceleration of mathematically gifted students. The most reputable and rigorous studies extend from the work of Stanley's Study of Mathematically Precocious Youth (SMPY). The longitudinal research from SMPY provided ample, reliable evidence that acceleration was an effective way of meeting the academic needs of the mathematically gifted. Stanley (1991) recognized that these students "were starved for mathematics at the proper pace and level and rejoiced in the opportunity to take it straight rather than being 'enriched' with math puzzles, social studies discussions, trips to museums, critical thinking training not closely tied to mathematics, and so forth" (p. 37).

Freeman (1998) described acceleration as the "cheapest, easiest and most usual form of special provision" (p. 37). Four key features of acceleration were identified by Wiczerkowski, et al. (2000) as:

- a highly structured approach oriented towards the regular syllabus;
- a highly selective process of identification;
- motivated by challenge, saving of time, avoidance of stagnation; and
- recognition of individual effort.

Students should be accelerated a year or two and this usually brings them closer to an appropriate level of challenge and pace and in contact with more stimulating intellectual peers (Feldhusen, Proctor, & Black, 2002). Feldhusen et al. (2002) presented the following conclusions from their comprehensive literature review (a reliable bibliography was provided):

- (a) There is no empirical basis for the belief that grade advancement will result in either social-emotional maladjustments or gaps in learning;
- (b) objective measures of educational performance and subjective measures of student and parent satisfaction suggest that grade advancement results in far more positive consequences than negative ones;
- (c) academically, it does not seem to matter which grade level the child does not directly experience.

(Feldhusen, et al., 2002, p. 170)

In the New Zealand setting, Rawlins (2000), using focus group interviews, found favourable student perceptions of accelerated programmes in mathematics. Students viewed the process as beneficial because it meant early completion of schooling, increased opportunity for higher examination results, and the opportunity to broaden subject choice by completing school mathematics sooner than expected. Students expressed having been bored in previous non-accelerated classes whereas they felt the accelerated classes enhanced their learning. Students reported increased confidence and self-esteem from being in these accelerated programmes.

There have been extensive studies, many longitudinal, conducted as part of the Study of Mathematically Precocious Youth (SMPY). Part of these longitudinal studies was “to better understand gifted individuals and the development of their abilities and achievements” (Swiatek, 2002, p. 141). Swiatek warned that the studies were based on those who chose to accelerate as it was unethical to design a study in which some groups of mathematically gifted students were accelerated and some were not. In the SMPY studies, students felt that the accelerated programme helped maintain their interest in mathematics (Swiatek & Benbow, 1991) and it was also found to be a positive predictor of educational success and satisfaction (Bleske-Rechek, Lubinski, & Benbow, 2004). Socially, the SMPY students did not report any regrets and instead found that it was more stimulating to be with academic peers than their own age group (Charlton, Marolf, & Stanley, 2002). This confirmed earlier findings from SMPY (n=2000) in which acceleration did not affect social interactions or self acceptance and/or identity and it also did not relate to social and emotional difficulties (Richardson & Benbow, 1990). However, a limitation of the research was the reliance on self-reported data.

Placing a child with intellectual peers is recognized as being more important than keeping that child with age peers (Winner, 1996). VanTassel-Baska (1992) also contended that acceleration was a highly effective intervention that improved motivation, confidence, and scholarship. Conversely, Gross (1992) described cases where extremely gifted students were not accelerated and suffered boredom, frustration, lack of motivation, low self-esteem, and academic isolation. A study by Rimm and Lovance (1992) proposed that subject and grade skipping actually prevented and reversed some kinds of underachievement. The 14 sets of parents in

the study were a biased sample as the children were already underachieving and presented concerns to parents or teachers. These young children were then grade or subject skipped in their first or second year of schooling; the researchers then conducted further studies with these same students in later years. The cases showed that students who underachieved because of an unchallenging curriculum (and not other factors such as personal, social, and family) benefited from acceleration.

Additionally, Kulik and Kulik's (1992) meta-analysis supported acceleration. When acceleration was used in tandem with ability grouping, it had greater effects on student learning than enrichment. However, the studies in the meta-analysis included many subject areas, grade levels, and types of acceleration. More directly applicable to this study is Kolitch and Brody's (1992) research which specifically focused on the effects of acceleration on student achievement and interest in mathematics. Quantitative and qualitative data were collected from 69 mathematically gifted students in their first year of university. This was a rigorous study that strongly supported the position that gifted and talented students can do well in mathematics courses taken several years earlier than is usual. These students successfully studied calculus on average two and a half years earlier than age peers on regular programmes. They also did not report any social and emotional concerns; there was little evidence of burnout and enthusiasm for mathematics remained high for all but one student. Interestingly, "males in the group were significantly more accelerated than females....females appeared to be less likely to take risks by accelerating greatly and to be more content with working at a slower pace" (p. 85).

Howley's (2002) study is of interest for its rural setting and successful implementation of acceleration strategies. The success of the acceleration strategies was attributed to each school tailoring its programme for individual needs, matching instructional materials carefully to instructional levels, close and regular monitoring of student progress, and mandatory programme evaluations. Rural schools face the challenge of catering for too few students for some provisional options and limited funds allocated to gifted programmes. Acceleration is viewed as a mechanism by which rural schools can provide instruction to match students' abilities and instruction levels. This study is not a report of only success stories; there were

schools who questioned the success of acceleration, but researchers found in such cases a lack of systematic procedures.

The academic outcomes of acceleration according to Rogers (2004) “are impressive” (p. 56). “Accelerated students consistently outperform non-accelerated ability-peers” (p. 56) and this is regardless of whether they have been accelerated by shortening the number of years spent in the primary and/or secondary schooling system or by engaging with advanced material in an area of special talent or interest at an age earlier than is expected. These findings were based on an extensive literature review. Gross (1992, 2004) and Robinson (2004), likewise, found positive socio-affective outcomes for students. Robinson (2004) noted that concerns about acceleration and the effects on socio-emotional status usually involve younger gifted students and placement in classes with older students rather than in advanced classes with similar aged students.

Those arguing against acceleration propose that accelerated students will not fit in socially and will lack friends by not being with students of their own age. Parents who seek to accelerate their child are sometimes seen as ‘pushy parents’ robbing their child of a normal childhood (Rogers, 2002). Accelerative options are sometimes objected to by practitioners because of this view of potential harm to the accelerant’s social and emotional development; this is despite the research literature showing no such risks (Southern, Jones, & Fiscus, 1989). Case studies, of two highly gifted preschoolers (Lewis, 2002), demonstrated some of the pitfalls and warned that acceleration was not enough. Lewis (2002) advised that acceleration was no guarantee that students would receive good teaching and that acceleration was not appropriate for all curriculum areas, although mathematics was acknowledged as one area which was more effective than others. Rogers and Kimpston (1992) conducted a meta-evaluation to try and understand if there were grounds for negative perceptions about acceleration. Their study put to rest the misconception that acceleration may have negative social and emotional consequences for gifted learners. There is however a practice, in some of the literature, of generalizing favourable results to all potential accelerants (Cornell, Callahan, & Loyd, 1991). ‘Who to accelerate?’ is perhaps now a much more important question than what are the benefits.

2.6.3 Enrichment

Enriching mathematics means broadening students' mathematical experiences by examining mathematics outside of the prescribed curriculum and also making connections with other curriculum areas. Stanley (1977) described four kinds of educational enrichment: busy work, irrelevant academic work, cultural enrichment, and relevant academic work. Busy work consisted of doing more work on something at which the student already excelled, irrelevant academic work was in a context unrelated to the area of giftedness, cultural enrichment gave the student experiences beyond the school curriculum, and relevant work was in the specific talent area. It was noted that there should be clear aims attached to the investigations. McClure (2001) made the point that the gifted and talented students were entitled to teacher time as much as the less able students. They should also not merely work at a faster pace nor merely complete "harder examples of the same kind of task" (p. 43).

Tasks are central to mathematical learning as they place different cognitive demands on students and structure the way students think. Mathematical tasks should be designed that encourage high-level mathematical thinking and reasoning (Henningsen & Stein, 1997). These researchers maintained that "engaging in high-level reasoning and problem solving involves more ambiguity and higher levels of personal risk for students than do more routine tasks" (p. 526). Henningsen and Stein's (1997) work from the QUASAR⁶ national educational reform project based at the University of Pittsburgh identified, examined, and illustrated the ways in which classroom-based factors shaped students' engagement with high-level mathematical tasks.

Criticism of enrichment is made when enrichment is irrelevant to the area of talent (Stanley, 1991). It becomes busy work that does not meet the students' real needs and "assuage their specific mental hunger" (p. 40). Stanley (1977) believed that there were certain types of enrichment that were justifiable but without acceleration, some forms of enrichment "tend to harm the brilliant student" (p. 93). In contrast to acceleration, enrichment offers:

- content from areas that are not traditionally covered;

⁶ QUASAR (Quantitative Understanding: Amplifying Student Achievement and Reasoning)

- duration of participation is determined by opportunities;
- challenging material;
- opportunity to work with others with similar interests; and
- motivation comes from interest in the discipline.

(Wieczerkowski et al., 2000)

It can be difficult to generalize the findings on enrichment. Although enrichment is a stated preferred approach in New Zealand to meeting the needs of gifted and talented students (Ministry of Education 2000; Riley et al., 2004; Townsend, 2004), it is a difficult concept to gain a real understanding of what it means for students' learning. The range of provisions reported under the umbrella of enrichment in mathematics varies considerably. There is a need for further research on enrichment in mathematics. The focus should be on the content and teaching approaches used in mathematics, and the teachers' understandings of enrichment. This should give us greater insight into the extent of these differences and, more importantly, the outcomes for students gifted and talented in mathematics.

2.6.4 Getting-it-Together

In practice, a combination of acceleration and enrichment is deemed to be the most effective (Ministry of Education, 2000; Riley et al., 2004; Townsend, 2004; Wieczerkowski et al., 2000). Although, like many reports, this study treats acceleration and enrichment as discrete processes, there are overlaps. Enrichment activities invariably lead to some aspects of advanced material. Much of the research has provided evidence that one or other process is effective. Some of the reports described an acceleration programme and upon reading the studies showed elements of enrichment and vice versa. Southern and Jones (1991) described acceleration versus enrichment as a fallacy; they do not view them as segregated options. Taking the concept of enrichment as broadening the curriculum, in a subject such as mathematics, means that the instruction will eventually entail aspects of acceleration, including advanced levels of analysis and abstraction.

Feldhusen et al. (2002) contended that the most appropriate provision was a "system of specifically designed classes which provide learning activities at an appropriate

pace and level and which emphasize the process skills of critical and creative thinking and research” (p. 170). A project founded by Stanford University (Accelerated Schools Project) reflected these contentions and according to Keller (1995) transformed hundreds of schools’ gifted education provisions. (There were 700 schools in the Project.) Despite the Project’s name the model incorporated aspects of both acceleration and enrichment; it gave schools opportunities to apply the model in their own ways. Essentially, lessons were based on constructivist principles, they were “not really fast-track but designed to enrich the learning experience through higher expectations, relevant content, and stimulating instruction” (Keller, 1995, p. 11). Underlying the model in this project, was a belief that expertise could be found within the school community.

The major criticism of efforts in both acceleration and enrichment is that they can be piecemeal and inconsistent across grade levels (Clark & Zimmerman, 2002). Keller (1995) reported that systematic change occurred when there was commitment and participation by the whole school community, and a shift in the school’s culture and environment. Ongoing assistance from experts in gifted education was also recognized as a key element in overcoming challenges and sustaining a programme of acceleration and enrichment. The Model Mathematics Program (Miller & Mills, 1995) was designed to meet the needs of students gifted in mathematics and was an excellent example of combining acceleration and enrichment in flexible ratios dependent on individual needs. All students (n=456) received an Individual Education Plan (IEP) and “modifications included such changes as increasing or decreasing the amount of enrichment vs acceleration in a student’s educational plan” (p. 141). Once placed in the programme, students identified as having high ability in mathematics, made dramatic gains in mathematics achievement. Interestingly, they had not been placed high enough in their regular mathematics programme.

Mathematically gifted and talented students learn mathematics rapidly; if there is a lack of challenge and too much repetition then students lose interest by Year 4, if not sooner (Mills, Ablard, & Gustin, 1994). It must be realized, that even within a group of highly able students, there can be a wide range of mathematical abilities and knowledge. This claim is well supported by Mills et al.’s (1994) study of gifted and talented mathematics students (n=306). The students (Grades 3 to 6) were enrolled in

a flexibly-paced mathematics course matched to individualized learning paces. They made gains far beyond the normative gains expected over a one-year period. Mathematically gifted and talented students do not necessarily reflect an entirely homogeneous group; other options should be considered apart from acceleration and enrichment.

2.6.5 Differentiation and Challenging Tasks

Gifted learners present cognitive differences that necessitate a differentiated approach to instructional practices in the mathematics classroom. The main differences are the capacity to learn at faster rates (Colangelo, Assouline, & Gross, 2004), to acquire new and more abstract information, to make connections more easily (Gallagher & Gallagher, 1994), and the capacity to find, solve, and act on problems more readily (Sternberg, 2000). Riley (2004) stressed the importance of “matching instruction to individual students...individualising and personalising education” (p. 345).

Acknowledging that students learn at different speeds and that they differ widely in their ability to think abstractly or understand complex ideas is like acknowledging that students at any given age aren't all the same height. It is not a statement of worth, but of reality.

(Tomlinson, 2001, p. viii).

A curriculum model should therefore reflect these differences and such modifications should be made across the dimensions defined by VanTassel-Baska and Stambaugh (2006) as content, process, product, and concept. Content topics refer to the domain of inquiry; transferable process skills include critical and creative thinking, problem finding and problem solving and research; product alternatives undertaken individually or collectively; and large concepts, themes, and issues that would be best utilized with gifted learners. Essentially, a differentiated curriculum is one where instructional practices mean a modification to depth, complexity, and pace; a “shaking up” of what goes on in the classroom (Tomlinson, 2001, p. 1). Coleman (2001) added the notion of sophistication which she believes is at “the heart of all out attempts to differentiate the curriculum for gifted learners” (p. 24) and what gifted learners thrive on. Tomlinson and Doubet (2007) advocated that what is “smart” for developing the capacities of our gifted and talented students will also benefit

virtually all students. With strong and skilled leadership, Tomlinson and Allan (2000) suggested differentiation could move from individual classrooms to classrooms throughout a school.

Diezmann (2005) suggested four key instructional strategies for supporting mathematically gifted students in the regular class. Her rationale for the development of these strategies was based on a recognition that many teachers struggle with providing a differentiated curriculum. Instead these strategies “capitalise on challenging tasks, accommodate the characteristics of mathematically gifted students, and can be regularly implemented in the regular classroom” (p. 53). The first strategy is to problematize the task by, for example, inserting obstacles to the solution, limiting the problem information provided, or increasing the magnitude of the quantities (see, for example, Diezmann & English, 2001). Another strategy was to implement mathematical investigations—open-ended and giving opportunity for team work, sustained effort, and creativity. Diezmann (2005) also suggested extending manipulative use so that students capitalize “on visual-spatial or kinaesthetic representations to support higher-level thinking” (p. 55). The final strategy was to modify educational games so that the games presented a higher degree of challenge. An engagement in modified games could reveal students’ risk-taking and higher-level thought processes (Lesh, Hoover, Hole, Kelly, & Post, 2000). Another feature of tasks, such as those described, is that they give opportunities for both collaborative and independent learning (Diezmann & Watters, 2000b; 2002b). They can be described as ‘lateral strategies’ that are interconnected to the regular curriculum but designed to be challenging and to empower students as mathematicians (Diezmann & Watters, 2004).

In a similar vein to Diezmann and Watter’s work with gifted students in mathematics, Cosgrave (1999) reported on studies from the Irish Centre for Talented Youth where students selected from two courses in mathematics: Mathematical Models and Investigational Mathematics. They did not require advanced mathematical knowledge, but needed an innate mathematical ability and to be interested in thinking about mathematical questions. Advanced mathematical language was avoided, but through carefully selected challenging tasks students were

exposed to aspects of number theory and proof outside their normal classroom experience.

An extensive seven-year field study, conducted by Freiman (2006) in Montreal elementary classrooms, showed how challenging situations not only helped to discover mathematical talent, but also enhanced this talent and increased young students' interests towards more advanced mathematics. From this study, Freiman proposed a "challenging situation model" that used "an active everyday use of open-ended mathematical activities that would engage children into a meaningful process of exploring, questioning, investigating, communicating and reflecting on mathematical structures and relationships" (p. 57). Differentiating the curriculum, according to researchers such as Coleman (2001) and Renzulli and Reis (1997), allows for the individualizing of classroom instruction with the purpose of providing a rigorous learning environment that challenges students at their individual levels.

2.6.6 Ability Grouping

There are several options for grouping mathematically gifted and talented students. When given a choice, most mathematically gifted students will work alone or with a group of students who are their intellectual peers (Mingus & Grassl, 1999). Gifted students have two different peer groups—age and ability. Ability grouping refers to groups organized by teachers within heterogeneous classes. According to Fiedler, Lange, and Winebrenner (2002) "ability grouping does not imply permanently locking students out of settings that are appropriately challenging for them; it means placing them with others whose learning needs are similar to theirs for whatever time works best" (p. 109). The argument for ability grouping is usually made by researchers specializing in gifted education, teachers of the gifted, and parents of the gifted (Winner, 1996). Those arguing against ability grouping, according to Winner, claim that children 'left behind' suffer from losing the academic leadership of the gifted and talented students. That ability grouping is elitist is a myth; educators work hard to develop an understanding of giftedness in the context of individual differences rather than a notion of superiority versus inferiority (Fiedler et al., 2002).

Generally, grouping the gifted and talented students together for instruction produces positive achievement outcomes when the curriculum provided to the students is

appropriately differentiated (Kulik & Kulik, 1992). That is, the instruction that occurs within the groups determines the effectiveness of the grouping strategy. Although classes may have students from a wide range of mathematical ability, the student interactions and groupings may be determined by the task demands and initiated by the students themselves. Grouping strategies should be flexible; students should be allowed to work independently and have opportunities to select their own groups based on common interests (VanTassel-Baska, 1992). Flexible grouping is a strategy, also strongly advocated by Tomlinson (2003), so that students work in a variety of groups based on readiness, interest, and learning profile. However, it is still “important to ensure appropriate challenge and support on an ongoing basis for each learner” (p. 85).

In contrast to other studies, the high ability students in Boaler’s (1997a) three-year case study in the mathematics department of a United Kingdom secondary school underachieved (the girls in particular) and became disaffected as a result of being in the top class (set). Although Boaler makes no claims for the generalizability of this ‘top set’ effect, she suggested that the damaging effects of pace, competition, and anxiety were not unique to mathematics classrooms. A later longitudinal study (Boaler, William, & Brown, 2000) with a larger sample (n=943) in six schools also found that homogeneous grouping for students in the top class meant students learned at a pace incompatible with their understanding and were under pressure to succeed. It would have been useful if Boaler et al.’s (2000) study differentiated among those ‘top set’ students to provide better insights within groups rather than merely across groupings.

This grouping issue as noted by Boaler (1997b) extends beyond the development of subject understanding and relates to the research, educational theory, and political agenda of the time. In gifted education, grouping has generated research and arguments on all fronts, much of it inconclusive about the strengths and weaknesses of homogeneous and heterogeneous grouping. “We must remember that decisions about grouping are preliminary and that what matters most comes next... Given poor instruction, neither heterogeneous nor homogeneous grouping can be effective; with excellent instruction, either may succeed” (Gamoran, 1992, p. 11).

2.6.7 Classroom Strategies

Classroom-based strategies commonly advocated for gifted and talented students include cooperative learning, independent study, and curriculum compacting. Cooperative learning situations may be either homogeneous or heterogeneous groups of students. Advocates of cooperative learning cited increased social skills behaviour, improved self-esteem, attitudes towards school, and acceptance of others (Johnson & Johnson, 1999). Neber, Finsterwald, and Urban's (2001) meta-analysis of 12 published studies on cooperative learning with gifted and high achieving students concluded, despite methodological concerns about some of the studies, cooperative learning may result in small to medium positive effects on learning achievements. When gifted students, in science, worked cooperatively in homogeneous groups they performed better than those who worked independently (Johnson & Johnson, 1993). Melser (1999) studied gifted students from six classes working cooperatively in different groupings—heterogeneous and homogeneous. The gifted students made comparable progress, but the gifted students in mixed ability groups had an increase in self-esteem whilst those in homogeneous groups had a decrease in self-esteem scores.

Students in Matthews' (1992) study were more positive about working with others in homogeneous rather than heterogeneous groups. They resented explaining material to others and the time taken away from their own learning, and saw little benefits for themselves. Likewise, Ramsay and Richards' (1997) study (n=800) found that gifted students did not evoke the social skill behaviours and positive attitudes articulated by the Johnsons. They saw little benefit for themselves and were frustrated with both pace and content. These negative feelings diminished when working with students of similar ability. Coleman (2005) suggested that there should be flexibility, choice, and challenge if we are to use cooperative learning with gifted students. The responsibility rests with the teacher to provide the challenging tasks and then to decide whether the task is appropriate for cooperative groups so that all students, including gifted learners, benefit.

As for a group of one, being an independent learner or self-directed learner is often cited as a characteristic of the gifted student (see, for example, Gallagher & Gallagher, 1994; McAlpine & Reid, 1996; Stanley & Benbow, 1982). Despite this

characteristic, many gifted and talented students still require help in developing the skills and attitudes necessary for independent study (Davis & Rimm, 1989; Gallagher & Gallagher, 1994). Gifted and talented students will also never be ready for independent study unless they have opportunities to learn how to take responsibility for their learning. Treffinger (1986) recognized this need and suggested strategies for identifying the level of help a student requires and recommendations for fostering self-directedness. Whilst Treffinger outlined steps for increasing self-directedness, Betts (1985, 1992) described a programme (Autonomous Learner Model) to help students become independent, autonomous self-directed learners. However, self-directed learning is not a single strategy, but a range of methods. Essentially students make choices, plan, set goals, identify resources, and self evaluate (Tomlinson, 1999). Independent study should be considered as a means for differentiating instruction and is strongly recommended in the literature (Clark, 2002; Davis & Rimm, 1998; Gallagher & Gallagher, 1994).

For the mathematically gifted it also makes sense to compact the curriculum. “Curriculum compacting is a flexible, research-supported instructional technique that enables high-ability students to skip work they already know and substitute more challenging content” (Reis & Renzulli, 1992, p. 51). The authors suggested that it might also be thought of as “organized common sense” (p. 51). Where practice is not needed (based on assessment results), curriculum compacting provides time for students to broaden and deepen their understandings in other areas of mathematics. It would seem very short-sighted to provide only the mathematics that is offered in the school curriculum. Curriculum compacting is viewed as a logical approach to mathematics differentiation because of the linear approach to the development of many skills and concepts. Renzulli and Reis (2003) reported that students showed increased motivation as the compacting process meant economizing on regular material and so created more time for self-selected pursuits. The curriculum compacting model described by Renzulli and Reis (1986) provides a combination of acceleration and enrichment and is supported by an Individual Educational Programming guide, ‘The Compactor’ (p. 235). According to Rogers and Kimpston’s (1992) meta-evaluation, curriculum compacting “results in significant positive academic effects, especially in mathematics” (p. 59).

Tomlinson (1999) suggested another model for provision that used a tiered objectives approach. This was presented as a manageable and effective method for telescoping mathematics curriculum in a mixed ability setting. In this approach, teaching and learning occurred in a layered fashion instead of a linear approach. The gifted students learned concepts or skills at two years worth of complexity with a limited number of repetitions. While the majority of students worked on the grade level expectations for a concept, the gifted students solved problems based on the increased complexity of the tiered objectives. An effective example of this approach was reported by Kettler and Curliss (2003) in a geometry unit with a mixed ability Grade 6 class. The mathematically gifted students were both challenged and accelerated, mastering higher level geometry skills and concepts. The optimal level of material and pace of instruction should be individually matched with ability and slightly above the student's current level of achievement (Mills et al., 1994).

2.6.8 School-Wide Strategies

A variety of school-wide strategies are suggested in the literature as a means of providing for gifted and talented students beyond the regular inclusive classroom. These include cluster grouping, withdrawal programmes, special classes, competitions, mentors, and out-of-school provisions.

Cluster grouping is an organizational strategy that is commonly used to refer to a school-wide strategy in which the gifted and talented students are grouped together, forming a subgroup within a regular classroom (Gentry & Owen, 1999). Other terms are used by schools and in the literature to denote different strategies for managing instruction for gifted and talented students within a school. They include fulltime ability grouping or tracking, within-class performance grouping, partial day grouping, and cross-graded classes (Rogers, 2002). These groupings are based on ability or achievement levels with the intention that the curriculum will be at an appropriate level for that group. There are limited empirical studies related to the effectiveness of cluster grouping (Riley et al., 2004), although Gentry (1999) reported that cluster grouping led to higher teacher expectations, greater use of gifted education strategies, and an increase in the use of ability grouping. In this study, the term cross-class ability grouping will be used to describe a school's strategy of

grouping the gifted and talented mathematics students identified within a year group, in the one class for their mathematics instruction.

Withdrawal or pullout programmes are essentially a form of ability grouping except that the students work outside of the heterogeneous classroom for mathematics. Kulik and Kulik (1992) reported from their meta-analyses that gifted students performed better when educated separately from those gifted students who remained in regular classes. However, the benefits reported are only modest ones. According to these studies, being placed in a gifted class does not “make children arrogant, nor does it lower their self-esteem because they are no longer the biggest fish in the pond” (Winner, 1996, p. 261).

Withdrawal programmes are usually only part-time. They can depend on school policy, teacher availability, and funding. Essentially, they can be a part-time solution to a full-time issue. According to Winner (1996), the activities presented in withdrawal programmes are often unrelated to the specific form of giftedness, have little continuity, and do not allow for systematic sustained study on a topic. Another perspective, based on a pilot study for this project set in a primary school using a withdrawal programme, was the teachers’ view that placing gifted students in a class of their own for mathematics led to student arrogance and elitism (Bicknell & Riley, 2006).

Tracking, streaming, and special classes are terms used in the literature for an organizational practice of sorting students into different classes based on grades, tests scores, or perceived abilities. In a British study (Hallam & Ireson, 2007) Year 9 students (n=5000), representing three levels of streams, responded to a questionnaire related to their satisfaction (or not) with their ability grouping placements. A substantial proportion of pupils expressed a wish to change class or stream, most in an upward direction mainly because the level of work was inappropriate; few reported social reasons for wishing to change class. Mathematics was the learning area in which students expressed the most dissatisfaction. The students wished to move to a higher class to do harder work and to work at a quicker pace. Tracking or streaming of students in ability classes has produced moderate benefits (Kulik & Kulik, 1992). Kulik and Kulik (1992) reported that when streaming means taking

more advanced courses, as it usually does in secondary schools, then a more positive picture emerged. However, even within a high-ability streamed class there is recognition that the curriculum should be differentiated. Civil and Planas (2004) warned that school-wide grouping strategies in mathematics may place barriers for students to participate in special programmes and possibly disadvantage some students. These barriers relate to the mathematics discourse of classrooms and pedagogical practices determined by the context of certain organizational strategies used within a school.

Kalchman and Case (1999) reported a study which attempted to address the range of abilities within a high-ability class. Using an experimental (n=24) and control group (n=21) of mathematically gifted students in a streamed class all students learnt a core set of concepts. The follow-up work provided for the control group was a traditional textbook-based programme, whereas the experimental group participated in an experimental functions curriculum loosely based on “jigsaw learning” (p. 326) in which students acquire expertise and then combine this expertise in group problem solving tasks. The experimental group achieved higher results and showed more diversity in their answers. It was a highly selective sample, but the study provided support for recognition of individual differences even within a streamed setting.

Competitions are recognized as part of the continuum of provisions for gifted and talented students (Renzulli, 1994; Riley & Karnes, 2007). Competitions can also be used as part of the multiple method identification process. Competitions offer students the opportunity to strive for personal achievement and to compare themselves with others. They are a means for “providing an encouraging environment in which gifted students compete, excel, and are honoured for their abilities” (Grassl & Mingus, 1999, p. 291). Karnes and Riley (1996) suggested that competitions also enhance students’ self-directed learning skills and sense of autonomy. The preparation for a competition in mathematics demands a good deal of independent study as most competitions require rapid and accurate answers under pressure. More recently, some competitions in mathematics, such as those organized by local mathematics teachers’ associations, have included group problem solving activities where team work and collaboration are important. However, most competitions rely on independent problem solving abilities. Success in mathematics

competitions, Ridge and Renzulli (1981) warned, is indicative of a particular type of mathematical talent and tells us little about the slower more logical formal type of mathematical talent.

Motivation from competitions can also be extrinsic, resulting in certificates and awards, selection for other competitions, and recognized prestige. Udvari (2000) in a comprehensive analysis of the literature on competitions, concluded that “learning to deal with competition in a constructive manner is essential for gifted children, especially given the competitive nature of Western culture and the central role of competition in high-level achievement” (p. 215). This view was supported by Riley and Karnes (1998/99) who declared that “the opportunities to tap and showcase kiwi talent far outweigh the negative elements often associated with competitions” (p. 25). The negative outcomes, cited by Davis and Rimm (1998), were stress and feelings of failure from excessive competitiveness. These negative effects, according to Cropper (1998), were usually because of poorly planned competitive goals. Little research is documented on the effectiveness of competitions in meeting the unique cognitive, social, and emotional needs of gifted and talented students. Campbell, Wagner, and Walberg (2000) acknowledged the need for such empirical research, but warn of the dilemma given the role of sponsorship that exists with many competitions. Research has focused more on Mathematics Olympiad students (Campbell et al., 2000; Curran, Holton, Marshall, & Haur, 1991/92), but not on younger students. Consequently, this study has incorporated a focus on the role of competitions for younger students.

In New Zealand schools, the main competition available to the more able mathematics students are the locally-organized competitions such as Canterbury’s *Cantamaths*, Hawkes Bay’s *Mathletics*, and Manawatu’s *Mathex*. These competitions are designed for primary, intermediate, and junior secondary school students. The *Australasian Schools Competitions* conducted by the University of New South Wales established a suite of assessments for primary and secondary students to provide diagnostic information about students’ abilities in core skills in areas such as science, mathematics, and English. It is expected that the assessments help identify students with particular talents. The New Zealand *Mathematics Olympiad* and New Zealand Association of Mathematics Teachers (NZAMT) offer competitions for secondary school students. The *Mathematics Achievement*

Challenge is designed to extend and enrich students in mathematics at Levels 3 and 4 of the New Zealand Mathematics Curriculum (Ministry of Education, 1992). The objective is that students complete in-depth mathematical investigations that are challenging and relate to everyday life. The students are encouraged to complete the challenges at school or home. These challenges do not really fit the category of competitions as such, but are used by teachers to provide enriching, extra challenges for the more able students in mathematics. The Mathematics Olympiads are intended for the crème de la crème of mathematically gifted and talented secondary school students and give opportunities for students to attend mathematics camps and to continue, if selected, to compete internationally.

Mentorships are another provision option for gifted and talented students. A mentorship is when a student is placed with a subject matter expert or professional in the field to further a specific interest and ability. The strategy may be used when this proficiency can not be provided by teachers in the regular setting. Mentorships have also been considered as a strategy for encouraging girls in areas such as mathematics, science, and technology (Reis & Graham, 2005). These researchers suggested that teachers should work to provide female role models and mentors. They reported that one of the greatest benefits from career day conferences was the opportunity for establishing mentorships and internship programmes so that girls with interests in these fields had the opportunity to work directly with female role models in a related career. Another intervention to ensure gender equity was to provide opportunities for older female students to mentor their younger female counterparts. Casey and Shore (2000) also focused on the role of mentors particularly for gifted adolescent females. Rogers and Kimpston's (1992) meta-evaluation of 19 reviews showed only small positive academic and adjustment benefits from mentorship. They reported concerns about how measurement may influence outcomes and considered the small positive improvement as surprising. There appears to be a need for empirical studies which examine the benefits derived by gifted mentees in different subject areas, and possible differences between the types and duration of mentorships.

Out-of-school provision for gifted education is offered in New Zealand by predominantly two models. They are one-day-a-week programmes and cluster school programmes whereby neighbouring schools form a cluster to provide programmes

for targeted groups of gifted and talented students in learning areas such as mathematics, creative writing, or visual art (Education Review Office, 1998). Gifted and talented students apply to attend the one-day-a-week programme and are selected based on a comprehensive assessment process that includes tests. The goal is to offer gifted and talented students opportunity to interact with like-minded peers in an emotionally safe and intellectually challenging environment. The Education Review Office (2008) found there needed to be stronger links and improved communication between the regular and off-site schools. These schools did “not plan, monitor, evaluate, or report appropriately on this provision” (Education Review Office, 2008, p. 28), and there were no links to the regular classroom programmes. These findings reflect some of the considerations raised by VanTassel-Baska (2006) based on the situation in the United States.

2.7 Supporting Gifted Students

As previously discussed, the education of gifted and talented students depends on the provision made by a school and within a classroom. However, there are additional support factors that should be considered. Three of these are presented in the following section: teachers, resources, and parents.

2.7.1 Teachers of the Gifted

It is an accepted understanding that teachers have a ‘significant’ influence on students. However extensive, reputable research on what makes an effective teacher of the gifted is limited. Clark and Zimmerman (2002) state that: “Most of what has been written about teachers for gifted students is ‘armchair speculation’ rather than the result of research” (p. 164). Teachers in Mingus and Grassl’s (1999) study acknowledged that working with gifted students was not an easy task. Gifted students often posed questions that they felt were beyond the parameters of the majority of the class and finding suitable material required considerable time and effort. Teachers are advised to plan and provide for suitable challenging work. This, McClure (2001) contested, is most difficult for teachers “who are not very confident in their own mathematical ability” (p. 43). An effective mathematics teacher is expected to have sound mathematics content (subject matter) and pedagogical content knowledge

(Ball, Lubienski, & Mewborn, 2001; Ma, 1999). McClure (2001) suggested that the most important issue was for teachers to understand what ‘greater depth’ means in the mathematical context as well as the appropriate vocabulary to use. Gifted students appreciated teachers who were “honest about their own mathematical abilities and were willing to learn alongside the students and demonstrate what it means to learn/explore mathematics” (Mingus & Grassl, 1999, p. 290).

In New Zealand, “many teachers have the willingness to cater for the needs of these students, but lack the knowledge and skills to be able to do so successfully” (Moltzen, 1998/99, p. 62). A key aspect in developing teacher knowledge in gifted education is professional development, although VanTassel-Baska (1986) writes that not all good teachers work effectively in gifted programmes, specifically accelerated programmes. On the other hand, teachers who may have the knowledge and skills to individualize programmes effectively to meet the needs of gifted students may be limited by school policy (Feldhusen et al., 2002). The Education Review Office (2008) found that many New Zealand schools “did not take a planned approach to building capability through professional development in gifted and talented education” (p. 12). This was seen as a “huge challenge” and schools also faced the ongoing issue of teachers with expertise leaving a school (p. 13).

The success of the Model Mathematics Program (MMP) (Miller & Mills, 1995) was attributed to the presence of highly motivated, knowledgeable teachers who were flexible in their thinking and instructional practices. Horn (2004) followed up on the ‘teacher expectation effect’ and through case studies found that high expectations, strong classroom practice, and intensive collaboration among mathematics teachers played a key role in supporting students’ long term successes. Teachers in Plunkett and Harvey’s (1999) Australian study acknowledged the need for professional development in the area of catering for gifted and talented students. Hansen and Feldhusen (1994) found, not surprisingly, that teachers with specialized training were more effective working with gifted and talented students than teachers without such training. This was supported by Plunkett and Harvey’s (1995) research when they found a considerable difference in the confidence of teachers who had some training in the area. The teachers (n=465) in Reis and Renzulli’s (1992) study on curriculum compacting confirmed the need for additional professional development—more

assistance for enrichment from gifted education specialists, and more training and assistance in locating and using appropriate enrichment materials. Subsequent research (Reis & Westberg, 1994) addressing this need, showed that staff development had a positive effect on teachers' abilities to modify curriculum for gifted and talented students.

The National Association for Gifted Children in the United States published a position statement about the competencies needed by teachers of gifted and talented students in 1994. They stated that gifted children deserved to learn from highly qualified teachers who were aware of and could respond to the unique qualities and characteristics of gifted children. The specific roles, responsibilities, and competencies of key personnel working with gifted students were comprehensively addressed by Leppien and Westberg (2006) and built on reputable research in gifted education. Their extensive tables of competencies for teaching the gifted do not focus specifically on the learning domains of mathematics. The teacher of mathematically gifted students has not been examined in the New Zealand setting and is thus another area that is to be contributed to by this study.

2.7.2 Resources

Resources are a source of knowledge for students and teachers. They may be people resources or non-human such as print material, web sites, and computer games. Selecting resources suitable for gifted and talented learners can be a daunting process. Exemplary resources “foster student engagement when they are varied and closely linked to students' reading levels, cognitive strengths, and interests” (Sak & Maker, 2006, p. 138). Unfortunately, there is limited research on the effectiveness of resources to enhance student learning and in particular the impact on gifted learners in mathematics.

Gifted and talented students in the upper primary and secondary school invariably work from textbooks in their mathematics schooling. These textbooks are usually written to reflect current syllabi. Mathematics textbooks commonly present mathematics in a particular sequence, suggest the content that teachers should teach, and include “excessive repetition of material [that] leads to shallow treatment of mathematics and fails to stimulate student interest or challenge student thinking”

(Reys, Reys, & Chávez, 2004, p. 62). The curriculum statement 'Mathematics in the New Zealand Curriculum' (Ministry of Education, 1992) stated that "teachers must realise that there are many dangers in adhering too closely to any particular textbook" (p. 13) and therefore supported no designated textbook. Accusations have been made that contemporary textbooks in the United States have been "dumbed down", reflecting a decreasing level of difficulty (Reis & Renzulli, 1992, p. 52). Amit and Fried (2002) suggested that textbooks are "probably the most immediate determinant of practice" (p. 374) in mathematics. They also acknowledged the theoretical and practical problems associated with textbooks. Dowling (2001) raised questions regarding the basis upon which students' learning was differentiated by the use of school mathematics textbooks and questioned whose 'meaning' students are intended to 'get' from such textbooks. Reis and Renzulli (1992) reported many of the brightest students were 'rewarded' by simply being given more pages of examples to complete as practice. Resources for gifted students, claimed Roberts and Roberts (2005), should help develop the process skills of knowledge, comprehension, application, analysis, synthesis, and evaluation as defined by Bloom's Taxonomy (Bloom, 1956). They should also go further than this, according to Coleman (2001) who added another level to Bloom's Taxonomy. She called this highest level, transformational application: "the use of knowledge to create new knowledge in an applied form—the ability to bring all of Bloom's levels together to solve a problem, think a thought, design a product, or create a work" (p. 25).

Web sites are a rich resource, but one that has been found to be underused in gifted education classrooms (Siegle, 2005). However, there is little research regarding the appropriate use of web sites in programmes for the gifted. Although the Instructional Technology (IT) field has developed strategies for the use of web sites in class programmes, they are not specific to gifted education. Teachers who use IT strategies and tools incorporate computers, internet, software, multimedia, and web sites in their programmes. These strategies and tools can support stimulating learning environments and therefore, according to Besnoy (2006), should be included in gifted education programmes. This supports Tomlinson's (1999) argument for the differentiated curriculum as previously described.

...gifted students must be exposed to authentic situations in which they are expected to synthesize multiple sources of information. By designing learning environments that utilize quality Web sites, teachers of the gifted provide their students with the opportunity to learn how to research information, compare it to prior knowledge, and create new ideas. Learning these practical, real-world skills empowers gifted students and increases their ability to maximise their potential.

(Besnoy, 2006, p. 30)

As with all resources, teachers should evaluate them for quality, content, accuracy, and suitability. Not all educational web sites are adequate for the classroom as reported by Mioduser, Nachmias, Lahav, and Oren (2000) in a study of 436 educational web sites focusing on mathematics, science, and technology learning. The use of resources such as textbooks and web sites is an under-researched area; this use has not been specifically explored in relation to mathematically gifted students.

2.7.3 Parental Involvement

The literature on parental involvement in children's and adolescents' education supports the assertion that parental involvement benefits children's learning (Eccles & Harold, 1993; Epstein, & Dauber, 1991; Fehrmann, Keith, & Reimers, 2001; Hoover-Dempsey, Bassler, & Brissie, 1992). Parents, as children's first teachers, see the interests and advanced abilities displayed by their gifted children from early years and assume roles in their children's education. According to Matthews and Foster (2005), parents can optimize learning experiences for gifted learners in a variety of ways. They "not only espouse the value of certain activities, fields or achievements, but they model attitudes and behaviours that foster achievement, direct the interests and activities of their child to these areas, model participation and achievement within the talent areas, and monitor and structure their children's time and participation" (Kulieke & Olszewski-Kubilius, 1989, p. 42). From an early age, most parents have recognized their child's mathematical talents and sought out additional support materials for their children (Lupkowski-Shoplik & Assouline, 1994).

Epstein and Dauber (1991) found that when teachers made parental involvement part of teaching practice, parents increased their interactions at home and felt more

positive about their abilities to help children. This study, using data from 171 teachers, reported that different parental involvement practices occurred across the curriculum areas. For example, reading and English used more homework practices than mathematics. Less information and guidance also occurred as students progressed beyond elementary school. The empowerment process in relation to the parent and the school was recognized as meaningful involvement of parents, teachers, and school administrators leading to improved student achievement (Cochran & Dean, 1991). This process was usually limited to traditional activities such as parent-teacher meetings, monitoring of homework, and reinforcement of school policies (for example, discipline). The authors advocated a redefining of the empowerment process as an “intentional and ongoing process centered in the local community, involving mutual respect, critical reflection, caring, and group participation, through which people lacking an equal share of valued resources gain greater access to and control over those resources” (p. 267). Instead of ‘one-way’ communication from school to home there should be a respectful partnership with both parties making a contribution. Schools also need to be aware that parents with a high efficacy⁷ are more likely to have increased levels of involvement (Hoover-Dempsey et al., 1992).

Parental involvement decreases as students move from primary to secondary school. The decrease in parent involvement may result from a decrease in parents’ feelings of efficacy as their children grow older (Eccles & Harold, 1993). As the schoolwork becomes more advanced and technical they feel less knowledgeable in some subject areas. Parents of high-achieving children may be more likely to participate in school governance and school activities than parents of lower-achieving children (Eccles & Harold, 1993). An ecological approach, reported by Comer and Haynes (1991), encouraged parent involvement at all levels of school life, through general support of schools’ educational programmes, active participation in daily activities, and in school planning and management. They found that parents provided useful perspectives on matters that served the best interests of children.

⁷ Defined as a set of beliefs that one is capable of achieving desired outcomes through one’s efforts and the effects of those efforts on others.

Using an extensive data base, Fehrmann, et al. (2001) examined the direct effect of perceived parental involvement on grades. Their study showed that parental involvement had an important direct effect on grades and additionally parental involvement led to increased time spent on homework. In a smaller study, conducted by Mingus and Grassl (1999), using data from seven cases, parents were viewed as the primary influence in the lives of the mathematically gifted students. Despite the students having more advanced mathematical abilities than their parents, the parents played a crucial role in providing the supportive framework—they encouraged them to work hard, provided stability, and encouragement.

Moon's (1995) multiple-case study involved the families of 10 gifted and talented students who were participating in a withdrawal enrichment programme. The cases were selected as extreme cases across a continuum of most positive to most negative about their experiences in the programme, and there was one unique case (learning disabled but accelerated student). Parents indicated that their children were more likely to talk about the enrichment programme activities than any other school work. The programme sparked many of the conversations and is perceived to have enhanced family cohesion in positive ways. Participation in the programme reinforced parents' perceptions that their children were gifted and talented, rather than changing those perceptions. One of the most important functions of the programme was to provide a link between home and school; the parents felt more connected to the school when their child was involved in the programme. Additional research focusing on exemplary programmes has also shown the need for increased support for talent development through sustained interactions with family and community (Briggs, Reis, Eckert, & Braun; 2006; Moon, 2003).

There are reported cases where parents have been dissatisfied with their children's education and have advocated for alternative provisions. In a few Australian case studies reported by Vialle, Ashton, Carlon, and Rankin (2001), some of the parents had taken on an advocacy role in order for their children to be recognized as gifted and placed in an accelerated programme. These parents had considerable knowledge about appropriate educational options. Parents of children participating in research and programmes in various American universities for mathematically talented students have expressed frustrations of having children who do not fit into the system

(Lupkowski-Shoplik & Assouline, 1994). Parents often have to go through layers of official channels and wait months at the start of the school year before their children are appropriately recognized and challenged. Some have to repeat this in subsequent years and others seek outside help. Assouline and Lupkowski-Shoplik (2003) commented that parents are their children's primary advocate and "in advocating for their children, parents are not "pushing" their children" (p. 19). They are merely responding to their child's interests and abilities. "Parents are the #1 advocates for their children and therefore assume a prominent role in the home setting for rules, expectations for success, and quality of work" (Callard-Szulgit, 2003, p. 73). It is also suggested by Matthews and Foster (2005) that parents, in advocating for one child, may make a bigger difference than they realize. Parents may also advocate for increased professional development opportunities for teachers that will enable better recognition of, and provision for, gifted and talented students. Home-school partnership in gifted education has been recognized in New Zealand with the recent release by the Ministry of Education of *Nurturing Gifted and Talented Children: A Parent-Teacher Partnership* (Bevan-Brown & Taylor, 2008). This addresses questions commonly asked by families and provides information about identifying giftedness.

Homework

There appears to be variability in the research related to homework, with differing definitions and understandings as to what comprises homework, and what constitutes parental involvement and support. Many studies focused on homework at the higher levels of schooling, whereas Hoover-Dempsey, Bassler, and Burow (1995) focused specifically on the elementary years. They argued that parents have an important part to play in the early years in forming attitudes towards homework, patterns of strategy, and accomplishment. From a representative sample, the researchers found that parents' involvement in their children's homework was based on their understanding of children's characteristics and their own abilities. As a group, they saw themselves as having an active role in structuring homework activities, motivating children, and working with them in relation to the tasks set, and interacting with the teacher about the homework.

Theoretical Frameworks

Parental involvement is by no means a unitary construct, but refers to substantially different types of involvement by parents. Most models for parental involvement were based on the assumption that student outcomes are influenced by parental involvement which, in turn, is influenced by factors such as socioeconomic variables or attitudes. These models, however, do not allow answers to the following question: In what way do parents become involved in their child's education? Hoover-Dempsey and Sandler's (1995) model provided a theoretical basis for examining parental involvement in children's education. The focus is on variables most salient to the parent involvement process and therefore is potentially subject to specific intervention. In this model, the authors believe that parents become involved in their children's education for three major reasons: "(1) their personal construction of the parental role; (2) their personal sense of efficacy for helping children succeed in school; and (3) their reaction to the opportunities and demand characteristics presented by both their children and their children's schools" (p. 313). As a consequence of this role construction, parents select levels and forms of involvement in educationally-related activities both consciously or otherwise, in both the home and school setting. If they choose to become involved, that level of involvement is based on a variety of factors such as the parent's specific skills and knowledge, total demands (which include family and work), and demands for involvement from children and school.

The role that parents play in terms of their children's interest and development in mathematics learning is provided in Hoover-Dempsey and Sandler's (1995) model. The essential elements of the model (in order from the bottom layer) are: (1) the parental involvement decision; (2) the parents' choice of involvement forms; (3) the mechanisms through which parent involvement influences child/student outcomes; (4) tempering/medicating variables; and (5) child/student outcomes. The model (Figure 2.3) provides a theoretical framework for examining variables that are deemed to be of importance in parents' decisions to become involved in their children's education and the forms that involvement takes. The model suggests "specific points of entry into (or predictions about) the process of parental involvement and child outcomes for both research and practice" (p. 329).

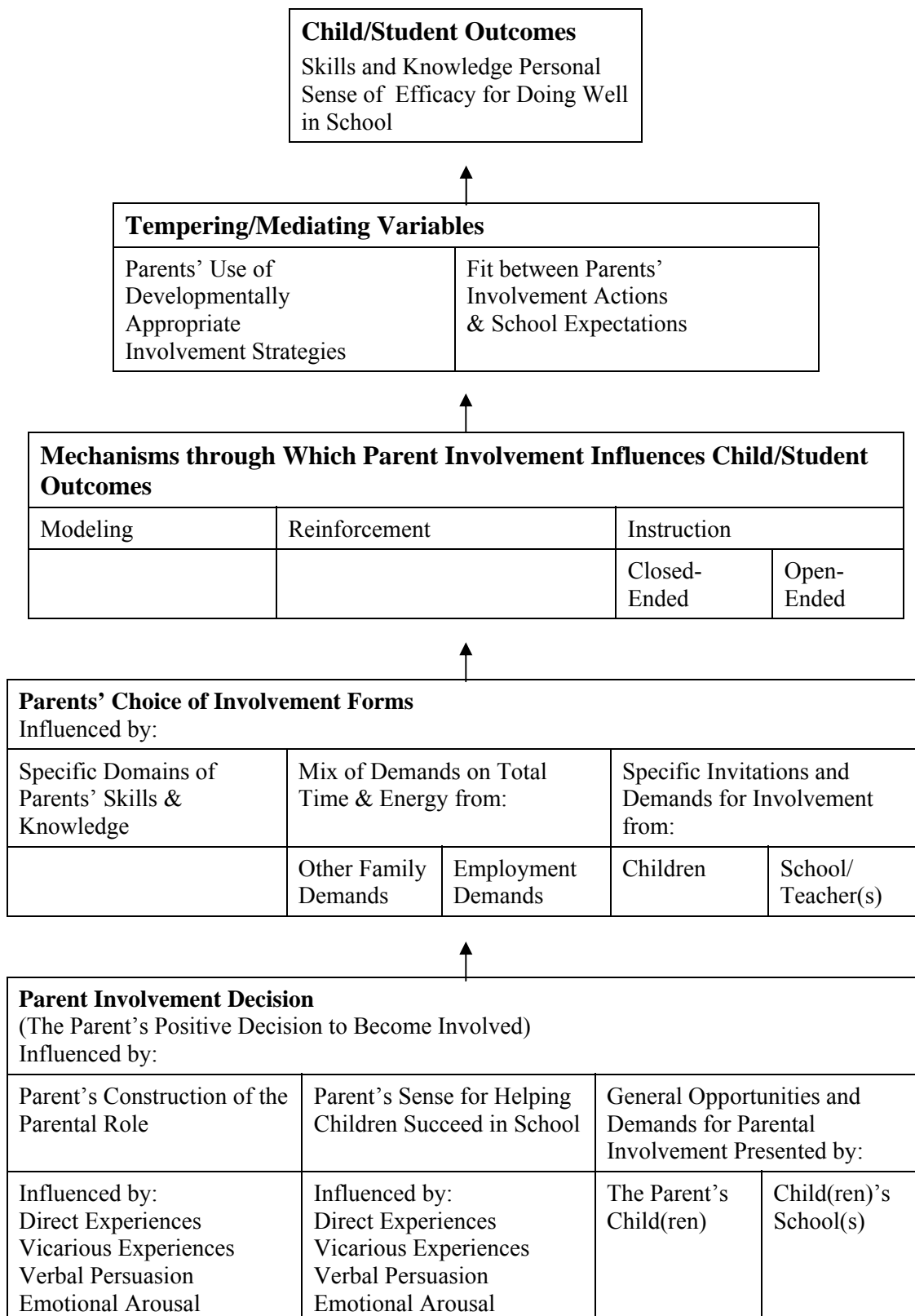


Figure 2.3. Casual and specific model of parental involvement, focused on variables of major significance that are also subject to intervention and change (Hoover-Dempsey & Sandler, 1995, p. 327).

Another framework for investigating parental roles was provided by Cai, Moyer, and Wang (1999). They identified five parental roles in middle school students' learning of mathematics: motivator, monitor, resource provider, mathematics content adviser, and mathematics learning counsellor. Parents as motivators, monitors, and resource providers are roles they play in providing emotional and resource support in students' learning. Mathematics content adviser and mathematics learning counsellor are roles that parents play in directly assisting students' learning of mathematics in the home setting. The initial study, conducted in the United States with the primary guardians of 220 middle school students, found that parental involvement was positively related to students' mathematics learning. The students with the most supportive parents exhibited higher mathematics proficiency and performance levels and more positive attitudes towards mathematics than students with the least supportive parents. Cai and associates continued with cross-cultural studies and developed a Parental Involvement Questionnaire (PIQ)⁸ to assess the level of parental involvement in students' learning of mathematics. The PIQ is a reliable and valid instrument that has been extensively trialled and revised (Cai, 2003). The 23 items relate to the five roles outlined: motivator, monitor, resource provider, mathematics content adviser, and mathematics learning counsellor.

Radaszewski-Byrne (2001) supported those roles described by Cai et al. (1999). She explained that the type of relationship between professionals and parents that may be critical for gifted children was the "parent as instructional partner" (p. 32). This is a partnership where both parties have a joint focus on the abilities and interests of the individual child, a willingness to work together, to communicate about assignments, and a joint commitment to responsibilities.

2.8 Transition or Transfer

Transfer is usually interpreted as the move from one stage of schooling and from one school to another whereas transition is the move from one year to another within the same school (Demetriou, Goalen, & Rudduck, 2000). However, some research uses the term transition for a transfer from elementary or primary school to secondary

⁸ The PIQ is used in this study.

school. In this thesis, the term ‘transfer’ will be used for the move from one type of school in the education system to another. Students can transfer at various ages with the most common experiences in New Zealand being Year 6 to Year 7 (intermediate school for Years 7 and 8) and Year 8 to Year 9 (secondary school). Variations exist, with some schools catering for Years 1 to 8, others Years 7 to 13. In New Zealand the transfer from primary school to intermediate is viewed almost as a *rite de passage*. It is an interim move, challenging students personally, socially, academically, and structurally in terms of a school’s organization. Transfer usually coincides with passages in child development such as the move from childhood to adolescence.

The consistent research findings from both the United Kingdom and the United States provided evidence of dips in pupil progress at each point in transfer—primary to middle school or middle to junior high (Anderson, Jacobs, Schramm, & Splittgerber, 2000; Galton & Morrison, 2000). Noyes (2006) raised the issue, specifically using the context of mathematics, of trajectories and how school transfer acts like a prism diffracting the social and academic trajectories of students as they pass through it. Students showed signs of anxiety and excitement at the prospect of moving to a new school which is often a much larger school and some students expressed difficulties with sustaining commitments to learning and in understanding the continuities in learning (Demetriou et al., 2000). However, for the majority of students any fears had largely disappeared after the first term. The main problem that typically remained was a lack of continuity across the curriculum. Students were faced with revision and a lower level of task demand which led to boredom (Galton, Morrison, & Pell, 2000), lack of motivation (Anderman & Maehr, 1994; Athanasiou & Philippou, 2006), disengagement from school (Anderson et al., 2000) and dips in progress (Catterall, 1998). This dip in achievement has been attributed to a lack of curriculum continuity between the primary and secondary stages of schooling, variations in teaching approaches, and the consequent failure of students to take account of these differences (Galton et al., 2000). What the research does not at this stage indicate is whether that dip in progress resulting from transfer is cumulative—hence the need for longitudinal studies.

Another contributing factor could be the practice of *tabula rasa* or ‘fresh start’ (Galton & Hargreaves, 2002). The justification for this practice is that secondary schools feel they are better equipped to make judgements about students’ abilities in subject areas because of teachers’ specialist knowledge. Galton and Hargreaves (2002) wrote that it was questionable, therefore, whether curriculum continuity is taken seriously and is an achievable goal. Addressing this issue, a Finnish study (Pietarinen, 2000) showed that professional dialogue between the teachers improved their ability to take account of a student’s learning environment and learning strategies. An extensive national Scottish report by Simpson and Goulder (1998) identified the liaison between primary and secondary schools as a vital component in the provision of continuity in students’ experiences. However, it was recognized as a complex process and attributed the issue with many difficulties. For example, they cited primary teachers’ perceptions of them as subject specialists as a barrier to successful liaison, lack of coordinated liaison activities, inconsistencies between records from different schools, the reliability of records from sending schools, and usefulness for planning for the secondary school when they considered them to be vague and sometimes misleading. With a potential level of distrust, it gives rise to the question as to whether teachers should spend considerable time and effort on compiling, improving, and refining records.

There is an expectation that schools will prepare students well for schooling in the next stage of the hierarchical educational system (Galton, 2000). Schools are held accountable for this preparation, but the Education Review Office (2006) found that there was a lack of focus on preparing students for the transfer to secondary school. This is despite many schools having strategic plans with statements pertaining to successful entry and transfer to secondary school. The Education Review Office reported that for the diverse groups of students, there were “limited or no opportunities to develop awareness of their strengths and abilities” and the students were “at risk of being unprepared for the transition to secondary school” (p. 2). This lack of focus on preparedness by teachers is supported in a New Zealand study by Hawk and Hill (2001) who found that many teachers were so focused on curriculum coverage that they did not take the time to prepare students for school transfer. Schumacker and Sayler (1995) found that students may lack adequate study and time management skills in making transfers, although the focus of this study was on the

transfer to early university entrance programmes. They also suggested the need for good organizing, recording, and reporting skills as well as good study habits and motivation.

A recent study (n=100) in New Zealand (Ministry of Education, 2008) found that transferring from primary to secondary schooling was “not the disaster that is often feared” (p. 4). Most students adapted quickly to the organizational changes, but the ‘danger period’ with respect to relationships with teachers, and learning and teaching in general, was in the second half of their year in the new school. Students’ achievements in mathematics showed a marked decline over the transfer from primary to secondary, but improved during the year. Students became “less engaged in aspects of their learning at school over time and more critical about some of the teaching they were experiencing” (p. 6). This study used Assessment Tools for Teaching and Learning (asTTle) items to measure achievements in mathematics, but did not focus specifically on gifted and talented students.

Parental interest and support is recognized as one factor that enables students to make successful transfers (Dauber, Alexander, & Entwistle, 1996). Mac Iver (1990) found that when parents were involved in the transfer process, they tended to stay involved with their children throughout secondary school. Successful transfers also occurred when reception schools made every effort to create a sense of community and belonging, and where students, parents, and staff were involved (Smith, 2001). According to Smith’s United State’s nationally representative sample, transfer programmes that targeted a combination of students, parents, and school staff had a measured impact. This positive effect worked only when the school provided complete support—students, parents, and staff. A comprehensive study (n=297) by Berndt and Keefe (1995) showed that friends also influenced adolescents’ adjustments to school. Both the characteristics of the friends and the quality of the friendships affected this school adjustment. The importance of keeping friends in the transfer process was also reported by Whitton and Perry (2005). Research has also shown that friendship, peer acceptance, and group membership has an established link with students’ academic achievements (Wentzel & Caldwell, 1997). Additionally, Anderson and colleagues (2000) found that students were more likely

to experience successful transfers if attention was paid to student preparedness and support, before, during, and after the transfer.

A longitudinal New Zealand study (Wylie, 2006) followed 500 students from their final early childhood years through their schooling years and compared views of school and performance levels at ages 12 and 14. The majority of students were looking forward to secondary school; 25% were expecting more challenge, 22% more choice and independence. No negative effects on student competency levels were found with their move to new schools and no major patterns associated with differences in social experiences and resources. The findings of concern were an increase in the level of boredom and those who thought they could do better if they tried. This study showed that in New Zealand there were not the dips in performance as feared. However, the data analysis did not differentiate among ability levels.

Students experience several transitions and transfers during their years of schooling. Each transfer is important and worthy of consideration in any child's schooling. However, just because a student has successfully negotiated one transfer does not mean that he or she will successfully negotiate the next one. The growing body of research on transfer has found that the overall impact from elementary or primary school to junior secondary school can be negative, leading to decreased self-esteem, lower self-concept of ability in school subject domains, declines in perceptions of competence, decreased liking in specific school subject domains, and lower school grades (Galton et al., 2000). However, the nature and extent of change is dependent on the school and a student's level of achievement. Parental involvement also plays a role in successful transfer (Mizelle, 2005); when parents are involved in the transfer process they tend to stay involved with their children throughout secondary school (Mac Iver, 1990). However, parental involvement tends to drop significantly as children enter the secondary system unless schools and teachers deliberately work to keep parents involved at this level.

The issue of transfer is attracting wider interest nationally and internationally. This is related to the drive for increased levels of student achievement especially in the areas of literacy and mathematics. However, whilst studies such as those previously described, contribute to our understandings of the process and potential challenges

academically, socially, and affectively, most do not attend to special populations such as gifted and talented students. More specifically, they do not attend to the process for mathematically gifted students. We know little about the practice of *tabula rasa* or ‘fresh start’, the use or non use of sending schools’ records (for example, NumPA results), and student preparedness. These are further aspects addressed in this study.

2.8.1 Conceptual Framework for Examining Transfer

Students face challenges in making a transfer at two levels—the macro level of the school’s physical structures and organization and at a micro level in the classroom with a teacher who is a subject specialist and a teacher who may use different teaching approaches. Anderson and colleagues (2000) suggested a framework with three major concepts for understanding and improving school transfer and success. These concepts were preparedness, support, and transitional success or failure. According to the researchers, preparedness is multidimensional and includes academic preparedness, independence and industriousness, conformity to adult standards, and coping mechanisms. Support from others, be it informational, tangible (resources), emotional or social, facilitates successful transfer. This support may come from peers, teachers, or parents. Transitional success or failure can be judged by factors such as grades, appropriateness of a student’s post-transfer behaviour, social relationships with peers, and academic orientation. These indicators are what are commonly commented on report cards, namely: achievement, conduct, and effort. This framework has been recognized as useful for also addressing transfer problems (Galton & Morrison, 2000). The issue of transfer needs to be considered along with the wider transition process. Galton and Morrison state that “the development of pupils as ‘professional learners’ requires not just our attention when pupils move from one school to the next but continuously” (p. 448).

2.9 Conclusion

Research in gifted education is growing extensively with a widening national and international interest. Early key studies of Terman, and Stanley provided a sound basis for subsequent studies and in particular for longitudinal research. More recently

Renzulli, Reis, and VanTassell-Baska have contributed significantly to the field. Taken as a whole there are numerous studies from which one can extract findings relevant to certain ages, contexts, identification practices, and provisions. Most of the studies have specific foci or agendas addressing usually only one or two of those aspects previously outlined. As noted in the introduction, the field of research is problematic, 'gifted and talented' means different things to different people in different places and situations. Definitions are important along with the selection of research participants, sample size, research methodologies, and claims for generalizations. Published findings with respect to provisions and organizational strategies are at times contradictory.

In New Zealand, the studies are very limited, especially with respect to identification, provisions, parental involvement, and transfer. Many questions remain unanswered, especially for mathematically gifted and talented students. The purpose of this thesis is to address some of these unanswered questions and to add a more holistic view on the education of mathematically gifted students. The following chapter will represent the aims supported by a discussion of the chosen methodological approach for this research study.

CHAPTER THREE:

METHODOLOGY

3.1 Introduction

This study aims to examine, from multiple perspectives, the mathematical learning experiences, past and present, of a group of students identified by their teachers as gifted and talented in mathematics. As a consequence of this study, the researcher contributes to the knowledge base synthesized in the previous chapter by adding multiple perspectives, situating the research in the New Zealand context, and by focusing specifically on gifted education within the learning domain of mathematics.

The chapter begins by re-stating the research questions followed by methodological issues raised with regard to conducting this research. Research practice does not exist in a vacuum and so it is important to articulate the researcher's view of reality. This view of reality in turn influences and impacts on how the researcher believes this field of the social sciences should be studied. There are challenges for researchers endeavouring to compartmentalize views within one particular paradigm. Paradigms are viewed as "ways of thinking that generate certain types of research questions and therefore lead to different interpretations of the results obtained by such methods" (Wardekker, 2000, p. 261). The following outline describes where this research resides in relation to the researcher's ontological, epistemological, and phenomenological views of the world.

The chosen research design is justified, along with views about the nature of the relationship between theory and research, what is appropriate and important knowledge about the social world, and how social entities can be viewed. An explanation is provided of the research design deemed most suitable for addressing the research questions, namely case study. Case study research has been "a cornerstone of research on giftedness" (Moon, 1991, p. 157). The selection of data gathering tools, ethical processes, and considerations are addressed in detail to give

the research project both validity and reliability. The methodology in practice is detailed in the subsequent chapter.

3.2 Research Questions

To meet the aims of the study, the following research questions were posed:

1. What are the characteristics of mathematical giftedness recognized by school policies and procedures, teachers, parents, and students?
2. How are mathematically gifted and talented students identified?
3. What provision for the students' education in mathematics has been made within the classroom and school contexts?
4. What are the characteristics of an effective teacher of mathematically gifted and talented students?
5. What roles have parents played in their child's mathematical development?
6. How is a school transfer managed for a mathematically gifted and talented student?

3.3 Epistemological, Ontological, and Methodological Considerations

In order to understand the methodological approach of this particular study, it is helpful to briefly describe some of the research paradigms underpinning social scientific inquiry. These paradigms reflect different 'world views' as "every worldview within which the researcher becomes immersed holds the key to knowing" (Bishop, 2005, p. 124). They denote particular ontologies, epistemologies, and methodologies. The researcher tends to "work between and within competing and overlapping perspectives and paradigms" (Denzin & Lincoln, 2005, p. 6). The researcher in this study grappled with the exclusivity of some paradigms and accepted that her 'world view' and desire to address research questions through engagement with 'significant others' meant a reluctance to subscribe to one particular paradigm. The researcher recognizes an open and eclectic view of inquiry in the social sciences and the "moral foundations of educational research" (Nixon &

Sikes, 2003, p. 5). It is important that a researcher acknowledges her own values and how they are matched in relation to those foundations.

In order to study the social reality of the world, it is necessary to acknowledge that a clash exists between an emphasis on the explanation of human behaviour (a positivist perspective) and the understanding of behaviour (Bryman, 2004). Positivism derives from a traditional scientific approach that relies upon quantitative methods to verify hypotheses. The explanation and understanding of human behaviour is embraced in a notion of a *Verstehen* approach as defined by Weber (1949). Weber (1949) described sociology as a science that “attempts the interpretive understanding of social action in order to arrive at a causal explanation of its course and effects” (p. 88).

3.3.1 Interpretivism

The interpretivist epistemology is predicated upon the view that “a strategy is required that respects the differences between people and the objects of the natural sciences and therefore requires the natural scientist to grasp the subjective meaning of social action” (Bryman, 2004, p. 13). It includes Weber’s notion of *Verstehen*. An epistemology is needed that recognizes and reflects a difference between humans, and acknowledges that social reality has meaning for people, and human behaviour is meaningful. It is then the role of the social scientist to interpret human actions and the world in which they live from their points of view. Research in the interpretive paradigm attempts to “find out what meanings people construct, how they construct them, and how these constructions guide their actions, with the intention of providing “heuristic schemes” that people may or may not use” (Wardekker, 2000, p. 266). The intention is to contribute to a collection of interpretive schemes. The outcome therefore should be on developing an understanding of the interpretations of the participants rather than the researcher’s interpretations. This could be considered a limitation of the interpretive paradigm as it means that the reader is reliant upon the researcher’s interpretations. However, the researcher should provide sufficient evidence to give the study validity.

3.3.2 Qualitative Research

Qualitative methods predominate within the interpretive paradigm, but that does not mean that an anti-quantitative view is taken. In fact, occasion arises where some of the data gathered are treated quantitatively to gain an overall sense of meaning. The question is not whether the research is absolutely qualitative, rather a matter of degree. Moreover, ‘meaning’ is paramount to the qualitative researcher; the researcher is interested in participants’ perspectives on the same issues and an exploration of the intersections and implications. It is also useful to consider the concept of phenomenology which is central to qualitative research. In considering one’s approach from a phenomenological perspective, a researcher is attempting to “understand the meaning of events and interactions to ordinary people in particular situations” (Bogdan & Biklen, 2003, p. 23). This approach is also located within the interpretive understanding of human interaction or *Verstehen*.

3.3.3 Naturalistic Inquiry

In naturalistic inquiry, researchers spend a considerable amount of time in places such as schools or homes and other locales in which they learn about educational concerns (Bogdan & Biklen, 2003). The data are collected by the researcher using such means as recording devices or merely pen and paper. Data may be gained on location, recorded, and then reviewed by the researcher with the researcher’s insight as the key instrument for analysis. The context or setting is important; the situation can be best understood by observing the participants in the setting in which the action, such as learning, occurs. It is not possible to describe or explain the context fully, but the naturalistic study comes closer than any other strategy in attempting to give a comprehensive understanding of context (Erlandson, Harris, Skipper, & Allen, 1993). “Qualitative researchers assume that human behaviour is significantly influenced by the setting in which it occurs, and wherever possible they go to that location” (Bogdan & Biklen, 2003, p. 5).

The naturalistic paradigm is characterized by natural settings, humans as primary data-gathering instruments, the use of tacit knowledge, qualitative methods, purposive sampling, inductive data analysis, grounded theory, emergent design, negotiated outcomes, case-study reporting mode, idiographic interpretation, tentative

application of findings, focus-determined boundaries, and special criteria for trustworthiness (Lincoln & Guba, 1985). Many of these characteristics that relate in particular to this study are discussed further in the chapter.

In naturalistic inquiry, it is important that the research process is clearly described so that it is apparent where the data originated, how the data were collected, analyzed, and the basis for summaries. The qualitative researcher may approach the building and testing of theory from two directions (Neuman, 2007). In a deductive approach the researcher begins with the abstract and moves to the concrete, whereas if the researcher uses an inductive approach, she begins with the detailed observations and moves towards more abstract generalizations. The theory therefore is grounded in the data.

3.3.4 Grounded Theory

A grounded theory perspective maximizes researcher interpretation, editorial control, researcher coding, and analysis. It emanated from the work of Glaser and Strauss (1967). Grounded theory seeks to capture some of the general principles of analysis. It seeks to go a little further than inductive logic, does not presume deductive reasoning, but seeks to examine more closely the interactions among data, ideas, research design, and data analysis. These principled relationships between data and analysis, using grounded theory, still align with Weber's notion of *Verstehen*. The sociological principles involve a meta-analysis, interpretations, or analyses by the participants, and analyses by the researcher. Fundamentally, "grounded theory methods are a set of flexible analytic guidelines that enable researchers to focus their data collection and to build inductive middle-range theories through successive levels of data analysis and conceptual development" (Charmaz, 2005, p. 507). In practice, it means that researchers stay close to the participants and setting, and from findings, synthesize, interpret, and make sense of the processes constituting how the participants' worlds are constructed. Within a grounded theory framework, there can be interplay between interpretation and theorizing on the one hand, and data collection on the other hand (Bryman, 2004). To go further than this would be to accept Berg's (2001) suggestion of a spiral approach in that theory-before-research and research-before-theory are seen as compatible. With this approach the researcher

begins with the idea, gathers the theoretical information, reconsiders and refines the ideas, examines designs, re-examines theoretical assumptions, refines ideas, and so on.

3.3.5 Qualitative Research in Gifted Education

Qualitative research in gifted education in recent years “has gone from being a novelty to being an accepted part of the literature” (Coleman, Guo, & Dabbs, 2007, p. 51). The research in the field has provided information about processes and conditions conducive to the development of talent, and insider perspectives on the understanding of giftedness. Coleman et al. (2007) found that none of their reviewed articles tried to develop theory. Most of the studies made no theoretical references, and in “most instances not enough information was provided to show more than a nominal connection between data and theory” (p. 58). The studies recognized as having the highest quality used a combination of procedures—participant observation, interviews, and the study of physical evidence. The writers recognized the need for more case studies in gifted education and the inclusion of the discrepant case.

3.4 Case Study

Case study is an eclectic term but one that encompasses the family of research methods with the common decision to focus on enquiry around an instance in action (Simons, 1980). Stoecker (1991) believed that we should reserve the term for “those research projects which attempt to explain holistically the dynamics of a certain historical period of a particular social unit” (pp. 97-98). The justification for case study is that it is, in broad terms, naturalistic and emancipatory (Kemmis, 1980). The basic case study involves the detailed and intensive analysis of one case. Stake (1995) provided one of the most cited descriptions of case study research and explained that case study research is essentially concerned with the complexity and particular nature of a case as a single entity such as a school, community, family, person, or event. Exponents of case study generally favour qualitative methods, but case studies frequently use both qualitative and quantitative methods (Bryman, 2004). Much case study research takes place on what Bryman (2004) terms the

‘exemplifying case’. The case is chosen because it provides a suitable context for the research questions to be answered. Case study can be associated with both theory generation (grounded research) and theory testing.

According to Merriam (1988), case study “is a particularly suitable methodology for dealing with critical problems of practice and extending the knowledge base of various aspects of education” (p. xiii). An outcome from the emerging understandings should be improvement in practice. The case study as such, rather than a specific methodology, draws from a variety of philosophical perspectives and methodologies. It is however a holistic and comprehensive description of a bounded phenomenon such as an institution, person, process, or social unit such as a classroom. The ensuing report may be a narrative, interpretive, or evaluative account of the case. The case study provides a blueprint for assembling, organizing, and integrating information (Merriam, 1988). The context of the case is important. Yin (2003) suggested the case study is particularly suited to situations where it is not possible to separate the phenomenon’s variables from their contexts.

Merriam (1988) provided four key characteristics of case study. A case study is particularistic in that the focus is on something or someone in particular. It is descriptive in that ‘rich’ or ‘thick’ descriptions are provided. ‘Rich’ descriptions are essentially well detailed and viewed as valuable by qualitative researchers (Denzin & Lincoln, 2005). Geertz (1993) borrowed and reinterpreted the phrase ‘thick descriptions’ as he called for detailed reports from anthropological studies in which writings are viewed as interpretations of interpretations. Geertz (1993) stressed multiple perspectives or interpretive frameworks. According to Atkinson and Delamont (2005) ‘thick descriptions’ should include “analytic attention to the multiple codings and structuring principles through which social life is enacted and represented” (p. 832). Case studies are heuristic in that they illuminate understandings, give new meanings, or confirm what is known. They may also lead to evaluations, summaries, and conclusions that increase the potential for application. Finally, they are inductive in that generalization, concepts, or theory may emerge from the data itself as described in grounded theory.

In planning the case study, the researcher needs to consider the circumstances of the case, the conduct of the study, and the consequences of the research (Simons, 1980).

The case may arise from the researcher's own interests. The researcher needs to consider the type of case study and suitability for addressing the research questions.

3.4.1 Different Types of Case Study

Cases may be considered for their uniqueness or their commonality, but also for intrinsic or instrumental purposes (Stake, 1995). A particular case study may provide the means to accomplish understandings about something or someone in particular. Case studies can also be differentiated as to whether they are primarily descriptive, interpretive, or evaluative (Merriam, 1988). Other terms to differentiate types of case study pervade the literature (see, for example, Bogdan & Biklen, 2003; Yin, 2003). Essentially, the descriptive case study presents a detailed account of the phenomenon being studied. Descriptive case studies are commonly used to form a database for comparative studies and for developing theory. The interpretive case study contains rich or thick descriptions and is used to develop categories based on common concepts or to support and/or challenge theories. Data are gathered for the purpose of interpreting or theorizing about the phenomenon. Evaluative case studies incorporate more than description; they go further and include explanations and judgements.

The pilot case study is part of the final preparation of the data collection process. The main criteria for selection of the pilot case study may be convenience, access, and geographic proximity (Yin, 2003). The participants in the pilot case study may be particularly amenable to the project aims and also accessible. The study is formative and helps in the trialling and development of questions and may also provide some conceptual clarification for the research design (Yin, 2003). The researcher may follow a pilot study with multiple-case studies.

3.4.2 Multiple-Case Studies

Multiple-case studies or collective case studies (Stake, 1995) take a variety of forms. A collective case study may be designed with a greater concern for representativeness; the purpose for collecting data from multiple sites may be to show generalizability or diversity. It may also be to compare and contrast particular characteristics or features. When working with multiple cases, most researchers do

not work across sites at the same time. This reduces the risk of confusion between or among sites. The first case study can also provide a focus to help refine the focus for subsequent cases. Multiple-case studies are based on the logic of replication not sampling (Yin, 2003). The researcher may also find that the case proves to be deviant, so considerations have to be made as to whether to include the case. In some instances a focus on the negative case may be a key purpose for the case selection (Denzin & Lincoln, 2005). Another approach is to extend the research and consider a longitudinal study.

3.4.3 Longitudinal Studies

Case study often includes a longitudinal element. The researcher may remain a participant of a community for a sustained period of time or revisit a setting and re-interview participants over a lengthy period. Similar research tools may be used or adapted upon each revisit. So, how long is a ‘lengthy period’? The question arises as to when a study is described as longitudinal. Flick (2006) describes studies as longitudinal when you “analyze an interesting process or state again at later times of the data collection” (p. 143). The strength of the longitudinal study is being able to monitor and document changes of view or action through repeated data collection phases. These repeated phases may strengthen the base for generalizing to a population.

3.4.4 Generalizability

Generalizability is a standard aim of quantitative research. However, according to Stake (2005), although no attempt is made to generalize from case study beyond the single case, the case helps to establish the limits of generalizability. The question of generalizability is raised when findings of a particular study are considered to apply beyond the participants and setting. However, most case study researchers do not delude themselves that it is possible to make generalizations from a case (Bryman, 2004; Silverman, 2006). Reporting the findings from one or more cases does not necessarily imply a true representativeness for the population as a whole. From the findings, interpretations can be made that could be applied to, or inform people in similar settings or situations. It is the quality of the theoretical inferences that is of

value, understanding the contextual conditions of the new setting, and how these differ from the setting of the original study in which the knowledge was produced.

Bassey (1999) introduced the term ‘fuzzy generalization’ borrowing the adjective fuzzy from ‘fuzzy logic’ (Fourali, 1997), the principle that everything is a matter of degree. Fuzzy logic, Fourali argued, is appropriate for many educational situations and allows educators to express views in more flexible ways. Bassey (1999) defined his term, ‘fuzzy generalizations’ as “general statements with built-in uncertainty” (p. 52). Unlike scientific generalizations which have no exceptions, the fuzzy generalization can be helpful in educational case study in that what has happened in one place may happen in another. Through replication another researcher may discover new material that could lead to amendments of the fuzzy generalization. However, it is only when the fuzzy generalization is read in conjunction with the research report that it can have any credence. There are many other aspects and roles associated with the process that the researcher must consider.

3.4.5 Roles of the Researcher

The researcher is the primary instrument for data collection and analysis (Merriam, 1988). It is through the researcher that the data is mediated; he or she is responsive to the context and receptive to the participants. The qualitative study is in fact limited by the sensitivity and integrity of the researcher. As the research unfolds, the researcher is guided by his or her own knowledge, instincts, abilities, and judgments. This is why the issue of ethical practice must be understood. Throughout the project, the researcher exercises discretion and at times has to adapt to unforeseen events and respond with sensitivity. This notion of ‘sensitivity’ is demanded in case study research (Merriam, 1988). The researcher must be sensitive to the setting, the people, agendas, and non-verbal behaviours. In the data gathering phase, it means being sensitive in situations such as the interview (for example, allowing for silence and knowing when to stop), and finally being sensitive to the data and researcher biases. Guba and Lincoln (1981) suggested that the best way to address researchers’ biases is to be aware of “how they slant and shape what we hear, how they interface with our reproduction of the speaker’s reality and how they transfigure truth into falsity”

(p. 148). It is also up to the researcher to communicate well, to establish a positive rapport with participants, and to instil a sense of empathy.

The researcher deliberately or intuitively makes role choices at the outset of the research, throughout the research, and even post research. The results are the product of the interactions between the research process, the practices, and experiences under study. As Wardekker (2000) warned, this means that change occurs not necessarily as a project ends, but even whilst a researcher is engaged in the research, there is a potential for learning and change. The researcher is co-responsible for both the research results and any resultant changes in practice. Aspects that have to be addressed by the researcher include the level of participation, when to act as an expert or neutral observer, when to advocate a position, and what to tell in the story. To ensure good practice and to reduce role conflict, the researcher should strike a balance between participation and distantiation. Stake (1995) wrote that the role of researcher is essentially “an ethical choice, an honest choice” (p. 103). There is a multiplicity of choices to be made and one of the first in case study is that of the choosing the case or cases—the sample.

3.4.6 Sampling

Sampling involves the selection of a research site, time, people, and events. The most common form of sampling in case study is what Patton (2002) terms purposeful or purposive. A purposive sample builds in variety and acknowledges opportunities for intensive study (Stake, 2005). Essentially, this type of sampling is strategic; the researcher decides on certain criteria for the case under investigation and then finds a case or cases that match these criteria. It is therefore theoretically grounded (Silverman, 2006). Stake (2005) also suggested that for multiple-case studies balance and variety are important. Even though the case is usually decided in advance there are subsequent choices to be made about what people, places, and events are to be observed. Hence, there may be cases within cases.

3.5 Data Gathering Methods

Data gathering methods refer to the research techniques that are used to gather information, the technical aspects to the study. The methods described here are consistent with the methodologies previously described and consequently ones that are used in this study. In order to understand the way participants think about their world and make sense of what is happening in their world it is necessary to go into that world to observe, talk, and gather material. Denzin and Lincoln (2005, p. 4) used the expression ‘researcher-as-methodological-*bricoleurs*’ as the researcher moves from a paradigm and research design to the specific collection of empirical materials.

Miles and Huberman (1994) describe qualitative data as “a source of well-grounded, rich descriptions and explanations of processes in identifiable local contexts” (p. 1). Qualitative data describe situations, events, people, interactions, documents, and observed behaviours. These descriptions, quotations, and excerpts are the raw data that are used to support, illustrate, and substantiate the findings. It is data gained *in situ*. The “propensity for description can also be interpreted as a manifestation of the naturalism that pervades much qualitative research because it places a premium on detailed, rich descriptions of social settings” (Bryman, 2004, p. 281).

The primary methods chosen for this study are interviews, observations, questionnaires, and documents. Quantitative data from questionnaires are also used to support qualitative findings. The opportunity to use multiple data gathering methods can be viewed as a strength of the case study and also support the most common application of triangulation (Silverman, 2006). Triangulation from this perspective is a strategy that adds “rigor, breadth, complexity, richness and depth to any inquiry” (Denzin & Lincoln, 2005, p. 5).

3.5.1 Interviews

One key way for the interpretive researcher to gain an understanding of differing views and values is to elicit these views from interviews. The type of qualitative interviewing that the researcher conducts should be tailored to the type of questions and also be personally comfortable for the researcher (Rubin & Rubin, 1995). The most common form of interview is the one-to-one interview although interviews may

be conducted with small groups or panels of people. Fundamentally, the interview is a conversation to obtain information related to a specific topic with the purpose of obtaining another's perspective. According to Silverman (2006), it is important that we do not hear interview responses as true or false reports on reality, but treat such responses "as *displays* of perspectives and moral forms which draw upon available cultural resources" (p. 144). Unlike the questionnaire, the interview should be designed for depth, detail, vividness, and nuance (Rubin & Rubin, 1995). Depth means the interviewer gets a thoughtful answer based on considerable evidence; detail is gained by asking for examples; vividness can be encouraged by asking for firsthand descriptions and by not interrupting; and nuance means precision in description.

The main types of interviews are structured, semi-structured, and unstructured. When interviewing in case study, the researcher primarily uses semi-structured interviews. A predetermined list of questions guides the research whilst at the same time the researcher may not use exact wording or question sequence. However, the interviewer ensures that all predetermined questions are asked and that a similar wording is used. This structure is important in particular with multiple-case studies for cross-case analysis. The semi-structured interview allows the researcher to respond to answers, elicit further information with additional questions, and pursue other unanticipated views or ideas relevant to the research aims. This process should provide the researcher with rich, detailed answers.

Other factors which influence the interview situation are the researcher's skills, respondent's attitude at the time of the interview, rapport, and external factors such as location and time of day (Hammersley & Atkinson, 2007). The interviewer-respondent relationship is complex, but needs to be acknowledged. Kvale (1996) proposed ten criteria for a successful interview:

- Knowledgeable—be familiar with the interview focus, a pilot can be useful;
- Structuring—gives purpose;
- Clear—simple, easy, short questions, no jargon;
- Gentle—tolerate pauses, give time to think, don't interrupt;
- Sensitive—listen attentively, be empathetic;
- Open—responds to what is important and is flexible;

- Steering—knows what he or she wants to find out;
- Critical—is prepared to challenge what is said and addresses inconsistencies;
- Remembering—relates what is said with previous responses; and
- Interpreting—clarifies and extends meanings without imposing meanings.

To this list, Bryman (2004) added the criteria of balance (neither talking too much nor too little) and ethical sensitivity.

The researcher may also interview the research participants on more than one occasion. The initial interview may be conversational in order to gain relevant background information and to make the participant comfortable with the researcher and the process. The second interview provides opportunity to pose additional research questions. A further element to be considered is that the interviewee may continue to talk once the tape recorder has been turned off and it may not be feasible or appropriate to turn the recorder on again. Such ‘unsolicited accounts’, according to Hammersley and Atkinson (1995), can often be a source of revealing information.

In qualitative research, the interview is usually audio-taped and transcribed. Not only is the interviewer interested in what is said, but also the way in which it is said. Transcriptions allow for a more thorough examination of what has been said, repeated examinations, and secondary analysis. It is however a very time-consuming procedure; there is the potential for equipment failure and the interviewer needs to find a venue with as little extraneous noise as possible—a situation that cannot be guaranteed in the school setting. The researcher may have copious interview data from which there is the possibility to construct meaning that differs from the interviewee’s intentions. The material, through a qualitative content analysis process, is reduced, passages explicated for further analysis, and used to collate, compare, and contrast subjective viewpoints. At times, material from varying interviewees may be synthesized and paraphrased with occasional verbatim phrases or sentences used to exemplify the claim. It is both the interview process and subsequent analysis that gives the researcher rich material with which to work, but also presents the potential for researcher bias. The interview “cannot be a neutral tool” (Fontana & Frey, 2005, p. 696), but the researcher can take an “empathetic” stance and become an advocate

and partner in the study. The participants' voices should also be retained, finding a "delicate balance between providing too much detail and too little" so informants are given a forum for presenting their case (Wolcott, 1994, p. 350).

3.5.2 Observations

As a research tool, there are a number of factors to be considered when using observation: what to observe, the relationship between observer and observed, and recording systems. Observations can take many forms: structured or systematic, participant, non-participant, unstructured, simple, and contrived (Bryman, 2004). In the structured observation, the researcher has specific rules for the observation and recording of behaviours. Participant observation is strongly favoured in the social sciences and entails observers immersing themselves in the setting. Non-participant observation means that the observer does not participate in the social setting, but may be conducting structured observation. The unstructured observation involves no observation schedule for recording behaviour. The researcher needs to be aware that people may change their behaviour because they know that they are being observed. This is known as the 'reactive effect' and is the effect that the research subject's knowledge that he or she is participating in scholarly research may confound the investigator's data (Webb, Campbell, Schwartz, & Sechrest, 1966). There are specific kinds of reactivity (Neuman, 2007), but it is important for the researcher to be aware of this effect. Reactivity is usually unavoidable in the context of observing students in class. Finally, in simple observations and contrived observations, the observer is unobtrusive and not observed by those being observed.

Observation is a useful technique "when an activity, event, or situation can be observed first-hand, when a fresh perspective is desired, or when participants are not able or willing to discuss the topic under study" (Merriam, 1988, p. 89). In case study the researcher is rarely a total participant or total observer. They are what can be termed a 'researcher participant' (Gans 1982, cited in Merriam, 1988) or 'reactive observer'. Angrosino (2005) uses the term 'reactive observation' for the observation-based research in which the people being studied are aware of being observed and are also amenable to interacting with the researcher when it is in response to aspects directly related to the research design. The researcher continues to function in the

observer role, but becomes partially involved in response to the specific situation. This role further supports the naturalistic emphasis because the researcher responds to the member of the social setting in their natural environment.

3.5.3 Questionnaires

The questionnaire or survey may be used as part of case study to provide quantitative and qualitative data from responses to structured questions. Formats vary, but most questionnaires consist of a series of closed questions that may require the respondent to indicate answers according to a predetermined list or scale ranging from very positive to very negative. Commonly, a Likert scale is used with five categories, sometimes four to avoid the median category. Survey researchers debate about whether this neutral position should be offered (Neuman, 2007). Piloting the questionnaire is important to check the suitability, clarity, and time involved. Responses can simply be reduced to a numerical value, and averages obtained. The highest score usually denotes the highest value and conversely, low scores reflect negative responses. Questionnaires are viewed as a reliable data gathering tool (Wilkinson & Birmingham, 2003); the researcher retains control of the data and if coded appropriately, results can be found reasonably quickly.

The questionnaire may provide some useful data to support the research questions or to provide background information about the participants. However, the quality of and usefulness of responses is determined by the quality of the questions. The following limitations have been recognized by Wilkinson and Birmingham (2003). These include factors such as the use of leading, complicated, irritating, ambiguous or unclear questions, and too many open-ended questions. Neuman (2007) warned of “social desirability bias” (p. 176) in which respondents give a socially acceptable response rather than an honest one. Other issues relate to aspects such as the length of the survey, the question order and ‘order effects’, format, and layout.

3.5.4 Documents

Lincoln and Guba (1985) distinguished between documents and records as to whether they are prepared to confirm a formal transaction (records such as birth

certificates) or whether they are prepared for personal reasons (documents such as diaries). The term document covers a wide range of sources. The two terms, documents and records, are often used interchangeably⁹. Documents may be personal, official, mass media outputs, or virtual. They are usually produced for reasons other than research, but can be a useful data source. Information and insights gained from documents, relevant to the research questions, may provide concrete evidence to support, refute, or add to findings from other sources. This secondary source may be used as part of the inductive process in building categories and theoretical constructs. The documents may or may not be accurate, but it is unlikely that a researcher would use them in isolation. Documentary data provides an objective source of material compared to other sources and “can ground an investigation in the context of the problem being investigated” (Merriam, 1988, p. 109). Guba and Lincoln (1981) explained how analysis of this data source “lends contextual richness and helps to ground an inquiry in the milieu of the writer. This grounding in real-world issues and day-to-day concerns is ultimately what the naturalistic inquiry is working toward” (p. 234).

Documents as a data source are not necessarily easier to work with than other primary data and once collected “considerable interpretive skill is required to ascertain the meaning of the materials” (Bryman, 2004, p. 381). One of the advantages of using documents is that they are non-reactive so that the possibility of the reactive effect, previously described, does not threaten the validity of the data. Scott (1990) suggested four criteria for assessing the quality of documents. They are: authenticity (how genuine is the evidence), credibility (error-free), representativeness (how typical of its kind), and meaning (how clear and comprehensible is the evidence). The documents must be understood in the situated context of their production. For analysis purposes, the researcher also needs to be aware as to whether they are from primary or secondary sources; so much depends on the “trustworthiness, professional credentials, and status of the author and supporters of the interpretation” (Hodder, 1994, p. 401).

⁹ The terms will be used interchangeably in this study.

3.6 Data Analysis

Data analysis is a complex, time-consuming, and intuitive process (Cresswell, 1994), especially when working with qualitative data which are far from simplistic and mask a good deal of complexity (Miles & Huberman, 1994). This means that in the process of data analysis, the researcher must be careful and self aware. Miles and Huberman (1994) suggested that data analysis consists of three concurrent flows of activity: data reduction, data display, and conclusion drawing and/or verification. Data may be analyzed whilst being collected, but usually intensive analysis occurs after all the data have been gathered. There are sensible grounds for ongoing analysis, such as the monumental amounts of data that can be generated through interview transcripts. Another reason is because it allows for the researcher to be more aware of emerging themes to pursue in later stages of the project. Several levels of analysis are possible, from descriptive accounts to developing categories, themes, and concepts. Qualitative research is usually regarded as denoting an approach in which theory and categorization emerge out of the collection and analysis of data. Details regarding specific data analysis will be given in the following chapter to ensure transparency; lack of transparency is a criticism that is often aimed at qualitative researchers (Bryman, 2004).

There is a strong need to establish meaning in a systematic way, but also to reduce the copious amounts of data that are usually accumulated by the qualitative researcher. “Data reduction is a form of preliminary analysis, which refines, iterates, and revises frameworks, suggests new leads for further data collection, and makes data more available for final assembly into case studies and cross-site analyses” (Miles, 1979, p. 591). The researcher needs to have an analytic strategy. This process usually begins with coding. The principles for coding have been well-developed by writers on grounded theory. In developing the codes, a number of considerations have to be made. Grounded theory suggests that coding should occur as the study progresses. This helps to sharpen understandings of the data (Bryman, 2004) and, as advocated by Miles and Huberman (1994), coding provides a mechanism for thinking about and reducing your data. In standard grounded theory practice, codes are seen as active, immediate, and short (Charmaz, 2005). Different levels of coding can be utilized, but the focus remains on making a close study so that the findings

can be synthesized. The data may end up with multiple renderings as each piece of data (interview transcript, field note, document, and observation) can inform previous data. Consequently, the comparative method of grounded theory means that the data are compared with data, data with category, and category with category. Charmaz (2005) also suggested that “coding practices can help us to see *our* assumptions, as well as those of our research participants. Rather than raising our codes to a level of objectivity, we can raise questions about how and why we developed certain codes” (p. 519). Levels of coding are commonly used; the term “pattern coding” is one way of grouping data into smaller sets or constructs to match the factor-analytic process used in statistical analysis (Miles & Huberman, 1994, p. 69). Bogdan and Biklen (2007) described families of codes and break major codes into sub codes. They warned that units of data may overlap and may also fit in more than one category. The researcher needs to be aware of some commonly held criticisms about coding. These are firstly, the potential for losing the context of what is said (Bryman, 2004) and secondly, that it may result in fragmentation of data so that the narrative flow is lost (Coffey & Atkinson, 1996).

Coding is only the first part of the analysis for it must be followed by interpretation. Interpretation of the coded material means that the data have to be examined for connectiveness and evaluated in terms of significance in relation to the research questions (Rubin & Rubin, 2005). One strategy to help make more conceptually coherent sense of the data is the strategy of ‘memoing’. The memo is “the theorising write-up of ideas about codes and their relationships as they strike the analyst while coding” (Glaser, 1978, p. 83). The objective is to tie together or cluster data related to a general concept, to elaborate or expand on ideas (Neuman, 2007), and to “go beyond codes and their relationships to any aspect of the study—personal, methodological, and substantive. They are one of the most useful and powerful sense-making tools at hand” (Miles & Huberman, 1994, p. 72).

In order to ensure high quality analysis, no matter what strategies are chosen, Yin (2003) suggests four main principles: show that you attend to all the evidence; address, if possible, all major rival interpretations; attend to the most significant aspect of the case study; and finally, use your own prior, expert knowledge. There should be a balance between a conceptual theme and the presentation of data. The

researcher should also avoid what Lofland and Lofland (1995) term “descriptive excess” (p. 165), providing too much description relative to analysis.

3.7 Reliability and Validity

These terms have traditionally been used in quantitative research. Reliability is concerned with the question of whether a study can be replicated. This is a difficult criterion to meet in qualitative research because human behaviour is never static (Merriam, 1998). Reliability assumes that there is a single reality and so when a study is repeated the results will be the same. Validity relates to whether a measure of a concept really does reflect that concept. This is sometimes referred to as measurement validity or external validity and the degree to which findings can be generalized across settings. Internal validity relates mainly to the issue of causality, the match between researchers’ observations and the theoretical ideas that they develop (Bryman, 2004).

Guba and Lincoln (2005) proposed a reconsideration of validity as authenticity and raised wider issues related to the political impact of research. They also suggested qualitative studies should be evaluated according to trustworthiness. According to Lincoln and Guba (1985) the four main criteria of trustworthiness are credibility (internal validity), transferability (external validity), dependability (reliability), and confirmability (objectivity). The writers also suggested authenticity as a criterion for judging the quality of the research process in case study. They raised issues related to the “the *authenticity* criteria of fairness, ontological authenticity (enlarges personal constructions), educative authenticity (leads to improved understanding of construction of others), catalytic authenticity (stimulates to action), and tactical authenticity (empowers action)” (Guba & Lincoln, 1994, p. 114). These criteria demand more attention in action research where greater emphasis is placed on the impact of the research.

Lincoln and Guba (1990) moved from a focus on judging the quality of the inquiry process to the judging the quality of the product. The four criteria they proposed for evaluating the case report were: resonance, rhetoric, empowerment, and applicability. Resonance means the degree of fit between the case study report and the underlying

belief system. For example, if the study is underpinned by naturalist inquiry then the report should reflect the multiple realities constructed by the participants. Rhetorical criteria relate to aspects such as form, structure, and presentational characteristics—unity, coherence, internal consistency, corroboration, simplicity, clarity, and craftsmanship. An empowerment criterion implies consciousness-raising and concluding a study with what should be happening next rather than ‘suggestions for further research’. And lastly, applicability means the extent to which the case study leads the reader to consider applicability in his or her own context or situation or leads to the re-examination or reconstruction of one’s own construction of a particular phenomenon.

Reliability can be improved by using a pre-test or pilot study to evaluate the effectiveness of a measuring tool such as a questionnaire or interview schedule. Janesick (1994) suggested that “before devoting oneself to the arduous and significant time commitment of a qualitative study, it is a good idea to do a pilot study” (p. 213). The researcher is able to focus on particular areas that may have been unclear, test questions, and develop an appreciation for the time commitment. The principle of using a pilot study extends to replicating the measures other researchers have used; thus, the time invested in a pilot study should be valuable and enriching for the later phases in the study.

3.7.1 Triangulation

The term triangulation appears to have been subject to “multiple renderings and interpretations” (Atkinson & Delamont, 2005, p. 832). The notion of triangulation was originally associated with quantitative research whereby more than one data gathering method would be employed to give greater confidence in research findings. Triangulation is more than the aggregation of multiple data types to give a better picture than what one source alone will give. A triangulated account recognizes “the multiplicity and simultaneity of cultural frames of reference—spoken, performed, semiotic, material, and so forth...” (Atkinson & Delamont, 2005, p. 832). Triangulation should also be thought of as “cross-checking” process (Guba & Lincoln, 1989, p. 241). This wider view of triangulation means that in qualitative

research there may be multiple observers, theoretical perspectives, sources of data, and methodologies.

3.7.2 Reflexivity

Another methodological issue is that of ensuring understanding and validation of findings. Reflexivity exposes and makes explicit many moral dilemmas that might otherwise go unnoticed. It should be an inherent and ever-present part of the research endeavour (Hertz, 1997). Etherington (2004) explained that our interpretations would be better understood and validated by readers who were “informed about the position we adopt in relation to the study and by our explicit questioning of our own involvement” (p. 32). This should enhance the trustworthiness of a study. It means a process of standing back, considering the researcher’s perspectives, interpretations, and casting a critical eye on the researcher’s role as interpreter and writer.

3.8 Ethical Considerations

Any research study should be built on a strong ethical foundation. Although the methodological description precedes this section, ethical considerations need to be at the forefront of any study. Not all ethical problems or challenges can be foreseen, but a researcher needs to consider potential ethical challenges before embarking on research. Ethical goals should be achieved through ethical guidelines, but it is up to the researcher to meet the challenge of conducting ethically responsible research practice.

3.8.1 Ethics in Theory

Qualitative research provides demanding ethical challenges. Using Flinders’ (1992) four ethical frameworks (utilitarian, deontological, relational, and ecological), the initial and ongoing ethical considerations and dilemmas will be discussed. As there is not ‘one best’ approach, all four frameworks can assist with ethical guidance and to ensure ethical practice throughout a study.

Firstly, in considering the study from a utilitarian framework, the concepts of informed consent, avoidance of harm, and confidentiality should be considered. This

includes recruitment of the participants, the avoidance of harm in conducting the fieldwork, and confidentiality in writing up a report. For example, in order to gain access to students, schools have to be approached and initial consent given by the gatekeepers—the Principal and/or Board of Trustees. For the consent to be genuinely informed, the researcher must provide information about the predicted scope and focus of the study with honesty and a degree of forthrightness. In studies concerning students and teachers, the notion of harm is not literal, but concerns issues such as the researcher’s presence when observing in the classroom, especially if the researcher is considered to be an ‘expert’ in a specialized field. Teachers and principals may consider professional standing or a school’s reputation to be ‘on the line’ through the researcher’s data gathering processes. The third utilitarian consideration of confidentiality simply means ensuring that participants are protected from identification. In practice, qualitative researchers use pseudonyms and coding systems, and deliberately conceal the identification of individuals and fieldwork sites.

The second framework, deontological, “gives special attention to the ethics of duty” (Flinders, 1992, p. 104). This supports the notion of the research incorporating an element of collegiality, that is, the research is conducted with mutual benefit and support. The ethical researcher, according to Sieber (1992), creates a “mutually respectful, win-win relationship with the research population; this is a relationship in which subjects are pleased to participate candidly, and the community at large regards the conclusions as constructive” (p. 3). A move from a utilitarian practical ethics to a deontological approach means that consideration is given to reciprocity not just informed consent, and avoidance of wrong rather than avoidance of harm and fairness. Where face-to-face interactions predominate, consideration should also be given to relational ethics and the notion of caring.

Relational ethics have gained recognition in part due to feminist research. The caring relation as advocated by Noddings (2003) is deemed to be ethically basic. Caring involves stepping out of one’s own personal frame of reference into the participant’s. It means that the “actions of one-caring will be varied rather than rule-bound; that is, her actions, while predictable in a global sense, will be unpredictable in detail” (Noddings, 2003, p. 24). This takes the researcher beyond the more business-type

relationship and encourages the researcher to consider collaboration, avoidance of imposition, and confirmation. These concepts do not limit the researcher “from making informed judgments, evaluating a teacher’s performance, or rendering descriptions that address both the strengths and weaknesses of a research participant” (Flinders, 1992, p. 107).

The ecological framework asks that the researcher recognize the participant as part of a larger system. It guides the researcher beyond aspects such as cultural sensitivity to consider the role of language, the words that are used to describe, interpret, and evaluate the research. Words may communicate findings explicitly, but also implicitly (with tone and style), notions of power, status, and privilege. Thus, there should be opportunities, as suggested by Newkirk (1996), for co-interpretation especially in the teaching situation. The researcher also has a responsibility when reporting findings to consider the audience. A thesis, for example, is presented for scholarly or academic purposes, but findings should be shared in other formats for different audiences. It is clear that ethical considerations go far beyond gaining required signatures on forms. Research is context bound and the circumstances and ethical issues that may arise could be unpredictable. “Researchers must learn to ‘read’ ethical concerns as they emerge, anticipate relevant considerations, and recognize alternative points of view. In qualitative research, these skills are not marginal; they are at the heart of what we do” (Flinders, 1992, p. 114).

3.9 Summary

In this chapter, the research topic and the specific research questions have been presented. The philosophical paradigms related to research in the social sciences have been addressed briefly, in order to give a basis for establishing the research perspective adopted in this study. A justification was provided for adopting an interpretive stance. From this interpretive view of the world, multiple methods were outlined as they provided the guidelines and legitimacy for the research. Backgrounded against these multiple perspectives and in order to answer the questions posed, a case study method was given as an appropriate design. Predominantly qualitative data gathering methods were described followed by a discussion of ethical considerations. The following chapter describes the sample, settings, time frame,

data gathering, analysis methods, ethical challenges, and evaluation—that is, the methodology in practice.

CHAPTER FOUR:

METHODOLOGY IN PRACTICE

4.1 Introduction

In this chapter, the methodology is presented as it was applied, firstly with a pilot study followed by two further phases of case study research. The case study approach has been justified as a suitable research design within the methodological paradigms described in the preceding chapter. The study focused on discovery, insights, and understandings gained primarily from the participants' perspectives. It began in 2004 with a pilot study and the subsequent design of the following two phases which were conducted in 2005 and 2006. An account is provided of the purposive sampling procedure to find suitable settings and participants. A range of data gathering methods is detailed along with a description of the data analysis process. The issues of authenticity and trustworthiness are addressed and finally the challenge of ethical practice in relation to this study is given attention.

4.2 Research Design

The research paradigm that guided most of this research was essentially interpretive, although aspects of naturalistic inquiry have been blended into the study. Elements from both of these theories resonate strongly in the researcher's world view and beliefs about the value of educational research. The researcher's theoretical orientation was further challenged as a shift occurred from interpretation to action as an ethical commitment. The general stance taken cannot therefore be categorized in an absolute way. In practice, it will be revealed that there was no perfect correspondence between the chosen research strategy and matters of epistemology, ontology, and methodology. It is also important to acknowledge an awareness of the influence of the researcher's values, for those values, to some extent, influenced for example, the choice of topic. Moreover, the method, conclusions, and implications are all grounded in the researcher's moral and political beliefs.

The study was designed using a case study approach and predominantly qualitative methods. Results from two questionnaires provided some quantitative data. The project began with a pilot study followed by two phases of data gathering. These phases are summarized in Table 4.1.

Table 4.1

Data Gathering Methods used in the Study

Research Question	Phase One (2005)	Phase Two (2006)
1. <i>What are the characteristics of mathematical giftedness recognized by the school policies, students, teachers, and parents?</i>	Student interview Teacher interview Parent interview Parent questionnaire Documents	Student interview Teacher interview Parent interview Documents
2. <i>How are mathematically gifted and talented students identified?</i>	Student interview Teacher interview Parent interview Documents	Student interview Teacher interview Parent interview Documents
3. <i>What provision for the students' education in mathematics has been made within the classroom and school contexts?</i>	Student interview Teacher interview Parent interview Parent questionnaire Documents Observations	Student interview Teacher interview Parent interview Documents Observations
4. <i>What are the characteristics of an effective teacher of mathematically gifted and talented students?</i>	Student Interview Teacher interview Observations	Student Interview Teacher interview Observations
5. <i>What roles have parents played in their child's mathematical development?</i>	Parent questionnaire Parent interview	
6. <i>How is a school transfer managed for a mathematically gifted and talented child?</i>	Student interview Parent interview Teacher interview Documents	Student interview Parent interview Teacher interview Documents

4.2.1 Case Studies

Case studies were chosen as the most appropriate method for answering the research questions. The case studies of this project have evolved as both *descriptive* and *interpretive*. Merriam (1988) supported this situation and acknowledged that case studies become interpretive when they move beyond description and that “in reality most case studies are a combination of description and interpretive or description and

evaluative” (p. 35). Through the case studies, the multiple complexities of the education of a group of mathematically gifted and talented students were explored from a variety of perspectives and over a sustained period of time.

4.2.2 The Researcher

From the outset of the study, the researcher’s intentions were made explicit to the gatekeepers and participants. Background information about the researcher’s credentials and experience was provided. Initial contact was made through phone conversations and prior to visits, before any formal data gathering took place. A positive relationship and rapport with participants was established and a professional manner maintained throughout the study. All participants were treated with respect and their contributions acknowledged.

4.2.3 Research sample

Choices were made for the cases and the ‘cases within cases’ based on a purposive sampling process. The criteria for the cases were firstly, that the participants would be Year 6 and Year 8 students from schools that identified and provided for mathematically gifted and talented students. Secondly, the aim was to include at least one school that provided for these students within a regular class programme, one that was streamed for mathematics, and one that provided for the students through a fulltime class for gifted and talented students. The 15 participants (four girls and 11 boys), type of school, and organizational provisions are outlined in the following three tables (Tables 4.2, 4.3, & 4.4). Table 4.2 provides a few details about the students. Table 4.3 outlines the three Phase One schools, teachers, and types of provisions. This is followed by Table 4.4 detailing the Phase Two schools, teachers and provisions. The Phase Two sites were determined by the schools that the 15 students in the study transferred to in the following year. The students in Phase Two moved from three schools to eight different schools across a much greater geographical area than the Phase One schools.

Table 4.2

Participants

Code	Pseudonym	Gender	Age*	Brief Description of the Student
A1	Lily	Female	11	Twice-exceptional: Asperger's Syndrome Attended one-day-a-week programme in Year 6
A2	Bob	Male	11	Articulate student, enjoys mathematics
A3	Nardu	Male	11	Maltese, educated overseas and in N.Z.
A4	Jarod	Male	11	British, educated overseas and in N.Z.
A5	Victor	Male	11	Māori student, interested in practical aspects of mathematics
B1	Mia	Female	10	Multiple talents, especially dance
B2	Eric	Male	11	Confident, very interested in mathematics and the research study. He was not identified as gifted and talented in Phase 2.
B3	Martin	Male	10	Reticent, lacking confidence in his ability in mathematics
B4	Ryan	Male	10	Very gifted in mathematics, attended one-day-a-week programme (Years 6 & 7)
B5	Tim	Male	10	Did not appear to be gifted and talented in mathematics
C1	Karen	Female	12	Not particularly interested in mathematics but a capable student in all learning areas
C2	Nina	Female	12	Indian, educated abroad and in N.Z. Very gifted student in mathematics and English
C3	Amir	Male	12	Bangladeshi, educated in N.Z.
C4	Lewis	Male	12	Enthusiastic, attended after-school mathematics programme
C5	Paul	Male	13	Chinese, educated in N.Z., finds mathematics easy but with few challenges, additional mathematics provided at home

* Age at the start of the study

Table 4.3

Phase One Schools, Teachers, and Organizational Provisions

Students	School	Class Level	Teacher*	Provision
Lily, Bob, Nardu, Jarod, Victor	School A	Year 6	Mrs N (School A _P)	Cross-class ability grouping (mathematics)
Mia, Eric, Martin, Ryan, Tim	School B	Year 6	Mrs J (School B _P) Miss S (School B _P)	Regular class ability grouping (mathematics)
Karen, Nina, Amir, Lewis, Paul	School C	Year 8	Miss L (School C _I)	Full-time gifted class (intermediate school)

*Code denotes title, an initial letter, school letter, type of school—Primary (P), Intermediate (I).

Table 4.4

Phase Two Schools and Teachers after Students made a Transfer

Student(s)	School	Teacher*	Provision
Lily	School D: Intermediate	Mrs J (School D _I)	Cross-class but within-syndicate ability grouping for mathematics
Bob, Nardu, Jarod, Victor	School F: Co-educational Years 7-13	Mr J (School F _{IS})	Streamed class
Mia	School G: Co-educational Years 7-13	Mrs K (School G _{IS})	Streamed class
Eric	School E: Intermediate	Miss S (School E _I)	Regular class
Martin, Ryan,	School E: Intermediate	Mrs O (School E _I)	Cross-school ability (withdrawal) grouping for mathematics
Tim	School H: Independent boys' school Years 5-8	Mr H (School H _{PI})	Regular class
Karen	School I: Co-educational secondary	Mr P (School I _S)	Streamed class
Nina	School J: Co-educational secondary	Mrs R (School J _S)	Streamed class
Amir, Lewis, Paul	School K: Boys' secondary school	Mr M (School K _S)	Streamed class

*Denotes title, an initial letter, school, type of school—Years 5-8 (PI), Years 7-8 (I), Years 7-13 (IS), Secondary (S).

4.3 Data Gathering Methods

The following section outlines the different data gathering methods that were used in the study: interviews, questionnaires, documents, and observations. This data gathering process was also supported by a research diary.

4.3.1 Interviews

The purpose of the interviews was two-fold, firstly to motivate the participants to share their knowledge and secondly to elicit information that related directly to the research objectives. The initial interview questions for students, teachers, and parents were trialled in the pilot study and then minor amendments were made for the final schedules (Appendices A, B, and C). In preparing the interview schedules, the following elements, as suggested by Bryman (2004, p. 324), were taken into consideration:

- create a certain amount of order on the topic areas so questions flow;
- formulate questions that help answer the research questions;
- use language that is comprehensible;
- do not ask leading questions; and
- gain relevant background or context information.

The sequence suggested by Charmaz (2005), an initial open-ended question, followed by intermediate questions, and then an ending question was used. For example from the Phase One—Parent interview:

Initial open-ended: *Tell me about your child's early mathematical development.*

Intermediate: *What do you think the special programme has provided mathematically for your child?*

Ending: *What are your future hopes for your child, specifically next year and beyond that?*

All of the interviews were conducted face-to-face and tape recorded. The students were interviewed twice; the second interview occurred in the year following a school transfer. (See Appendix A, for interview questions.) The first student interview gave an opportunity to gain background information about the child's interests, a historical perspective of mathematics learning experiences, a perspective on the current

mathematics programme, teacher qualities, school choice, preparation for school transfer, and expectations for the following year. The second interview provided a forum for following up on the transfer process and to gain insights into the mathematical teaching and learning experiences in the new school. The timing for these interviews differed for each of the students because of issues related to access, school programmes, and teachers' and the researcher's commitments. These second interviews were all completed in the one year.

Each teacher in the study was interviewed once to gain an understanding of the school's and teacher's views of gifted education. Questions (Appendix B) focused specifically on the teacher's understanding of the characteristics of the mathematically gifted student, the identification of and provision for mathematically gifted students, and the topic of school transfer. The teacher also provided background information about their own teaching experience and educational information about the student(s) in the study. In the Phase Two schedule, the questions also focused on what information had been provided by the sending schools about the student and how this information was used.

Parents were interviewed twice. They were interviewed once in the first year of the study (Phase One) and again in the following year. Likewise, the scheduling of these was influenced by a variety of factors including when their children were interviewed (the second student interview preceded the second parent interview) and availability. The Phase One parent interview schedule (Appendix C) was designed to gain information about early mathematical development, signs of special abilities in mathematics, school experiences, parental involvement, and factors influencing school choice for the following year. In the second phase, questions focused on the school transfer process and perceptions of the child's experiences in mathematics in the new school.

The interviews were transcribed verbatim. Some of the interviews were transcribed by the researcher and the rest by contracted transcribers who signed a confidentiality statement (Appendix D). All of the transcribed interviews were checked by the researcher for accuracy. Subsequent amendments were made because of the transcribers' inaccuracies. The transcriptions were completed in stages as data were

used for papers submitted for publication whilst the study was in progress (Bicknell, 2006a; Bicknell, 2006b; Bicknell & Riley, 2006).

4.3.2 Questionnaires

Two questionnaires were used in the study—one for the students and one for the parents. The student questionnaire was Rogers' (2002) 'Mathematics Interest and Attitudes' inventory (pp. 458-459). The inventory (Appendix E) is a measure of the student's attitude towards learning and what motivates them in a particular subject area. Three adaptations were made to the original. The word 'math' in each item was changed to mathematics and Question 2: *My math teachers are usually the best teachers I have in school* was deleted as the students (in Phase One, when the questionnaire was given) had the same teacher for all curriculum areas. Finally, a space was provided for students to record comments; this was optional. As a tool, the questionnaire enabled the students' interests and motivation levels in mathematics to be measured.

The parent questionnaire (Appendix F) was used to gain specific insights into the types and levels of parental involvement in their child's mathematics learning. The questionnaire was originally designed by Cai et al. (1999) and then re-used in more recent research (Cai, 2003). It was developed to assess the level of parental involvement in students' learning of mathematics. The 23 questionnaire items were designed to assess parents' roles as motivators, resource providers, monitors, mathematics content advisers, and mathematics learning counsellors. There were either four or five questions in each category. A few minor changes were made to the questions that related to contexts not relevant to the New Zealand setting. In Question 14: *I am always aware of my child's mathematics requirements by checking notebooks, using learning line, or through phone calls to school*, the term 'learning line' was deleted as this is not an approach used in New Zealand schools. In Question 16: *I think I know enough about algebra to help my child*, the word 'algebra' was changed to 'mathematics'. Although algebra is delineated in the curriculum statement as a strand with number, teachers give the topic less explicit emphasis in the primary school than other strands. Children are often unaware that the mathematics they are doing is algebra and therefore unlikely to talk about algebra

with their parents. Also, given the age of the students in the study, it made more sense to keep the general term ‘mathematics’. The purpose of the questionnaire was to gain an understanding of the roles that parents play in their child’s learning of mathematics and the level of that involvement. The Parent Involvement Questionnaire (PIQ) is recognized as a reliable and valid instrument for assessing parental roles in students’ learning of mathematics. It has been used extensively in both ‘within nation’ and ‘cross-nation’ studies (Cai, 2003). For each of the PIQ Likert scale response items the parents chose from strongly agree, agree, disagree or strongly disagree. To help parents identify tendencies, neutral choices were not provided. Those statements worded in a positive way were scored from 4 to 1. The scoring was reversed for any statements written with a negative connotation, for example, Question 11: *I seldom spend time talking with my child about his/her progress.*

4.3.3 Documents

A variety of documents were gathered during the course of the research. These documents were provided by the principals, teachers, and students in relation to the research questions. They consisted of school policies related to gifted and talented education; mathematics curriculum delivery documents; teachers’ planning documents; students’ results in mathematics tests, examinations, and competitions; and students’ work books. Some of these documents were personal (teachers’ and students’) and some (in the case of school policy) were open to public scrutiny. The purposes for collecting these documents were to help contextualize the cases; provide background information; ascertain students’ levels of achievement in relation to peers; and confirm, contrast, and validate some of the data gained from other sources. All documents were dated and the original source noted.

4.3.4 Observations

The research questions focused on the mathematical experiences of the students in the classroom, so it was important to include observations in the study. The observations of the students in classes were unstructured, although a guiding rubric from Artz and Armour-Thomas (2002) provided a focus to the observations without

making them formally structured. The dimensions focused on were: tasks (modes of representation, motivational strategies, sequencing, and difficulty levels); learning environment (social and intellectual climate, modes of instruction, and pacing, administrative routines); and discourse (teacher-student interactions, student-student interactions, and questioning). The observations were used as a means of verifying student, teacher, and parent responses and to help the researcher contextualize the study. Each class in the study was visited for four to seven days in which the researcher followed one unit of work (such as a statistics or algebra unit). These were consecutive days of the mathematics unit, but not necessarily consecutive school days because of the variability of school programmes. This was organized in response to the teachers' commitments and programmes.

4.3.5 Research Diary

The purpose of the research diary was to log school contacts and dates, record anecdotal experiences, classroom observations, and post-interview notes. It was structured according to each site in Phase One and Two with subsections devoted to classroom observations, teachers, students, and parents. The sections enabled the researcher to maintain a chronological sequence and to preserve the sections in relation to each case and cases within a case. After leaving each observation and interview, field notes were made. These included key ideas, reflections, and some of the emerging themes. This personal log assisted in keeping track of the research in progress, how the plan was affected, and also prompted awareness of how a researcher was influenced by ongoing data collection.

4.4 Data Analysis

The data analysis was also an ongoing process that was completed in different stages. As Simon (2004) proffered: "Analyzing qualitative data is much like solving a mathematics problem; each step leads to greater insight as to what might be tried subsequently" (p. 161). This ongoing process is justified in terms of identifying emerging themes that influenced interview schedules in later phases of the study, the rationale for the development of grounded theory, and the desire to publish findings from a study 'in progress'. After collecting the data from the multiple sources as

outlined, they were sorted. For each school, background information (from the Education Review Office's web site and the school's web site) were obtained, policy documents, teachers' planning notes, and students' work samples were collected, and recordings were made of classroom observations. Both sets of questionnaires (students' and parents') were ordered to correspond with the sequence on Table 4.1. Parent interviews were similarly ordered and student interview transcripts separated into Phase One and Phase Two. The researcher listened to all tapes, checked transcripts for accuracy, and made corrections.

After this organization, the Parent Involvement Questionnaire (PIQ) results were calculated. Firstly, a total score was calculated for each parent and then a sub score was calculated for each parent in each category of motivator, resource provider, monitor, mathematics content adviser, and mathematics learning counsellor. The mean score for each role was then calculated so that comparisons could be made across the roles. A few parents had made additional notes, which were coded according to the role that they supported. These were organized in tabulated form, two outlier results were highlighted, and a separate score calculated for four specific questions (Questions 4, 10, 15, and 19). These questions were isolated as they were worthy of separate analysis in relation to the research questions. The student questionnaire, 'Mathematics Interest and Attitudes' inventory was likewise treated quantitatively. Each student was given a score and these were tabulated to see individual scores and also combined to see if there was a difference between Year 6 and Year 8 scores. Each of these questionnaires was analyzed based on the theoretical lens provided by Rogers (2002) in relation to student motivation.

The school policies were each examined and coded based on Riley's (2000) key components for school policy in gifted education: rationale, purposes, definitions, identification methods, programme design, professional involvement and development, community and parent involvement, resources, and evaluation processes. At the same time as coding, memos were recorded as marginal notes; they suggested new leads, some important issues that the given code did not highlight (for example, the issue of pastoral care), and points of difference or 'significant' interest (for example, initial non-identification of one of the students). The second phase after coding and synthesizing results for each school policy was to re-group the data

under each of these codes. The analyzed data from each school policy were woven into case descriptions to provide the background for the study and are reported in Chapter Five.

The next source of data was the interview transcripts. Firstly, these were coded according to broad themes that matched the research questions: early characteristics, identification, provision, teachers of the gifted, parents' roles, and school transfer. These were then coded again based on more specific categories or pattern codes that had emerged from three sources: the literature review, ongoing research, and analysis. The researcher developed an extensive conceptual map that incorporated these pattern codes grouped under the main themes. Take for example, the theme of transfer. From this first level of coding, the next level used the conceptual framework of Anderson et al. (2000) and the categories of preparedness, support, and transitional success or failure. The third level of coding came from common threads in the participants' accounts such as school choice, role of siblings, concept of 'little fish in a big pond', and 'fresh start'. Each set of transcripts was revisited for the themes and tables created for some of the pattern codes (Miles & Huberman, 1994) or sub codes (Bogdan & Biklen, 2007) For example, tables were created specifically under the topic of provisions for enrichment, acceleration, and differentiation; another set of tables for resources, textbooks, and competitions. This process was repeated for several of the sub codes. This was to give a better quantitative picture of how many participants used specific strategies.

The data analysis process was reflexive (Miles & Huberman, 1994) and cyclical (Rubin & Rubin, 2005). Interpretations were ongoing through the coding process and interesting points of difference were also noted as part of the memoing process (Glaser, 1978; Miles & Huberman, 1994; Neuman, 2007). This repackaging process and aggregation of the data meant that emphases were identified; this was followed by a cross-checking of tentative findings. The reporting occurred in relation to the key themes using the combined multiple perspectives to present coherent results in chapter form. Quoted material has been included in each of the results chapters as Wolcott (1994) advised to: "let readers 'see' for themselves" and "informants speak for themselves" (p. 350). Thus, the data analysis was approached from two directions—deductive and inductive (Neuman, 2007).

4.5 The Pilot Study

A pilot study was conducted at the end of 2004 as a preliminary to beginning the main study in 2005. The purpose was to trial several of the data gathering tools. These included the suitability of Rogers' (2002) 'Mathematics Interest and Attitude Inventory', Cai et al.'s (1999) 'Parental Involvement Questionnaire', and to trial a schedule of interview questions for both students, teachers, and parents. The pilot study site was chosen because of a variety of factors: the principal was known to be very supportive of educational research, the school had identification procedures and provisions in place for mathematically gifted and talented students, and the researcher had an established rapport with the principal and the teacher involved in the withdrawal programme for gifted and talented mathematics students. This meant that the pilot site was most suitable for the trialling of the data gathering tools and to evaluate the research objectives.

The study was conducted following all the University's guidelines for ethical practice as outlined in the main study's procedures. The principal gave approval after receiving detailed information about the pilot study. All of the participants (students, teachers, and parents) were aware of the early stage (pilot status) of the research and were amenable to the agenda. They were also very interested in the topic and keen to gain feedback from the pilot study. The study provided worthwhile feedback on the various tools as well as the case study itself. This case study focused on a withdrawal class for Year 6 students gifted and talented in mathematics. Eighteen out of a class of 20 students participated in the study, as well as their class teachers, the specialist mathematics teacher, and the children's parents. The results were published in a journal article (Bicknell & Riley, 2006), the principal received a written report, and findings were shared at the World Council for Gifted and Talented Children's Biennial Conference in New Orleans, 2004.

The study informed some changes to the data gathering tools. The questionnaires were confirmed as suitable for the New Zealand setting; potential problems with language and context had been considered and adaptations made. However, a few changes were made to the interview schedule. Parents commented on their interest in further provisions for their children and concerns about when they moved on to a new school. Consequently, it was decided to strengthen the focus on the transfer

process by obtaining all participants' perspectives as well as by examining school policies and procedures. Another question that was added to the parent schedule after piloting, focused on the early identification by parents. It was also decided that a more rigorous observation schedule (Artz & Armour-Thomas, 2002) would be helpful for focusing the researcher's classroom observations.

4.6 Ethics in Action

This research adhered to the *Massey University Code of Ethical Conduct for Teaching and Research involving Human Subjects Guidelines* (Massey University, 2004). All material related to ethical practice was presented for approval to the supervisors and a low risk notification was granted. Potential ethical dilemmas were also discussed with the supervisors.

Informed consent was gained from all participants. The Information Sheets were tailored for the different groups of participants, but met the criteria that each group of participants would be informed about the nature of the research, their commitments, and the right to withdraw at any time. The initial contact was with school principals by phone and this was followed (in the pilot study, all Phase One schools, and some of the Phase Two schools) by personal visits. It was not feasible to make preliminary visits to some of the Phase Two schools because of geographic location. The purpose was to address any questions about the study and to impress upon principals that teachers were not to be coerced or put under pressure to participate.

Once the school principals and Boards of Trustees had granted permission, an invitation was extended to the teachers of the gifted students in the targeted groups. It was made clear that no commitment was expected from the teachers until they had met with the researcher and all questions had been answered. After this approval and written consent (Appendix G), the researcher spoke to the group of students that the teachers had identified as mathematically gifted and talented in their special programme or class. Each student was given a full description of the research aims and objectives, the research process, and what their commitment involved. They were given a research pack to take home that contained a Student Information Sheet, Parent Information Sheet, and Consent Forms (Appendices H and I).

All participants signed consent forms and prior to each interview they were reminded of their rights, including the request to turn the tape off at any time during the interview. The issue of anonymity was discussed especially given the limitations posed by others knowing who was participating in the study. For example, teachers within the school, students withdrawing from class for an interview, and parents talking among themselves. However, one strategy to protect participants' anonymity was to not include transcripts in the Appendices. At all times the raw interview data was treated as confidential to the researcher and the transcribers. Other material such as teachers' plans and students' workbooks were only viewed by the researcher. In the reported findings no identifiable names or complete descriptions of schools are used that could potentially lead to recognition.

Every effort was made in classroom observations to protect the anonymity of participants. The researcher focused observations on the whole class rather than on the research participants in particular. Provision was made to interview students at a time deemed suitable by both the student and his/her teacher so that there was minimal disruption.

Newkirk (1996) says, in referring to ethical challenges, that "every qualitative researcher I know has a story to tell" (p. 3). What follows are brief descriptions of situations that presented ethical challenges. The fundamental ethic of caring underpinned the researcher's actions when presented with these ethical dilemmas. There was a conflict of interest between the role of researcher and that of carer. For example, a participant made a request for advice. Caring meant a response was needed because it was in the best interests of the participant. Actions were taken, not because the researcher was seeking gratitude from the student and parents, but to enhance the educational welfare of the student and to bring about a favourable outcome. Newkirk (1996) warned that such activism is an ethical responsibility and could be perceived as a payoff for those volunteering to participate in the study. This instance will be described in the findings.

When asked for assistance on another occasion, the following 'story' evolved. This situation involved a principal who keenly welcomed the researcher into the school to conduct the research. However, it turned out the principal had his own agenda which was to have the researcher observe in a class and report back to him; he wanted an

opinion as to what was going on in that particular classroom. The researcher firmly restated the research objectives and refuted any notion of an evaluative role except in relation to the research questions. There was no intention of reporting anything back to the principal except as it related in general terms to the study. This would have threatened the willingness of the participants (teacher and students), the researcher's integrity, and ethical practice.

Another ethical challenge is faced when findings bring to light aspects that may be viewed by stakeholders as negative. Educational researchers may not always give indications of this possibility from the outset; despite well-meaning intentions, findings may be viewed negatively or as judgemental. An attempt was made to address this dilemma by sharing findings in general terms with the principal and teacher, and then supplying a summary sheet which concluded with considerations that applied to addressing some of the negative outcomes such as perceived poor home-school communications. For schools that did not have policies on gifted and talented education, but expressed interest in developing one, the researcher supplied resources and provided the names of contacts for developing these documents.

4.7 Evaluation

At the end of the study, both the process and the end product were revisited. With criteria available to guide the evaluation, a justification is given for the reliability and validity of this research.

4.7.1 Evaluating the Process

Instead of the traditional concepts of reliability and validity which originate from quantitative research, the concepts of 'trustworthiness' and 'authenticity' proposed by Lincoln and Guba (1985) and Guba and Lincoln (1994, 2005) provided alternative criteria for evaluating this research. It is intended that by providing sufficient details then the results of the study should be repeatable. The study should also be able to be replicated. It is also an aim to provide valid research. The integrity of the research and researcher is at stake.

The process of transcribing and having tapes transcribed verbatim followed by listening to all of the interviews and checking the accuracy against the transcriptions, should have guaranteed that this material was reliable. All interviews were supported with field notes made immediately after the interview and these usually contained the researcher's views about emerging themes and notes that reflected the tone of the interview. There were aspects not recorded in the transcripts such as sighs, pauses, and body movements.

At all times, a deliberate attempt was made to make transparent decisions about the process, and to justify the choices and actions. The prolonged nature of the study, both in terms of sustained classroom visits, conversations with students and teachers, and interviews with parents during a two-year period, meant a good rapport was established with participants. This also meant ongoing findings were shared and validated.

As a study based on naturalistic inquiry, following and developing questions about a targeted group of students in the school setting was an 'empowering' process. The process hopefully also empowered some of the participants; a feature of naturalistic inquiry identified by Erlandson, et al. (1993). For the students it gave voice to their views; they really wanted to be involved. The teachers often began the interview with "Can you help me with...?" The parents wanted an opportunity to articulate their ideas, joys, trials, and tribulations. A positive relationship between the participants and the researcher developed. However, the researcher, whilst responsive, retained research objectivity.

4.7.2 Evaluating the Product

The study presented a few limitations that should be acknowledged. The sampling process was limited to schools that the researcher was aware had processes in place for identifying and providing for mathematically gifted and talented students. The student participants had been identified by their teachers as gifted and talented in mathematics so were therefore invited to be part of the study.

The aim of the research was to understand a situation from participants' perspectives; this in itself is problematic. What is happening is that the researcher is intruding into

the participant's world and making interpretations. These interpretations are based on a conceptual scheme or emerging scheme (in the case of grounded theory). The process could be said to distort the participants' experiences, but it is hoped that through the 'rich' descriptions of the methodology in practice and the researcher's reflective approach that the results and interpretations that follow produce a legitimate view; a view that is useful in understanding the education of mathematically gifted and talented students.

The researcher's opinions, prejudices, and other biases must inevitably have some effect on the data. The data that follow have been filtered through the researcher's mind, therefore, a claim cannot be made that it is truly objective data. The explicit documentation of the multiple data gathering methods and detailed rendering of events should give the findings credibility. Through the process of triangulation a cumulative view is presented; data have been drawn from a variety of sources and contexts. The focus throughout remained on the purpose of the study which was to add to knowledge in the field.

4.8 Summary

The intention of this chapter was to make explicit the chosen methodologies in practice. By detailing all aspects of the study from participant selection, through data gathering processes, and analysis it is intended that the readers have a sense of trustworthiness of the ensuing findings and outcomes of the research. The research project, although planned from the outset based on a key idea, did not follow a linear approach. It supports Berg's (2001) suggestion of theory-before-research and research-before-theory. The question of generalizability will not be considered from a scientific perspective, but will reflect Berg's (2001) concept of 'fuzzy generalizations'. The implication from this study is not that this is the situation for all mathematically gifted and talented students. However, the case studies are firmly anchored in real-life situations and provide multiple perspectives in order to address the research questions.

The following chapters (Chapters Five to Nine) present the findings synthesized in relation to the research questions, key themes, and perspectives. Discussions are

integrated at the end of each chapter rather than at the end of the thesis. Chapter Ten draws these findings together and presents conclusions in response to each of the research questions.

CHAPTER FIVE:

BACKGROUND FINDINGS

SCHOOL POLICIES

5.1 Introduction

Since 2005, Boards of Trustees, through their principals and staff, have been required to implement provision for gifted and talented students. Schools were notified of the change to the National Administration Guideline 1(iii)(c) in December 2003. The requirement was to use good quality assessment information to identify gifted and talented students, and to develop and implement appropriate teaching and learning strategies. An indicator of ‘good practice’ is that a school has good quality policies, procedures, or plans for gifted and talented education (Education Review Office, 2008). School policy can be an important and powerful tool for ensuring appropriate provision for gifted and talented students (Gallagher, 2000, 2002; Rogers, 2002). “Embedding the provision for gifted and talented students in school policies and practice makes it sustainable rather than tenuous” (Education Review Office, 2008, p. 8). School policies cannot therefore be overlooked.

This chapter begins with a description of the policies of the schools in the study: Phase One Schools (Schools A, B, and C), followed by Phase Two Schools (Schools D to K). The policies were examined according to the criteria outlined in the Literature Review and with a lens specifically on mathematics. Essentially, the criteria are rationale, purposes, definitions, identification methods, programme design, professional involvement and development, community and parent involvement, resources, and evaluation processes (Riley, 2000). Additional material, from school documents relating to policy in practice, is also acknowledged. Indented text or double quotation marks indicate a direct quote from a school policy document. These policy findings contributed to aspects of the research objectives pertaining to characteristics and definition, identification, provision, and school transfer.

5.2 School Policies (Phase One)

5.2.1 School A

School A is a primary school that used a cross-class ability grouping practice to ensure that those students of the same year level, identified as gifted and talented in mathematics, work together. This school used the term Children with Special Abilities (CWSA) and had a CWSA committee comprising three staff members, including the principal. The policy was revised in 2005 to bring it in line with the new Ministry of Education requirements. The two teaching staff on the committee were provided with professional development in gifted education (they attended a one-day course) and received release time to rewrite the school policy. The policy included a rationale, purposes, and guidelines. The school acknowledged that the term CWSA was “seen as a generic label for any student who demonstrates potential and/or performance”.

The identification process was overseen by the CWSA committee and began “at school entry and [is] ongoing through a school-wide approach that involves staff, students, parents and some members of the wider community”. The policy outlined methods of identification described in the policy as “criteria for selection”. They included:

- a. Teacher, parent, peer and self nomination
- b. Standardized tests: PAT Listening
Numeracy testing
STAR Reading test
ARB Resources
- c. Ongoing assessment tasks that are part of the regular class programme
- d. Curriculum levels
- e. Student progress and behaviour observation in various settings
- f. Analysis of class work and completed projects

It was suggested in the policy that “in order to meet individual needs students defined as CWSA require differentiated programmes that are not offered as part of the regular classroom curriculum”. The school-wide organizational strategies included: withdrawal groups in a variety of curriculum areas (including

mathematics), inter-school academic competitions, integrating programmes for CWSA into the regular class timetable, and special programmes and activities outside school hours. The issue of assessment and evaluation was addressed briefly, noting the use of a range of strategies to monitor and assess students' progress and to evaluate programmes. It stated that a student's progress was to be tracked by the School's CWSA committee and there was to be reporting on the programmes as part of the regular Board of Trustee's cycle. There was recognition in the policy for the need for professional development and resource material for both staff and students.

The policy was supported by a 'Policy to Practice' statement that focused on identification purpose, principles, and methods. Programme options were listed for both school-wide and in-class provisions. Following this policy development, a framework was developed in 2005 with the focus on specific groups of students and small projects. The framework consisted of the targeted curriculum area, criteria for selection, objectives and learning outcomes, assessment, organization, and resources. A preformed letter informed parents and/or caregivers of their child's selection for a programme. Figure 5.1 is an example of the mathematics letter sent to the parents of one of the students identified as gifted and talented in mathematics.

February 2005

Dear Parents/Caregivers

It is the policy at School to provide opportunities for children with special abilities (CWSA) to develop and extend their identified ability.

..... has been identified with ability in mathematics.

Time Frame: Term One

Curriculum Area: Mathematics

Learning Outcomes: The children will investigate a variety of aspects pertaining to time:

Clocks, time zones, codes, events in a timeline, cultures, calendars, school week, digital and analogue times, phases of the moon, daylight saving, comparing measuring devices.

Please encourage your child to share the work/activities in the programme.

Signed:

Figure 5.1. Parent letter.

The particular provision, referred to in Figure 5.1 for students “identified with ability in mathematics”, centred on a challenge provided by ‘Mathematics Achievement Challenge’, a national-based programme offered to schools. Students were also selected to participate in training (three weeks) for the local mathematics competition during Term Three. The teacher wrote in her report to the Board of Trustees that these students (four of whom were participants in this study) “showed special aptitude in geometry, algebra, and number”. They “learnt to work well as a team and by the end of the training sessions were able to listen carefully to each other and were able to give good reasons for their solutions”.

One student research participant from this school attended an out-of-school provider for gifted education one day a week. There was no reference made in the school documents to this provision, although as part of the enrolment process, the regular class teacher would have completed a nomination form. The school also received copies of weekly homesheets and newsletters from the one-day-a-week programme outlining the topic being studied by the student.

The CWSA committee provided a written report on the professional development received by two staff members at the end of the year. The professional development had focused on ways in which CWSA could be accommodated in the classroom using a practical approach to differentiating classroom material. The teachers felt that the course provided many ideas useful to teaching all children in the class and not just those with special abilities. It was reported that they had “created an excellent structure in the senior school to cater for a wide variety of special abilities”. The full report provided evidence of a variety of scheduled activities including gardening, floral art, music, swimming, and creating a newspaper. Particular students were selected for participation in each of these activities.

5.2.2 School B

This primary school provided regular class provisions for students gifted and talented in mathematics. As a consequence, the students in this study came from two different classes in the school, but participated in programmes based on the same school policy. This school had a policy that acknowledged changes made to the National Administration Guidelines (NAGs) and National Education Goals (NEGs) with respect to gifted and talented students. The school used the term ‘gifted and talented’ and stated that:

The term ‘gifted and talented’ should include the potential for gifted behaviour as well as achievement or performance already manifested. We need to meet the needs of those who have disabilities or specific learning difficulties as well as those with special abilities. Being inclusive in this way, may mean that we identify 15% of our school population rather than only 1-2%.

The school document on gifted education provided principles for identification such as “remembering that identification is a means to an end, rather than an end in itself”, and noted that there would be open communication with the school community about identification, and a systematic, coordinated school-wide team approach would be utilized. The methods for identification described were:

- a. Teacher observation and nomination
- b. Rating scales
- c. Standardized testing: Tests of intelligence, achievement tests, and other assessment measures

- d. Portfolios, performances, auditions, product evaluation
- e. Parent, caregiver, and whanau nomination
- f. Peer nomination
- g. Self nomination

It was also noted that competitions such as Mathex, Australian competitions, and Mathematics Problem Solving Challenges could be useful indicators of talent.

A range of provisions were articulated in the school documents and included regular class programmes, special programmes that may operate outside the regular classroom, one-day-a-week programme, school networking, and Clubs and Associations. Examples of regular class programmes were listed as the use of integration and/or differentiated curriculum, grouping across curriculum areas, independent study, Correspondence School, and enrichment and/or acceleration.

The process for monitoring, identification, and provisions for the students was described as:

Class teachers will first and foremost identify children through their initial testing/observations/formal and informal dialogue then alert the SENCO¹⁰ coordinator to these children through class profiles. Children who are identified in class profiles will be added to the G & T register and from here programmes will be implemented as resourcing allows. As children complete G & T programmes, the facilitator of the programme will enter data related to that child's involvement, skills and abilities on the G & T register.

Resources, web sites, and resource people were noted and a list of learning, creative thinking, motivational, social leadership, and self-determination characteristics was included as an appendix (McAlpine & Reid, 1996, Ministry of Education; 2000). (The school had not acknowledged the sources for this list of characteristics.)

5.2.3 School C

This intermediate school had a 'Children with Special Abilities' policy and provided for gifted and talented students in two fulltime classes, one Year 7 and the other Year 8. The policy was based on Renzulli's key principle that 'a rising tide lifts all ships'

¹⁰ Special Education Needs Coordinator

(Renzulli, 1977). The policy stated that: “Children with special abilities should be provided with a differentiated learning programme that realises their talents and allows them to strive towards their full potential”. Renzulli’s (1977) three-ringed model of giftedness provided the definition, that is, children with special abilities are those that have above average ability, a high level of task commitment, and a high level of creativity. It was noted that “multicultural concepts of giftedness will be integrated into our identification process”.

The purpose was outlined as:

- a. To provide specific classroom programmes for gifted and talented learners to match their individual learning needs.
- b. To create a school culture that identifies, supports, and nurtures students with specific learning talents.
- c. To recognize diversity of identification features in a multicultural community.
- d. To use a range of identification methods that allow for recognition of sub-types of giftedness.

This school provided well-defined guidelines for the identification process for students to be selected for the special abilities classes. These were:

- a. Notification of testing dates is provided to Year 6 students from contributing schools and current Year 7 mainstreamed classes.
- b. Parent, teacher, self, and peer nomination is sought.
- c. Students are invited as guests to the school for half a day and they complete three identification tasks. These include a CWSA mathematics indicator test, a creative writing/thinking task, and the Test of Scholastic Abilities (TOSCA).
- d. The results are analyzed and data from other sources such as PAT results and teacher comments are acknowledged.
- e. Students are sent a copy of the results and those identified as suitable for the CWSA class are offered a placement for the following year.

The programme offered was described as differentiated and “designed to develop creative thinking, problem solving and critical thinking based on enrichment and

acceleration processes”. Other provisions in a variety of curriculum areas were listed, although for mathematics, the only extra provision mentioned was the local mathematics competition.

The professional involvement consisted of the principal, deputy principal, and co-ordinator. They were responsible for the collation of identification data and class placements. The teaching staff in the CWSA classes had opportunity for professional development and access to targeted funds. The two classes were set up with autonomy to provide programmes to meet identified needs for these students.

It was documented that the effectiveness of the policy and programmes was reviewed annually by classroom teachers and senior management. Academic progress was measured through standardized school-wide assessments and external opportunities as available. Programmes were reviewed through the use of student, teacher, and parent feedback.

5.3 Policies (Phase Two)

The following eight schools named Schools D to K contributed to the background of the study because the 15 research participants transferred as part of their natural schooling process to one of these schools. Five of these students made the transfer to Years 7 to 13 schools, four to intermediate schools, one student to a Years 5 to 8 school and the five intermediate students transferred to secondary schools (Years 9 to 13). Consequently, these schools became part of the study in the second phase as a result of the participants’ transfers. The policies and practices of these schools are briefly outlined as background to the study and to contextualize the results and discussion.

5.3.1 School D

This intermediate school had a recently-approved CWSA policy. The rationale for the policy was drawn from the school’s strategic plan and stated: “all students need stimulating and challenging opportunities to ‘achieve personal standards of excellence’ and to ‘reach their potential’”. Children identified with special abilities

should be catered for through appropriate educational opportunities”. The purposes were outlined as:

1. To recognize a wide range of abilities.
2. To develop a responsive school environment in which children with special abilities can flourish and be challenged cognitively, emotionally and socially.
3. To provide opportunities for children with special abilities to develop skills and knowledge through involvement in the wider community.

The Guidelines suggested:

1. Annually evaluate and report on all aspects of the Children with Special Abilities programme.
2. A multiple method approach to identification of children with special abilities will be employed. Identification processes employed should include teacher observation; classroom achievement-based assessments; tests of scholastic ability and information from previous schools and parents.
3. Early identification of children with special abilities will enable clustering of small groups of children with special abilities in “cluster classes” across the school.
4. In-class programmes using methods and instructional techniques designed to develop higher thinking processes should be developed.
5. In-class support for children with special abilities may be provided through compacted curriculum programmes and/or differentiated learning programmes.
6. Team programmes will also provide opportunities for differentiated learning.
7. Learning opportunities for children with special abilities will be provided through programmes such as
 - a. Extension group programmes
 - b. Science and Technology Fair
 - c. Mathex
 - d. Newspapers in Education (NIE) Quiz

- e. Super Sports
 - f. Performing Arts Groups
 - g. School assemblies and festivals
 - h. Learning experiences outside the classroom (LEOTC)
8. Communication between teachers, parents, and students on educational matters associated with programmes for children with special abilities will be encouraged.
 9. It is recognized that teachers need special skills to enable them to teach children with special abilities, hence each year's budget will take account of staff training needs.
 10. Each year's budget will also take into account the need for the purchase of special resources.

The policy was approved in 2006 (review date April 2009) and concluded with the statement that: "the school will nurture growth in individual abilities and encourage and support children with special abilities towards achieving their potential". In practice, this school used cluster grouping within syndicates of classes (they described them as cluster classes) in order to make it easier for teachers to meet the needs of students by reducing the achievement range of students within a classroom.

As a receiving school, the school used two key placement forms. One was titled: 'A Parent's Perspective of Your Child's Needs'. The purpose was to assist with the placement of the child and aimed "to provide a parent's perspective of the child that will assist in matching a child to teacher". There was opportunity for the parent to comment on academic strengths including experiences in extension programmes and strengths and weaknesses in sports, the Arts, and Essential Skills (those defined by The New Zealand Curriculum Framework, Ministry of Education, 1993), out-of-school interests, and personal qualities. The form also asked the parent to list the type of teacher that they thought their child might work well with—the desired teacher strengths, interests, and personal qualities.

The Student Placement Form had a separate section for 'Special Abilities and Achievements' with the categories of Academic, The Arts, Sporting, and Other. It was also noted whether students had been involved in extension programmes and

attended a one-day-a-week programme. This was a comprehensive document that clearly provided extensive information about the students from the sending schools.

5.3.2 School E

This intermediate school had a curriculum statement for CWSA that included a definition of special ability, rationale, and delivery policy. In response to the question “what is special ability?” the document stated that “each gifted and talented student is unique, with his or her own set of behaviours and characteristics”. It was noted that these characteristics could be classified as learning, creative-thinking, motivational, social leadership, and self-determination characteristics (McAlpine & Reid, 1996; Ministry of Education, 2000). How each of these may be evidenced was described for each of the categories.

The rationale stated that the school aimed “to provide all learners with an education matched to their learning needs. Gifted and talented students should be provided with a curriculum rich in depth and breadth. Giftedness is evidenced in all societal groups, regardless of culture, ethnicity, socioeconomic status, gender, or disability (learning, physical, or behavioural)”.

The policy stated that identification included: teacher and parent nomination; ‘Teacher Observation Scales for Identifying Children with Special Abilities’ (McAlpine & Reid, 1996); standardized tests of intelligence, achievement, and creativity; teacher-made tests; portfolios; and performance-based tests. Using this information, a student profile of strengths, abilities, and qualities was created. CWSA delivery was documented as a mixture of enrichment and acceleration. Enrichment was defined as “differentiated learning experiences by way of both depth and breadth of learning, and which offers challenges ‘in addition to’ and ‘different from’ the regular curriculum”. Acceleration was defined as “the practice of increasing the pace of delivery”.

Provision was made through withdrawal special classes, competitions, and leadership groups. There was acknowledgement of professional development for all staff in the understanding and implementation of identification procedures and a yearly review of the CWSA programme and identification methods.

The key resources listed included Assessment Tools for Teaching and Learning (asTTle) in reading and mathematics, Assessment Resource Bank (ARB), portfolios, Teacher Observation Scales, teachers, the community, and one key resource person. There was a supporting document that described the identification methods and the need for multiple methods. Guidelines were also provided on the features of suitable content, processes, and products. It was noted that the grouping of the gifted and talented students should be changed to match needs with different activities provided for different groups. Descriptions were provided for learning environments which “invite and respond to individual learning” and for appropriate enrichment and acceleration as “complementary approaches”. The need for provisions to be culturally appropriate and relevant was also acknowledged.

5.3.3 School F

This Years 7 to 13 co-educational Catholic integrated school was ‘divided’ into two schools: a Junior School and a Senior School. Four students in the study transferred to the Junior School (Years 7 to 10). The school had a strategy statement for the ‘Development of Opportunities for Gifted and Talented Students 2005-2006’ with the goal “to develop procedures and programmes to maximise the educational outcomes for students identified as ‘gifted’ and ‘talented’ within the junior school”. This was supported by a rationale that recognized the change to the NAG and the importance of identifying and providing for gifted and talented students. The school acknowledged that attempts in the past to meet these students’ needs had tended to be “uncoordinated and spasmodic”. In response to this, a two-year initiative was formulated to explore and trial options for identification and the development of programmes and strategies.

The document defined ‘gifted students’ as “those with the potential to exhibit superior performance across a *range* of areas of endeavour” and ‘talented’ as “those with the potential to exhibit superior performance in *one* area of endeavour”. The review of current practices was clearly outlined with actions, baseline information, staff responsibilities, resources, and a timeframe. The second review objective was to develop school-wide procedures to cater for potentially gifted and talented students. Clear procedures for this were documented, also with a timeline. This was followed

with the objective to then trial strategies and to provide professional development for teachers. In 2006, a group of interested staff (including the teacher in this study) participated in a structured and applied programme for professional development in gifted and talented education provided by an external organization. The goal was to up skill interested staff in the theory and practice of gifted education. The programme included the use of case studies to contribute towards this goal. The final objective, by the end of 2007, was to review the implemented strategies for addressing the learning needs of gifted and talented students.

5.3.4 School G

This Years 7 to 13 school was a day and boarding co-educational Christian college. The policy on gifted and talented education was written in 2005 and included a definition, rationale, purposes, and guidelines. The definition acknowledged that gifted and talented students have exceptional abilities and that they have “the potential for outstanding performance, either in a range of areas or in a specialized field”. The policy also recognized that “giftedness and talent can mean different things to different cultures and appropriate action will be taken to provide learning opportunities in keeping with the special character of the school, which acknowledge and support cultural diversity and enhance the potential of individual students.”

The school document recognized that the learning needs of these students were significantly different from other students, including the fast pace at which they learn, the processing of material to a greater depth, the “intensity in energy, imagination, intellectual prowess, sensitivity, and emotion that are not typical in the general population. Therefore they need a programme that is qualitatively differentiated, a curriculum with breadth, depth and pace to match their learning needs”.

It was suggested that the school provide opportunities through “enrichment programmes, created within the class, by acceleration, or by regionally or centrally-designed programmes and initiatives”.

According to the policy the identification should be:

- a. Unobtrusive

- b. Include multiple methods of identification
- c. Ensure a careful match between method of identification and area of giftedness or talent
- d. Be undertaken in a classroom environment that is culturally and emotionally responsive and supportive
- e. Enable teachers/educators to design educational programmes that develop and enhance individual gifts and talents

The methods for identification included:

- a. Teacher Observation Scales/nomination
- b. Standardized testing
- c. Parent nomination
- d. Performance
- e. Portfolios
- f. Differentiated programmes utilizing curriculum models

The Learning Support Centre at the school had a designated role to assist teachers with professional development in identification, programme planning, implementation, and programme evaluation. The methods and procedures used in identifying gifted and talented students were to be constantly evaluated and the strengths and interests of teachers involved with working with the gifted and talented monitored to allow for professional development where appropriate.

The policy recommended that programmes “provide learning opportunities that integrate basic skills and higher level thinking skills and encouraging students to reflect on the way in which they learn”. It was expected that students would be provided with a differentiated programme that “builds on learners’ strengths and interests and if necessary integrates both acceleration and enrichment”. In order for this to happen, there would be consultation between students, classroom teachers, and the Learning Support Coordinator.

The options to be considered when organising the programmes were:

- a. Individualized programmes
- b. Withdrawal or pullout programmes within the school or community
- c. Flexible grouping

- d. Mentoring
- e. The Correspondence School
- f. Liaison with universities and tertiary providers.

It was expected that the formulation of programmes and the monitoring of student progress would be conducted using a team approach comprising the Learning Support Coordinator, students, family (whanau), classroom teacher, and outside providers when appropriate. The Learning Support Centre was to keep an inventory of resource people and was also responsible for the documentation of programming and evaluation for each gifted and talented student.

5.3.5 School H

No policy was provided by this independent school for boys aged 9 to 13 years. The school had not developed a policy at the time of this research.

5.3.6 School I

This co-educational secondary school had a policy for ‘Students with Special Abilities’. The purpose was to “develop and maintain structures to ensure that the educational needs of students with special abilities are met, both within the regular classroom through alternative programmes and other activities. Special abilities are recognized in all fields—academic, sporting, and cultural”. The Guidelines were as follows:

1. Students will be identified using a range of methods as defined in the students with special abilities scheme.
2. Extension programmes will be developed by individual departments and included in departmental schemes of work.
3. Grouping and/or student acceleration in individual subjects or form levels will take place after consultation with student, parent/caregivers, teachers and subject HODs.
4. Individual programme development will take place within the constraints of staffing, timetable, and course limitations.

5. Programmes will be regularly evaluated for their effectiveness by individual departments.
6. Students will be encouraged to participate in appropriate academic or other events such as external examinations, competitions, and exhibitions which offer extension and stimulation.
7. Students with Special Abilities will be individually catered for. The College will allocate resources to assist with meeting the needs of those identified students through enrichment programmes and accelerated learning.
8. The Principal will ensure there is a staff member responsible for the oversight and development of programmes for students with special abilities.

One of the goals of the Mathematics Scheme was “to help foster and develop mathematical talent”. The classes in this school had been streamed in to extension, core, and foundation classes. This streaming was based on a pre-test given to Year 9 students on entry to the school. The extension programme was described as one in which “extension will be in the form of broadening knowledge and skills, as well as exploring higher level opportunities. Students will be expected to maintain high levels of commitment as well as seeking and creating mathematical challenges”. There was acknowledgement that the teaching strategies and resources had been fine-tuned for the three different programmes. This was evident in the detailed scheme for each mathematics topic which catered for the three groups in the level of mathematical content, investigations, and additional activities. Mathematical investigations were used “to develop understanding while retaining emphasis on learning and practising new skills”. Enrichment units were to be included as time permitted. For the Year 9 students, this included spreadsheets, problem solving, codes, and paper constructions. The major resource for the Department was identified as textbooks. The students in the extension class were encouraged to take part in mathematics competitions.

5.3.7 School J

This co-educational secondary school had guidelines, procedures, and a rationale for gifted and talented students. Under NAG 1, the Board of Trustees stated that “on the basis of good quality assessment information, identify students and groups of students who have special needs (including gifted and talented students)”. The overall aim of their guidelines was to maximize the educational outcomes of schooling for gifted and talented students. There was recognition that the learning needs of these students may differ cognitively, socially, and emotionally from other students and that the school would work “together with the students’ families to put programmes and procedures in place to help these students realize their potential”.

This school defined gifted students as “those with the potential to exhibit superior performance across a range of areas and endeavour” and talented students as “those with the potential to exhibit superior performance in one area of endeavour”. ‘Cultural awareness’ was given specific attention acknowledging that New Zealand is a multicultural society and therefore relevant cultural values should be incorporated into a concept of giftedness and talent. For example, concepts of special abilities in Māori need to be “holistic in nature and reflect Māori values, customs and beliefs”.

The School stated that it would:

1. identify its gifted and talented students;
2. provide professional development opportunities for all appropriate school personnel in meeting the learning needs of gifted and talented students;
and
3. provide an appropriate range of opportunities for its gifted and talented students.

Mathematical ability was a specific aspect of giftedness to be considered and included under the category ‘Logical’ which appeared in a list of multiple intelligences based on Gardner’s (1993) work. The final statement was that “teachers will make planned provision to meet the learning needs of gifted and talented students in their classes”.

The policy continued with an expansion of the aims considering the identification process and methods of identification. A multiple method approach to identification was suggested with reference to the Ministry of Education's (2000) handbook. The school acknowledged the following methods: teacher nomination (including visits to contributing schools), achievement tests and Department entrance tests, Entrance Scholarship examinations, PAT, and parent and/or student nomination.

Professional development for staff was said to be provided in response to identified needs of students and staff. Heads of Departments could also nominate personnel and staff-wide professional development would be provided through meetings. Those staff responsible for teaching extension classes would also be given departmental or cross-curricular professional development opportunities annually. The school allocated responsibility for the implementation of the policy to one person for each year group. There were goals regarding support systems, staff awareness, liaison with parents, students' placements, monitoring, links with outside groups for mentoring and enrichment opportunities, and recognition for full or part-time enrichment, extension, or acceleration programmes.

The teaching and learning strategies that teachers were to consider included:

- a. Examine the level of challenge (incorporate problem solving, inquiry and creative production; extend the curriculum and use accelerated learning)
- b. Introduce individualized enrichment programmes (contract work, research, peer tutoring, mentors)
- c. Use curriculum compacting (pre-testing to acknowledge pre-knowledge)
- d. Nurture gifts and talents that are valued by other cultures
- e. Plan a range of tasks that offer choice
- f. Cater for learning styles needs and multiple intelligences (pose open-ended questions, activities and assignments)
- g. Use group work (to allow scope for leadership, student-initiated perspectives) and independent work
- h. Have appropriate expectations (specific goal setting)
- i. Provide opportunities for success
- j. Provide work that is meaningful (suitable also for those gifted and with disabilities)

Recognition was given to the need for both teachers and students to evaluate the effectiveness of the programmes. This might include “observation, teacher diaries, self-assessment, teacher-made tests, interviews and questionnaires and focus groups”. Based on this information, there was an expectation that changes or adjustments would be made to programmes. The policy concluded with recommended resources and references.

An additional report (that supported an application for funding for an action research study of the school’s gifted and talented programmes for Year 10 students) provided some detail that supported the ‘policy in action’. The school’s two-pronged approach for those students identified as gifted and talented was to enrol them in Enrichment Learning Groups as well as streamed extension classes. In the Enrichment Learning Groups, students were exposed to an enriched educational environment through mentors, guest speakers, discussions, and educational trips. In the extension classes students were placed in an educational environment where the delivery of the curriculum was targeted to their unique learning needs and there were very high standards of teaching and learning. This proposal was in response to a review that had shown that many students in the programme had expressed a strong interest in shaping the design and delivery of the programme.

5.3.8 School K

This single sex secondary school was in the process of developing a policy for gifted and talented students. There was a definition: “Gifted and talented students at [School K] will be recognized as having or the potential to have exceptional abilities in one or more domain (intellectual, creative, socioemotional or sensorimotor). These learning characteristics give them potential to achieve outstanding performance. ‘Gifted’ is defined as “academic ability in one or more subject areas and ‘talented’ as ‘ability in creative arts or sports’.” The policy in draft format stated that the school would develop provision for gifted and talented students by:

1. Providing opportunities for demonstrating, developing, and celebrating high levels of aptitude and ability
2. By treating provision for gifted and talented students as a whole-school issue and monitoring this at both a whole school and departmental level

3. By offering extension in depth and enrichment in breadth
4. By accelerating and expanding learning whenever appropriate
5. By going beyond the school into the wider learning community
6. By celebrating the excitement of excellence

5.4 Summary and Discussion of the Policies

All, but one of the schools (School H), provided policy documents or at least a statement (School K) for the education of gifted and talented students. The following summary and discussion is based on the other ten schools' policy documents.

5.4.1 Rationale and Purpose

The rationale and purpose for each of the schools' policies in gifted and talented education was in response to the Ministry of Education's gazetted requirements (Ministry of Education, 2003). These requirements, pertaining to gifted and talented learners, were to be mandatory from Term One, 2005. Two schools specifically took an inclusive approach, recognizing gifted and talented students under the umbrella of matching an education to the learning needs of all students regardless of learning difficulties, disabilities, or abilities. The rest of the policies were based on the NAG 1(iii)c and (iv) that state that:

- (iii)c on the basis of good quality assessment information, identify students and groups of students; who have special needs including gifted and talented students;
- (iv) develop and implement teaching and learning strategies to address the needs of students...above.

(Ministry of Education, 2003)

The rationale and purpose of these policies in gifted education laid the foundation about who they were educating and why. With a mandatory requirement the foundation is specified in law, but it is what followed, the school's concept or definition of giftedness, and how these particular students would be identified that differed.

5.4.2 Definition and Identification

The students were referred to in five policies as *Children with Special Abilities* (CWSA) or *Students with Special Abilities*. Four policies used the term *Gifted and Talented* and two of these schools differentiated between ‘gifted’ and ‘talented’. The definitions were mostly compositional in that they borrowed from multiple perspectives. For example, they were based on definitions used in the literature such as Renzulli’s (1978), Gagné’s (1985), and Gardner’s (1983, 1993) definitions. They were also generic in terms of the concepts of giftedness or talent although some acknowledged different domains of giftedness such as academic and sporting. Two schools acknowledged that multicultural aspects should be considered and only one school specifically outlined the concept of special abilities in terms of Māori customs, values, and beliefs.

The issue of definition should not be the primary matter for discussion, but it is the meaning that is attached to the term and the accompanying policy that addresses the ‘so what?’ question that is of importance. Over time, different terms and definitions have been considered internationally, nationally, and at local level. The changes in definition have been from that of intelligence (Terman, 1925) to Renzulli’s (1978) set of behaviours, and Gardner’s (1983) multiple forms of intelligence. The definitions used in the policies in this study were both conceptual and operational (Moon, 2006). The operational definition is closely linked to identification procedures.

Multiple methods of identification were listed in eight policies and these included those outlined in the literature, namely: parent, peer, self nomination, observation, tests, and student work samples. One school did not define any methods of identification. The mathematics policy of one of the secondary schools stated that identification in mathematics was by a pre-test.

These policies showed promise in terms of the documented variety of identification tools. They incorporated both formal and informal identification procedures. However, where identification was based exclusively on a formal procedure such as a test, there were related issues as evidenced in this study (reported in Chapter Six). The practice of formal assessment was used as a gatekeeper (to identification and

subsequent provisions in mathematics) for eight students in the study when they transferred to their next school.

There was no specific attention given in the documents to early identification in the primary schools or links to early childhood information. One of the intermediate schools (School D) included information in their school transfer documentation to assist in the identification process.

For two of the schools (Schools I and J), the documented identification procedures showed specific consideration for the mathematically gifted. However, there was no reference in these policy statements to identifying students through aspects such as those noted by Diezmann and Watters (1997), Hoeflinger (1998), and Sheffield (1999). These authors included a focus, for example, such as identifying students by examining their levels of mathematical reasoning in problem solving. No school documents detailed characteristics of the mathematically gifted that could then be used to inform teachers' and parents' nominations. These policies failed to meet all of Gubbin's (2006) criteria that high-quality identification procedures should be comprehensive (no policy achieved this), include student characteristics (this was generic in all cases), use objective and subjective tools (eight schools), and have identification criteria that are defensible and inclusive (Schools C, E, and J). With identification procedures in place, it should follow that provisions would be made to address students' learning needs in particular learning areas such as mathematics.

5.4.3 Provisions

Nine of the school policy documents outlined a range of provisions for gifted and talented students. School I articulated this specifically for the mathematically gifted and talented. The schools used a variety of different organizational strategies in order to group the mathematically gifted students so that they could work together. These included cross-class ability grouping (School A), ability grouping within the regular class (School B), special fulltime gifted classes in the intermediate schools (Schools C and E), cluster classes (School D), and streamed classes in Years 7 to 13 (Schools F and G) and secondary schools (Schools I, J, and K). The strengths and weaknesses of homogeneous grouping of students in mathematics, as discussed in the literature review, are contradictory. However, the majority of studies based on provision for

gifted students supported the practice where the gifted students were grouped together using one of the above organizational strategies. This study refutes Rogers' (2006) perspective that how gifted learners may be organized for their instruction "has nothing directly to do with what or how they are taught" (p. 208). The organizational decisions by these schools affected who received acknowledgement as a gifted and talented student and therefore the types of programmes designed to meet their needs.

Four schools (Schools A, C, D, and G) stated that one of their goals was to provide differentiated programmes. Differentiation is usually through a qualitative difference which is how School G viewed differentiation. With little supporting documents, it is not possible to describe the other schools' views on this provision. The terms used in most of the policies were enrichment, acceleration, and extension. The acceleration practices were not well defined in any of the policies, although there were schools in the study that practised deliberate acceleration of students in streamed or special gifted classes. These students worked one year level in advance of their age peers. Enrichment and extension activities were not described in mathematics except for School I who had a mathematics scheme outlining specific enrichment topics such as codes and paper constructions.

At the policy level, these schools included acceleration and enrichment as provision options. If these policies were put into practice, then there should be evidence of curriculum differentiation so that content, pace, instructional strategies, process, and products are modified to cater for gifted and talented students (Maker & Neilson, 1995). Other provisions outlined in the policies included competitions, curriculum compacting (School J), mentoring (School G), a one-day-a-week programme, Correspondence School, and liaison with universities. All of these provisions reflect recommended practice in New Zealand schools (Ministry of Education, 2000; Riley et al., 2004).

5.4.4 Professional Development

Six schools acknowledged the need for staff professional development. The schools differed in their approaches to professional development in gifted education. School F was in the process of review and had contracted an external provider to give formal

professional development in gifted education to interested staff over a sustained period of time. This school showed a real commitment to professional development with detailed strategies and timelines. The other schools were not committed to focused and sustained professional development although they had recognized it as a consideration.

It is undisputed that practitioners should have the knowledge, competencies, and dispositions required to be a teacher and address the individual needs of students (New Zealand Teachers Council, 2008). However, there is foundational knowledge for teachers in gifted education (Leppien & Westberg, 2006; Mingus & Grassl, 1999) and specific challenges for teachers of the mathematically gifted (McClure, 2001). All teachers of mathematics require sound content (subject matter) and pedagogical content knowledge (Ball et al., 2001; Ma, 1999). It seems that none of these school policies addressed this specific need for teachers of the mathematically gifted. The policies were broadly based and only one included a professional development plan to ensure an ongoing systematic process.

5.4.5 Community and Parent Involvement

Six schools explicitly stated that parent nomination would be one of the identification methods considered in the identification process. Apart from School D, there were no systems in place to formalize this opportunity for parents to nominate their child. Six schools acknowledged parents and community in their policies. For School A, this was through targeted projects, School B by networking with clubs and associations, and for School D through involvement with the community to develop knowledge and skills. School D also recognized the value of communication among students, teachers, and parents. This school had a comprehensive Parent Placement Form for articulating aspects of their child's interests and abilities to assist in provisions for special programmes. School G provided an inventory of community resource people in gifted education and acknowledged the importance of liaising with other groups in the community. Schools I and J agreed that there would be consultation with parents over matters such as acceleration, class placement, and competitions. School J recognized that links could be made with outside groups for mentoring.

Links to the community and parent involvement in relation to the gifted and talented education policies were minimal. Three schools did not acknowledge this in their policies. Interactions with families and communities are a feature of exemplary gifted education programmes (Briggs et al., 2006) and the part that parents can play in the education of mathematically gifted children has also been well documented (see, for example, Epstein & Dauber, 1991; Lupkowski-Shoplik & Assouline, 1994). It would be expected, therefore, that there would be stronger recognition for the contributions that can be made by parents and the community in the education of gifted and talented students. Schools should look to the community for support and expertise. For example, including mentors (who may be found in the community) can lead to greater interest, satisfaction, and increased levels of achievement (Reis & Graham, 2005; Rogers & Kimpston, 1992).

5.4.6 Resources

Eight of the school policy documents identified the need for resources as part of their gifted and talented education policies. It was not evident that it was a budget consideration; for most, it was merely given as a list of resources. These resources included books, textbooks, web sites, and resource people. This was a relatively undeveloped section of the school documents and was not learning domain specific (except for School I).

Selecting materials is seen as a daunting prospect as resources need to be linked to the students' cognitive strengths, in this case mathematics. Resources need to accommodate the critical differences among students (Sak & Maker, 2006), yet most schools in this study merely listed textbooks that could be used by students working at a targeted curriculum level. The most helpful way ahead for these schools would be to include guiding principles such as those presented by Sak and Maker (2006) to ensure that resources contain depth and are developmentally appropriate for students. The resources should enhance content knowledge, process knowledge, and student products. People resources specific to a learning area such as mathematics, as well as experts in gifted education, could also be identified (documented by School F).

5.4.7 Evaluation

Evaluation is linked to all of the previous components of a policy. Eight of the schools included evaluation strategies in their policy documents. Naturally, some of the schools related this to their assessment, reporting, and tracking procedures. Schools B, D, and G had registers in place to monitor the placement and provisions for gifted and talented students. This was a coordinated approach involving a lead teacher and/or coordinator and the student's class teacher. The focus for evaluations was on identification methods (School E and G) and provisions (Schools A, C, E, G, I, and J). School J noted that this evaluation was to be followed by adjustments to programmes. These schools had made an effort to acknowledge the role of assessment and evaluation, but this was not comprehensive for most schools. Clear assessment practices, recording, and tracking of the achievements specific to gifted and talented students were not articulated in most policies. The exceptions were Schools C and J. Evaluation criteria were also not provided by most of the schools. Only four schools (Schools A, C, D, and F) acknowledged that there was to be regular review and reporting to the Boards of Trustees.

It would be expected that the evaluation component of a gifted policy would outline a systematic process of collecting data from multiple sources to inform judgements about the effectiveness of identification and provisions for gifted and talented students (Callahan, 2006). Gifted education programmes, like provisions for all students, are accountable and evaluation is a critical outcome of that accountability process. This accountability is monitored for the government by the Education Review Office. There are several stakeholders in this process: students, teachers, parents, schools, and government. They are critical in the formulation and implementation of the evaluation of a gifted and talented education policy to practice.

5.5 Conclusion

The purpose of this chapter was to help situate the study and to provide a sense of the schools' documented perspectives on gifted education and in particular the education of mathematically gifted and talented students. The chapter provided documentary evidence of schools' identification practices, and programme provisions.

The schools provided the rationale and purpose in response to mandatory requirements. This requirement is therefore non-negotiable and relatively straightforward. However, there was a conflict between the notion of gifted and talented being inclusive of special needs and the concept of gifted and talented students as a special population in their own right. The concept of definition is a difficult one, especially if a school is to move from the generic to the specific. There is still no commonly accepted term or definition. New Zealand traditionally used CWSA, but the prevalent term used internationally is that of 'gifted and talented.' Working parties, ministerial positions, and publications now use 'gifted and talented'. The use of terminology is in itself not problematic, but it is the definition that accompanies these labels that pose difficulties and challenges. There was a lack of focus on multicultural awareness and attention to Māori concepts of giftedness. Without clear definitions and a sound theoretical perspective, teachers may grapple with their school's concept of giftedness and the identification procedures. Lists of multiple methods are not helpful without knowledge, for example, of the characteristics and behaviours of mathematically gifted students.

The schools used a variety of organizational strategies to group and cater for identified gifted students. Likewise, provisions covered the spectrum as outlined in the literature including differentiation, acceleration, and enrichment. The term extension was commonly used and like all provisions is open to interpretation if there is no supporting detail in school schemes or 'policy to practice' documents. A variety of provisions may be listed in policies, but any specialized provision, such as differentiation, is unlikely to be adopted without support from experts and systemic growth (Tomlinson & Allan, 2000). Professional development was recognized by half of the schools with a variety of approaches and targeted staff. Likewise, community and parent involvement was briefly acknowledged along with other resources. Evaluation was given attention although most of the policies lacked supporting detail as to the means for tracking students' achievements and progress, and for evaluating programmes.

The school policies provided the background and insight into each of the school's (except School H) perspective and emphasis on gifted education. The students in this study were identified by their schools as gifted and talented in mathematics. So what

were their behaviours and characteristics that enabled them to be identified and placed in these programmes for mathematically gifted students? Characteristics of the mathematically gifted and talented and the issue of identification will be addressed in the next chapter.

CHAPTER SIX:

CHARACTERISTICS AND IDENTIFICATION

6.1 Introduction

So who are the mathematically gifted? The characteristics of the students in this study, who have been identified as mathematically gifted, will be examined from the multiple perspectives of students, teachers, and parents, and then compared and contrasted with the literature. The data are derived from the student questionnaire and the interview material (students, teachers, and parents). The purpose is to gain insights into the students' interests, levels of motivation, and views about being mathematically gifted. It is important to acknowledge that although the results have been analyzed for all students in the study and from the multiple sources, two of the students could be classified as outliers. Although teachers identified the students as gifted and talented in mathematics, the parents of these two children said that they were surprised that they were included in the study. As explained in the description of the ethical practices, no student working in the group classified by the teacher as mathematically gifted and talented was to be excluded from the invitation to participate in the study. As the study ensued, it became apparent to the researcher that they were not gifted and talented in mathematics. This is explained later in the study and is an issue that is explored in relation to the research questions.

The second section of this chapter addresses the identification processes based on the school policy documents, the views of teachers, students, and parents, and the students' experiences. The process of identification is important in relation to the operational definition of mathematical giftedness described earlier in the thesis, and the focus on characteristics, attitudes, and behaviours. The chapter concludes with a summary of the findings about the characteristics of the mathematically gifted students in this study and the identification processes. These results are then discussed in relation to the literature.

6.2 Characteristics of the Mathematically Gifted

The findings pertaining to the characteristics of the mathematically gifted and talented are presented based on four themes. They are: early interest and ability in mathematics; characteristics as evidenced in ‘school mathematics’; students’ interests and hobbies; and students’ mathematical interests and attitudes.

6.2.1 Early Interest and Ability in Mathematics

The majority (12) of the students recalled an early interest in mathematics. For a few of the students, this memory was from before starting school. This very early interest in things mathematical was noticed by some of the parents. The parents had observed their young children building with construction toys, doing jigsaws (but taking a different approach to most children and adults who complete the perimeter first), creating symmetrical patterns, displaying tremendous memory, ability to grasp mathematical concepts quickly, and ‘playing’ with numbers.

From these early signs, described by parents and students, there was evidence of a difference within the domain of mathematics. Mia and Lily, for example, were more interested in the spatial or geometric view of the world.

I think my ballet teacher helped me a lot with it, with angles and things, you know like getting feet at the right angle and things. So I’ve been good at the angles and things since I was quite little because of dancing. (*Mia*)

She has always had an impressive concentration, she would sit for hours, literally when she was two, two and a half with Lego....everything was symmetrical and all colour coded....Maths was always a big part....She always loved jigsaws....She never did all around the outside and then fill in the middle. She goes for a patterny bit and then a bit more. (*Lily’s mother*)

Ryan, on the other hand, had a more logical, analytic, and arithmetic approach to mathematics that was evident from an early age. His mother told this story:

I think probably the first time we noticed, I used to walk my eldest son to school, [Ryan] would have been two and a half when [the other son] started school and [Ryan] used to read the numbers off the letterbox all the way to school. It started with the easy ones....we got to 356 and this is a two and half to three year old. He used to read all the way there and back. I obviously thought this child has an interest in numbers. At kindergarten he spent an entire morning...so he must have been four, sitting at the front of the gate with a chart

he's asked the teachers to make for him, counting cars, marking off the cars and what colour they were in what box and then added up the different colours. The whole three hours he spent counting cars. They would make a circus and [Ryan] would go off and make tickets for everyone and they would have numbers on the top of them...consecutively numbered. Or there was a big magnetic board which had numbers and he would spend hours starting at one and numbering consecutively until he ran out of numbers. I remember him getting to the nineties and getting upset because he ran out of nines; this was at kindergarten level.... he loves it; he plays games with numbers. (*Ryan's mother*)

Likewise, Martin had a fascination with numbers.

I think from the start, anything that came to numbers, he could recognize numbers and understand their meaning quite quickly....his perception of things adding up and subtracting from each other, he had that from an early age. When he was three or four, one of the uncles gave him a times tables poster....he would just pop up one day and say "Did you know that 4×6 is 24?"....he was very interested in money when he was a preschooler and when we started giving him little bits of money to spend he would work out how much he wanted to put away for a bigger present. (*Martin's mother*)

Three students in the study showed an early interest in all things mathematical, both geometric and numeric.

He did a lot of hands on like blocks and k'nex, he made these angles...recognition with how things went....when it came to mathematical problems, two plus three equals five or something like that he just tended to understand that. He says "give me something with figures"....He just solves problems....At day-care and kindy, that was noticeable even at that early age. (*Victor's mother*)

I just think he has a brain which is mathematical, he sees things as mathematical, sometimes he is too mathematical. His realization that numbers and maths are important for life.... He loves it and has a passion for it. If things can come down to numbers he's quite happy....The first thing he told me, "Ma it turns. Look Ma, it turns"....Then he got very interested in space, so for him that became big, like maths could go into the millions, kilometres, large numbers....I can see he is probably trying to use his basic mathematical skills to apply them to something that would work....he's into algebra now, that perception that x can be a number and if you add y to that you can get another number. (*Nardu's mother*)

The parents recalled many specific instances when their children displayed a 'mathematical cast of mind' and viewed their early childhood world from a mathematical point of view. This interest was both numeric and geometric, and evidenced in both their play and their talk. The students' memories were based more

on experiences since beginning school where there was class time designated to mathematics learning.

6.2.2 Characteristics as Evidenced in ‘School Mathematics’

After a year or two at school, the students developed an awareness of a differing level of interest and ability in mathematics compared to their peers. For the parents, who suspected that their child might be gifted and talented in mathematics, this was confirmed as their children progressed through school. Take Martin for example:

When he went to school, he’d only been at school a few months and he got a principal’s award and it basically read something like: “For knowing more about money and numbers than your teacher or your principal put together” and that was just their way of acknowledging that, yes, he had a special interest in it. (*Martin’s mother*)

For two students, this recognition came in Year 2, their second year of formal schooling.

Probably since Year 2, I began to like it more and even when I wasn’t that good, I liked it and I became better. I liked the class games and competitions...then became better at maths. In Year 3 it was the same and in Year 5 and 6 we went off in groups and I got in better groups and got to do more and then at intermediate I got in the extension room. (*Amir*)

The furthest I can think back would be Year 2. I learnt about borrowing with subtracting. I just started liking it, the subject. (*Eric*)

It was repeatedly mentioned by some of the students and parents that Year 3 was a ‘significant’ year. This also seemed to be a time when students became aware of their ability because of comparing themselves to others and the type of groupings being used in the mathematics classroom. Ability grouping became a more obvious feature of the mathematic class as students recognized that they had been placed in “the top group” and were “above average in ability in maths compared to others” and “faster learners”. For one student the realization that he was “actually good, really good” and ahead of other students was when he received ‘High Distinction’ in an Australian mathematics competition.

The teachers believed that the characteristics, that stood out the most initially, were the students’ keen interest in mathematics, their real thirst and passion for

mathematics, enthusiasm, flexibility in thinking, logical thinking, sense of humour, and the viewing of the world through a mathematical lens.

They have a sense of humour...creative thinkers as well as logical thinkers. They are hugely enthusiastic about maths...they play with numbers, a lot!...One or two of them seem to be almost instinctively mathematical, they would know the answer almost as though it happened unconsciously. (*Mrs J, School B_P*)

Three teachers recognized the students' advanced thinking skills, their ability to grasp new concepts more quickly than other children in their class, and the ability to think in more abstract terms than their age peers.

[Karen] would regularly be able to talk at quite a complex level about the question...if I had talked with other students they would not have been as abstract. In Piagetian terms, she is at that abstract level already; she can talk like that. (*Mr P, School I_S*)

The difference in ability and achievement across the strands of mathematics was recognized by both students and teachers. Two students noted that they did not achieve as well in geometry as in other strands and two teachers also recognized the differing types of mathematical giftedness. Mrs N (School A_P) and Mr P (School I_S) explained:

They usually do stand out in one way or another, some of them are gifted in only one area of maths; others are able to do a whole lot of maths that they enjoy. You'll get children who are amazing with visual patterns and some of the geometry things like rotation, translation, etcetera but they may not be very good at addition, subtraction, multiplication, and division. (*Mrs N, School A_P*)

There are those that have very good spatial skills and those that have very good mathematical computational skills. (*Mr P, School I_S*)

The perseverance with mathematical problems was regularly observed by Mrs J (School B_P) who commented: "I'd come into class or if I was working with another group they'd have a whiteboard covered with numbers and diagrams; they worked out things, laughed, and were so excited about maths". This perseverance with problems would continue through morning tea break or they would take a problem away and go on thinking about it and return the next day with other possibilities. "Even when we'd solved a problem they would be carrying on, working at it, thinking about it in a number of different ways". Miss L (School C_I) also observed

students returning to class at morning or afternoon tea to play mathematics games or puzzles, or returning to work on their mathematics projects.

Four of the teachers noted the behavioural challenges that these students sometimes presented. Miss L (School C₁) commented: “A lot of these gifted and talented kids are not very well behaved or hard workers. They have a sense of humour; you have to have your wits about you”. They were also described by Mrs K (School G_{1S}) as “not sit-still kids. They’re not kids who are going to sit still very long unless their brains are actually engaged”.

Other teachers have identified them and said ‘I can’t stand that kid’, the kids who are challengers...it’s definitely not always recognized as people see them as cheeky, rude, and precocious, inappropriate and their jokes not a smart thing to say. But really, it’s a very smart thing. (*Mrs J, School B_P*)

The majority of those kids can be quite demanding almost to the point where they are a little bit arrogant. If they don’t rate the teacher, good kids will turn and blame the teacher for not doing well. (*Mr M, School K_S*)

For one teacher this issue of challenging behaviour was problematic. She expressed concerns and was observed having difficulties managing her class; this issue was also raised by the parent with a child in this class.

Additionally, although it could perhaps be considered a minor aspect, is the issue of presentation skills. Overall these gifted and talented students did not present their work to a particularly high standard (work samples were collected from all students in the study). Some of the students commented that it just was not an issue for them. They saw it as a teacher problem and were usually frustrated by teachers who demanded neat layout. A few of the Year 6 students cynically mentioned the teachers who liked borders around project work. As Mr J (School F_{1S}) said, “generally their handwriting is terrible, but they are accurate too”. The teachers commented that they were more interested in gaining insight into a student’s thinking. However, some of the students expressed frustration at having to write down their thought processes and explained that answers sometimes just came into their heads and they really were not interested in how they got there, but “it was right, so who cares?” One parent explained that she tried to convince her son about the importance of being able to record his thinking. Victor’s mum explained that “he does know what he’s doing, but

he's too lazy to write it down". Victor's response was "What's the big deal I know the answer? It didn't say 'show'".

6.2.3 Students' Interests and Hobbies

The students reported in the interviews a range of interests and hobbies. These are shown in Table 6.1.

Table 6.1

Students' Interests and Hobbies

Name	Interests & Hobbies¹¹
Lily	Animals, Reading (long books)
Bob	Animals, Sports
Nardu	Computer games
Joshua	Soccer, Computer games
Victor	Computer games
Mia	Dance: ballet, jazz, hip-hop, Scouts
Eric	Computer games, sports
Martin	Sports (touch, cricket), reading (Sci-fi), computer games
Ryan	Origami, code breakers, computer games, sports (speed skating, gymnastics, hockey, touch).
Tim	Sports (hockey, cricket, rugby), Computer games
Karen	Drawing, artwork, reading
Nina	Reading (fantasy), daydreaming, keyboard, karate, art, modelling, writing (poems & fantasy)
Amir	Computer games, sports
Lewis	Reading, sports, animals
Paul	Sports (badminton, tennis, basketball), computer games

There were few commonalities to be drawn from this except that the students' interests were wide ranging and included outdoor pursuits. Computer games were the most common interest across the group and were mentioned by nine of the students (all boys). Five students listed reading and a few of the activities (origami, codes, and modelling) could be considered to be mathematical. Some of the activities demand

¹¹ Recorded in the order given by the students.

self-directedness, but it is not possible to comment on the level of task commitment, persistence, and motivation in relation to these interests and hobbies.

6.2.4 Students' Mathematical Interests and Attitudes

The following tables (Tables 6.2 and 6.3) are the collated results from Rogers' (2002) Mathematics Interest and Attitude Inventory.

Table 6.2

Mathematics Interest and Attitude Questions and Average Score for Year 6 and Year 8

Question	Average Score (Year 6)	Average Score (Year 8)
1. Mathematics is my favourite subject at school.	2.7	2.0
2. It is important to work hard to be successful in mathematics	3.7	3.2
3. I am very good in mathematics.	3.4	3.0
4. I plan to study advanced mathematics in high school and college.	2.8	2.6
5. Learning new ideas in mathematics is the most interesting part of class.	3.3	2.2
6. Solving mathematics story problems is the most interesting part of class.	2.9	2.0
7. I love to work on mathematics assignments.	2.8	2.2
8. I try to learn more about mathematics outside of school time.	2.4	2.2
9. Mathematics is easy for me.	3.1	2.8
10. I try to do my best work in mathematics and on mathematics tasks.	3.4	3.2
11. I work on mathematics problems and puzzlers outside of school.	2.9	2.6
12. I enjoy finding out more about mathematics on my own.	3.1	2.2
13. I would like to be some sort of mathematician someday.	2.0	1.8
14. I wish I could have more than one mathematics lesson each day.	2.9	1.6
15. I could learn anything about mathematics I wanted to if I worked hard enough.	3.5	3.0
16. I wish most mathematics classes could be longer.	3.1	2.0
TOTAL AVERAGE	3.1	2.4

The previous table, Table 6.2, gives a breakdown of the questions and the average score for each group of students for Year 6 (n=10) and Year 8 (n=5). An average score was calculated based on a 1 to 4 scale, negative to positive as described in Chapter Four. An average of 2.67 or higher across all the items on the scale indicated that the child had ‘motivation’ in mathematics and an average above 3.34 suggested that the child was ‘highly motivated’ in mathematics (Rogers, 2002, p. 60). The rubric posed challenges for one of the students in terms of understanding the questions.

Both groups of students rated Question 2 the highest. This was followed closely by (or with) Questions 10, 15, and 3. The students attributed success to hard work despite acknowledging in Question 9 that they agreed mathematics was easy for them. The Year 6 students found solving mathematics story problems a more interesting part of the mathematics class than the Year 8 students. The students, on the whole, planned to study advanced mathematics, but did not see themselves as mathematicians in the future. This data shows that less interest and motivation was reported from the Year 8 students compared to the Year 6 students. The Year 6 students as a group could be classified as ‘motivated’ in mathematics. However, given the sample size, this information is best used on an individual basis. The following table, Table 6.3, provides the individual scores for each student in the study.

Table 6.3

Students’ Mathematical Interests and Attitudes

Name	Year	Average Score	Student Comments
Lily	6	2.25	
Bob	6	3.56	<i>I would like to do more maths at school</i>
Nardu	6	3.56	
Joshua	6	3.31	
Victor	6	2.62	
Mia	6	3.06	<i>Mathematics is easy for me. I really enjoy maths in books like ‘Figure it Out’.</i>
Eric	6	3.13	
Martin	6	2.31*	Parent’s comments recorded below

Ryan	6	3.25	
Tim	6	2.56	
Karen	8	1.44	
Nina	8	3.13**	Extensive student comments recorded below
Amir	8	2.44	
Lewis	8	2.5	
Paul	8	2.56	

* Martin's mother commented:

[Martin] found the questions quite hard to answer (hence lots of 'sometimes' answers). Eg. For Question 4, he said: "How would I know I'm only 10!" He also found it hard to define his feelings about maths—thinking mathematically is something that has always come naturally to him, not something he has consciously worked at.

**Nina's additional comments

I take a neutral outlook when regarding mathematics on a whole because I consider it as a necessity; something that needs to be learnt and the sooner and faster, the better. Also, just because you're good at something doesn't mean you necessarily like it either. I like learning maths, because that makes me better at it and I like to be good at things. I get pleasure from getting good marks in tests—which happens often. I like solving mind-bending problems and it doesn't matter if I get them wrong or not—I store them away in my brain and prepare for the next question(s) because I know I'll be better prepared, I enjoy doing algebra as well and I like to learn more and more about it. Usually the more I learn the happier I become; but this only applies to algebra—being my favourite strand of maths. I have never learnt from games/puzzles because I have always managed to learn the straight forward way. I have been able to learn fast and easily so usually I don't need to work too hard while learning—one of the trickier parts being when I combine what I learn to form a path to a solution. This year, I have enjoyed being in Mathex (I've been in it for the past three years) and I like working in a team (of other brainiacs) to solve problems.

Five of the students (Joshua, Mia, Eric, Ryan, and Nina) were rated as 'motivated' in mathematics with only two students categorized as 'highly motivated' (Bob and Nardu). As a tool, the questionnaire encouraged the students to examine their attitudes towards mathematics and also their levels of interest and effort. It also gave the parents, who were interested, an insight into the aspects of mathematics that their child rated highly or otherwise. Nina, the student who showed evidence of being highly gifted in mathematics, had an interesting perspective on mathematics and did not rate as 'highly motivated' on this survey. She recognized her advanced ability in

mathematics, but she explained that did not mean it was her favourite subject. Karen scored an average of only 1.44 and was not motivated in mathematics. She declared mathematics was not her favourite subject, knew she was good at mathematics, but had no desire to work on mathematics problems. So, how were these students identified by their schools and/or teachers as gifted and talented in mathematics?

6.3 Identification

All of the school policy documents acknowledged the importance of using multiple sources for identification. These included teacher observation and nomination; rating scales; standardized testing; portfolios; performances and auditions; product evaluation; parent, caregiver, and whanau nomination; peer nomination; and self nomination. There was specific reference to either the academics or mathematics in most of the school policies on gifted and talented education with achievement or standardized tests as the most common identification method. There was no mention of using off-level testing or acknowledgement of the ‘ceiling effect’.

The question to answer is: How does policy manifest itself in practice? According to eight teachers, their schools, in practice, used a multiple method approach for selecting students for their gifted and talented classes or programmes. This multiple method approach included teacher nomination, parents, and tests. Only one of the schools used self and peer nomination as part of this approach. The issue of misdiagnosis by teacher nomination was raised by one teacher.

Some of them came to me as having been identified as gifted in maths and I didn't always agree....the previous teacher tagged some and failed to tag some as well because I guess it's the old story particularly the girls who work neatly, logically and are really focused; they listen to what's being asked and follow instructions well; they are frequently the ones not gifted in maths. (*Mrs J, School B_p*)

The teacher expressed a genuine concern related to misgivings about the identification process and in particular the process of teacher identification.

The schools relied predominantly on test information; this was reinforced by the teachers who stated that testing was used by their schools as part of the identification

process. These tests included the Test of Scholastic Ability (TOSCA) (n=2), Progressive Achievement Tests (PAT) (n=5), Assessment Tools for Teaching and Learning (asTTle) (n=4) and school-designed tests (n=2). Most of the teachers accepted that formal tests were an answer to the problem of identification in mathematics. However, three teachers acknowledged that even though they used tests as a form of identification, there were students who might miss out because they did not do well in tests. In both of these cases, they stated that the school had a flexible policy, they may not always get it right, and there may be movement later in the year.

How we place the kids in the classes early on isn't an exact science so there are some kids in the second class who are just as good as the guys in the first class. (*Mr M, School K_S*)

Sometimes students mask themselves or whether it's because they get overawed by coming in and doing tests and then shine out or whether it's been sitting there latently and finally they find the push button and move on. (*Mr H, School H_{PI}*)

One school, (School E) relied exclusively on a test as their sole identification tool. The teacher commented that "initially asTTle was the big decider". She acknowledged this as a shortcoming, which led to an extensive range of mathematical abilities within the class. As a consequence, the class included students who she felt were not gifted in mathematics. There was no movement in or out of this designated 'extension' class for gifted mathematics students. When questioned about the lack of movement, the teacher explained: "I can't do that to the kids; I can't...Not one of them wants to leave".

The parents were aware of their children being identified for particular groups or classes because of test results.

I guessed he'd been in the top group and that's why he'd been selected. I don't know of any other process other than just the normal testing. (*Eric's mother*)

Very much hands-off, basically, they had the test and then we had the letter sent home to say that: "We've identified him as being a child who would probably enjoy this or benefit from it". (*Martin's mother*)

One parent was prepared to acknowledge what he perceived to be a rather 'ad hoc' approach to identification.

I believe that New Zealand could really lift its game incredibly by clearly identifying these kids. There is no real identification apart from individual schools using tests. I think they purchase some and use TOSCA. (*Lewis' father*)

The issue of misidentification was apparent from the students that were included in this study. They had been identified by their school and/or teachers as gifted and talented in mathematics, yet parent information, student data, and researcher knowledge and expertise would support misidentification of at least two students. Both of the students (Bob and Tim) were from Year 6. One of the students was in a cross-class ability group and the other student was in an ability group within a regular class. The students were observed to be working happily and successfully with other students in the groups. The students explained that they enjoyed mathematics. However, according to the parents and the researcher, they did not display some of those special characteristics associated with mathematical giftedness. They scored moderately well in tests and were observed working diligently in class. One parent had commented how surprised she was that her son was included in the study; she felt he was a hard worker, but not gifted in mathematics. This parent considered that it was beneficial for her child's self-esteem to have been invited to be part of the study.

The issue of ongoing identification came in the following year when the students in the study were tracked through a transfer. This issue is also raised in Chapter Nine: School Transfer. The students believed that because they had been identified as gifted and talented in one year that this would continue in the following year. They realized that there would be greater competition the next year. For all students, it meant moving to a larger pool of students whether to an intermediate or secondary school. (This notion of 'small fish in a big pond' is explored in Chapter Nine.)

The majority of the students understood and accepted that selection was based on the results of a test sat for the receiving school. However, Nardu had faith that his selection for the 'Mathematics Enrichment' class would be based on the information passed on from his previous school stating that he was good at mathematics, and consideration would be given to his previous years' test results. He also knew that he had to sit a test at his new school, but he expected to get in this streamed class for

mathematics. Likewise, Martin expected to get in to the CWSA class; he knew selection was based on a test. If he had not made the class, he said that his mother was prepared to question the selection process. Both Nardu and Martin were placed in designated ‘special abilities’ classes.

One situation concerning lack of identification is briefly outlined in the following case of Eric. Eric’s mother raised the issue of her son not being identified for the intermediate school’s streamed (cross-school) mathematics class. The story is left for the parent to tell in her own words.

Well I went to that parent interview and it came up about maths. I thought I’d see what she [the teacher] had to say. In the end she said to me, “I think that he needs to go into the extension class” and I thought, well this is interesting....I’ve asked and there’s no room....I said, “He’s found it at times very boring....he comes home from school and says ‘I did this in Year 4....I don’t think that he’s telling an untruth”. (I think she [the teacher] was quite shocked)....I said, “I’m just terribly worried that he’s going to lose his enthusiasm for maths....he’s loved maths....I have no idea how you organize it and it’s up to you, it’s your school, but you asked how things were going in maths and that’s how it is”. (*Eric’s mother*)

Meanwhile, students from the streamed mathematics (CWSA) class were enrolled in the Australian Mathematics Competition. Eric was not allowed to take part as he was not a member of the CWSA class. His mother, on her son’s behalf, persisted with the school and explained to the principal that Eric had competed successfully for several years and wanted to participate again. As her story unfolded, it became clear that the principal was puzzled that Eric was not in the CWSA class, and he agreed that he needed to look into the matter.

Eventually, the school received Eric’s results from the Australian Mathematics competition. He had obtained one of the highest marks in the school and the category of ‘Distinction’¹². Consequently, Eric was placed in Term Three in the ‘Children with Special Abilities’ streamed mathematics class. This was a case of non-identification despite parent nomination, student nomination, and information forwarded from the previous school about his achievement levels in mathematics.

¹² Top 5% Year 7 participants in N.Z.

6.4 Summary and Discussion

Characteristics of the mathematically gifted and talented students were described from the multiple sources of data. Some of the parents, through their experiences with other children in the family, or their own knowledge and experience, were aware of some of the early signs. These early signs included aspects such as ‘playing with numbers’, a sense of symmetry in pattern making, and viewing the ‘world through a mathematical lens’ (see, for example, Diezmann & Watters, 2000a; Gardner, 1983; House, 1987; Johnson, 1983; Straker, 1983). Many of the parents gave detailed accounts of the mathematical behaviours they observed in their children’s play and talk. They described situations in both the home and early childhood environments. Descriptions of these atypical instances of mathematical play were passed on to the parents by the early childhood teachers. None of the parents were aware of information about their children’s special interests and abilities in mathematics being passed on, or taken into account, as part of the transfer process to primary school.

The students showed an awareness of their mathematical giftedness when they were able to compare themselves with peers at school. The teachers articulated some characteristics, but no teacher described in depth the range of characteristics associated with the mathematically gifted and talented. Collectively, the teachers mentioned most indicators but their contributions were based on anecdotal evidence gained from teaching experience. None of the school policy documents supported the teachers by providing indicators of mathematical giftedness.

The notion of an appreciation for different types of mathematical giftedness was evident from student, parent, and teacher data. The parents were able to differentiate between early signs of spatial reasoning and arithmetic reasoning. The students, on the other hand, associated mathematical abilities with numeric reasoning and computational ability, although later in their schooling, especially when trialling for mathematics competition teams, they realized the importance of problem solving skills. These different types of mathematical giftedness were most clearly defined in the literature by Krutetski (1976). The focus from the students and teachers in this study was not on these differences. However, these are differences that had been apparent to some of the parents in their children’s early childhood experiences and to

two of the teachers. Spatial giftedness has often been overlooked (Webb, et al., 2007), so it is important that this view of mathematical giftedness is given attention in the identification process.

The students reported a variety of general interests and leisure activities; computer games were listed by the majority of the boys. Sport also featured in most of the students' lives and five children listed reading as a leisure activity. A few of their leisure activities, such as origami, codes, and modelling, could be said to have links with mathematical thinking. This information about their hobbies and interests was sought from the students as young children's interests and leisure activities have been found to be a reliable predictor of future high achievement in that area (Freeman, 2000).

Motivation is a key component in the gifted literature (for example, Renzulli's concept of giftedness, 1978) and an element included in the operational definition for this study, and so it was decided to examine these students' levels of motivation in mathematics using a reputable tool. Only two of the students rated on Rogers' (2002) Interest and Attitude Inventory as 'highly motivated' and five students as 'motivated'. The rubric posed a few challenges, but encouraged the students to think about a variety of factors related to their mathematics learning. The results showed that students' levels of motivation differed between the two year groups. Many of the students attributed success to hard work, and despite planning on continuing their studies in mathematics, they did not see their future in mathematics. The students' intrinsic motivation was evident in many of their responses and a case-by-case examination of separate items was interesting. The tool provided information on individual students that would be of interest to a parent or teacher and could contribute to the identification process.

In practice, identification for mathematics relied primarily on test and competition results. This practice resulted in one student in the study not being identified as gifted and talented post school transfer. This particular student did not perform well on a test used to identify students for the withdrawal CWSA mathematics class at intermediate school. Eventually, the result from a competition was used as evidence that he could be moved to this class. This school had not used multiple identification methods. If they had used parent, student, and teacher nomination, and records from

the previous school, then it is highly likely that the student would have been placed in the appropriate class in the first instance. There is also the potential for the ‘geometric’ student or the ‘creative problem solver’ to be excluded from selection if a test focuses on a narrow range of knowledge and skills. The hard working student, who performs well in a test (for the targeted age level and not allowing for the ‘ceiling effect’), may be included in the selection process and may not necessarily be gifted and talented in mathematics, as was the case for two students in this study. The other issue is that test results (such as the PAT¹³ used for students in this study) may not differentiate among the most able, with the consequence that students may not receive an appropriate mathematics education.

There was no mention of formal identification processes early in a student’s schooling, despite those early signs of giftedness recognized by the parents. This means that potentially a student could miss out on identification. There were students in this study that the researcher believes were misidentified. The evidence showed that multiple methods were not used in the identification process. The students and parents admitted that they did not think that they were gifted and talented in mathematics. The outcome has not been problematic; the students have worked hard in mathematics and experienced mathematics programmes that may have been possibly more differentiated than they might otherwise have experienced. Without knowledge about the characteristics of gifted behaviour or potential, then it is possible that the ‘teacher pleaser’ may be misidentified as gifted and talented in mathematics. Likewise, the gifted underachiever may go unnoticed. Students transferring from class to class, within the same school, will be exposed to the same identification processes which may be reliant on limited methods such as teacher nomination and test results.

The process of identification can be problematic. A school policy may document what multiple sources can be used, but it is evident that what is put in to practice appears to differ given the cases cited here. Multiple means more than one source; you would expect a range of sources that includes parent and student nomination. Given that the school documents examined in this study did not describe the

¹³ PAT has since been redesigned to address the ‘ceiling effect’.

characteristics of the mathematically gifted, then as Renzulli (2004) questioned, how can you identify a gifted population if you do not know what you are looking for? There was no documented information pertaining specifically to the identification of mathematically gifted students apart from nominated tests. There was also no documented identification processes as part of the transfer process from early childhood education to primary school.

These two topics, characteristics and identification, are interconnected especially if one takes the view that an identification procedure is necessary. The schooling system in New Zealand states that there is a legal obligation to identify gifted and talented students. It is the researcher's view that this would be untenable without awareness of the associated characteristics. Identification provides the "means to an end and not an end in itself" (McAlpine, 2004b, p. 126) and so once students have been identified, the focus should be on the quality of provisions. The nature of the provisions for students may influence whether and to what degree a student's mathematical potential develops.

The following chapter explores the qualities of the teacher of the mathematically gifted and the varying components of mathematics programmes as experienced by the participants. This is supported by students', teachers', and parents' views about suitable provisions and related issues.

CHAPTER SEVEN:

THE TEACHER OF THE MATHEMATICALLY GIFTED AND THE MATHEMATICS PROGRAMME

7.1 Introduction

This chapter addresses the question concerning the qualities of an effective teacher of mathematically gifted and talented students. This is followed by multiple perspectives on the nature of educational provisions for the students in this study. The features, strengths, weaknesses, and challenges of the various provisions are presented. The use of out-of-school provision is briefly described as two students attended a one-day-a-week programme. All of these aspects are then summarized and critiqued in relation to the literature.

7.2 Qualities of a Good Mathematics Teacher

The teachers had responsibility, within their school contexts (influenced by policy, as described in Chapter 5), for the detail of the programme content, the teaching approaches, and to some extent the resources used. However, the quality of the programme planning and delivery is influenced in part by the individual teacher (Leppien & Westburg, 2006). There are personal and professional characteristics that make a good teacher and in particular a good teacher of mathematically gifted and talented students (Mingus & Grassl, 1999). The students during Phase One interviews were asked a specific question pertaining to this topic and the teachers were asked to comment on any challenges in providing a programme for mathematically gifted and talented students. The data from the parents relevant to this topic is included when it arose in the context of responses to other questions rather than from an explicit interview question.

The students were in agreement on several characteristics of a good mathematics teacher for gifted and talented students. The most favoured attribute, from the

students' perspectives, concerned the teacher knowing the student. According to the students, this meant treating each student as an individual and showing understanding if the student was grappling with a concept. The importance of teachers knowing their students and having an empathy with them was also recognized by both the teachers and the parents. The teachers acknowledged that you had to "really know the students" and one teacher stated that it was important to specifically identify those aspects students excelled at in mathematics. The teachers believed that you had to establish a good relationship between teacher and student, "be interested in", and "value" the students.

Another commonly reported attribute was the teacher's mathematical content knowledge. Students expected their teacher to be good at mathematics and to "know tons of maths". Aligned with this competence in mathematics, most students agreed, was the teacher's enjoyment of mathematics. The teachers acknowledged that it was important to be interested in mathematics; the secondary school mathematics teachers articulated the importance of strong content knowledge so that a teacher knew where the students were heading in their study of the subject.

Some of the parents also acknowledged the importance of the teacher's subject matter knowledge. Parents were aware that the secondary mathematics teacher was expected to have specialized qualifications in this subject area. Bob's mother explained that "the [mathematics] teacher is more qualified; he's not a jack of all trades. He's got a good knowledge of the subject". Subject matter or content knowledge was a greater expectation once their children moved on from primary school. Some of the parents did not view strong content knowledge of mathematics as the reserve of the secondary school teacher, but an expectation from Year 7 and Year 8 teachers as well. In one of the primary schools (School B), the gifted and talented students spent some of their mathematics time with their school principal. The principal also helped prepare the students for competitions. Both the students and parents acknowledged the principal's expertise, interest, and enjoyment in mathematics.

Another quality mentioned by the teachers and students was flexibility. Flexibility was talked about in different contexts: organizational, time, responding to students, and in the use of resources. For one of the teachers from School B (two teachers from

this school were in the study), flexibility in teaching time was important. Gifted students, according to this teacher, sometimes wanted to spend sustained periods of time on a particular mathematics problem or investigation. Mrs J (School B_p) believed that the teacher needed to recognize this and respond accordingly. This was one of her reasons for being an advocate of catering for gifted and talented students within the regular class. Without tight timetable restraints and cross class grouping, she explained, you could let students continue with a particular problem or investigation.

The other notion of flexibility was a teacher's ability to respond to the students as individuals. This aligns with the earlier attribute expressed by the students as "knowing the student". One teacher described it as the ability to recognize "the teachable moment" and be flexible enough to pursue the student's "line of thinking". Another skill, identified by the teachers, was the ability to adapt material and to use resources flexibly. Several of the teachers talked about this as a valuable skill given that there were not resources available written specifically for gifted and talented mathematics students. Miss L (School C₁) explained that "it's about making sure that there's stuff available and the tools so you just have to be flexible with the challenges that do come up, and you adapt".

One student affirmed this and stated that she expected material to be adapted to meet each student's individual needs; a teacher who "doesn't give the same thing to everyone, adapts things". Nina elaborated:

Mostly you need to know what each gifted child's abilities are so that you can show them the next step upwards....If it was a whole class of gifted students the teacher would need to know each of their abilities [and give them] the right level of work so that it's neither too hard nor too easy. If it's a gifted child each child needs to be given separate versions, grouping doesn't really go. (*Nina*)

Teachers talked about other skills such as the ability to provide "open-ended tasks", "to be able to question well", "to encourage higher-order thinking", and to be able to "give them confidence". Students, teachers, and parents acknowledged that an effective mathematics teacher must provide the right level of challenge. This is presented in the next section in relation to provisions. It was acknowledged as a quality, but also as a challenge in itself.

In the majority of cases, the parents appreciated their children's mathematics and/or class teacher and used adjectives such as "inspiring", "dedicated", "absolutely wonderful for pushing him further", and "a one-off, amazing, push them really hard teacher".

Education is all about the quality of the practitioner standing in front of your child. [Mr M] in terms of maths is absolutely fantastic. He obviously has very high personal standards and skills, and he expects that of everyone; he is quite fantastic. (*Lewis' father*)

There was acknowledgement by some of the teachers that the students could present behavioural challenges and so the teacher needed to provide a motivating and challenging programme to keep students on task. This was discussed in the previous chapter as one of the characteristics of gifted and talented students. In two cases, the parents were not happy with the teachers and schools (Phase Two Schools) and their lack of recognition of their children's needs. They found the situations for their children "distressing" and "disappointing". The reasons for this were different for each case. In one case, the parent felt that the teacher had very poor behaviour management skills and that the programme was not challenging her daughter. The second is the case of the student who was not placed into the gifted class until half way through the year and had a regular class teacher who admitted that she did not have the mathematical expertise to provide suitable challenges for him in the programme.

Paul sums up the key attributes and expectations for a good mathematics teacher of gifted and talented students.

A good teacher is one who understands what they're talking about. They know the best way to show how it's done. They should have good resources. They should know their students. (*Paul*)

The students experienced mathematics firstly through the primary school system with generalized teachers who did not have in-depth specialized mathematics knowledge. One group of the Year 6 students in Phase One of this study had been identified as gifted and talented in mathematics and organized in to a cross-class ability group (School A). This class was taught by a teacher who had interest in mathematics and wanted to take this particular group of students. She had no specialized qualifications in mathematics, but had attended a gifted education

professional development course. The other Year 6 students (School B) were ability grouped within their regular classes and had additional mathematics classes taken by the principal. One of these teachers at School B was very experienced and strongly interested in mathematics and the other teacher was relatively inexperienced and relied considerably on the use of computer programmes.

The Phase One students at the intermediate school (School C) were in the special fulltime gifted class and were taught by a teacher with expertise and experience in gifted education. She was also a teacher with a keen interest in mathematics. The situation for the students in Year 7 (Phase Two) varied considerably. The teachers had wide-ranging expertise in mathematics and in their knowledge and experience working with gifted and talented students. The three secondary school teachers each had several years of mathematics teaching experience and experience with teaching streamed classes. Within these streamed classes they had all taught students gifted and talented in mathematics. One of the secondary teachers had additional training in gifted education and another secondary school teacher had a Masters degree in psychology.

In this study, the students, teachers, and parents collectively recognized the following as the qualities of an effective teacher of mathematically gifted students:

- knows the students as individuals;
- establishes a good rapport with students;
- has sound content knowledge of mathematics;
- is interested in and enjoys mathematics;
- appreciates and provides challenging mathematics; and
- is flexible—with time, organization, planning, and use of resources.

The teacher has the dual challenge of teaching mathematics and teaching this subject to a special population, the gifted and talented. There are many programme options available; the following section presents the findings about programmes experienced by the students in this study.

7.3 The Mathematics Programmes

All the participants were asked about the mathematics programmes. The teachers were asked about the key features of their programmes, the students were asked to describe not only their current programmes, but also what they perceived to be a good programme for mathematically gifted students, and the parents gave their perceptions of their children's mathematics education. All of the students were observed in Phase One mathematics classes and then again in their Phase Two mathematics classes. Each of these observation periods was of four to seven days duration; the period of time was dependent upon several variables as described in Chapter Four: Methodology in Practice. The responses were merged to build a thematic picture about the nature of provisions for mathematically gifted and talented students; these descriptions were verified through the multiple perspectives, observations, and documents (teacher plans, student workbooks, and school policy documents). The school policies have already been examined (Chapter Five) to discover the range of educational provisions advocated in the schools' documents. In this section, the focus is on policy to practice.

7.3.1 Acceleration

Seven schools mentioned acceleration in their policy documents although planned acceleration was evident in only one intermediate school (School C) and two of the secondary schools (Schools J and K). In addition, School I (co-educational secondary school) had a separate 'extension programme' for their most able students. This was not planned as an acceleration programme although there were mathematical concepts included in the scheme that were not taught to the core Year 9 classes. The intermediate teacher (School C) and two of the secondary teachers planned acceleration programmes, one year in advance, choosing material and using textbooks that targeted the year ahead. The students were working as an ability grouped or a streamed class, with the content selected by the teacher and pace determined by the students. One teacher acknowledged that acceleration in the form of grade skipping was a considered option although none of the students in this study had been deliberately grade skipped.

We've had a lot [of students] that have jumped from Year 5 to 7 so they tend to then do the two Years 7 and 8 at intermediate. Then you have the ones that will go straight from Year 7 to 9 and leave out Year 8, those really bright cookies. I'm not sure of the wisdom of it; I think it's on a case by case basis that you have to make that decision....I think it's the better grounding, we run a two-year programme so there isn't the repetition theoretically. (*Miss L, School C*).

Three secondary mathematics teachers recognized benefits for the students from accelerating their mathematics learning. These benefits were the potential for greater flexibility in subject choice and the relative early gaining of qualifications. There was a clear pathway for this process in two of the secondary schools although the teachers acknowledged that it was individualized once the student reached Year 13. The deliberate acceleration of students through the secondary boys' school (School K) was well considered by the teacher who had responsibility for teaching advanced classes. This acceleration process included Year 13 students studying university papers.

By Year 13 you want to be doing your first year at university here at school. That has to be their goal. I tell them the benefits of that, the papers are free, they don't have to pay. When you go to university, you basically start second year or you can do a double major; you've got options because you've got some of that first year under your belt already. At the very least you have to make that your goal. (*Mr M, School K_S*)

One teacher expressed reservations about accelerating students. She commented that her aim was:

...to extend them, but not to extend too much vertically, we try on a whole not to go past Level 4 of the curriculum, we try to do our extensions horizontally rather than vertically because we have found in the past when they went off to intermediate they were stagnating, a lot of those better children. So...a decision was made to do as much as we could as a horizontal rather than vertical extension. (*Mrs N, School A_P*)

One teacher (Mrs R) showed a genuine concern for the potential for burnout for gifted and talented students. She supported the acceleration process, especially in the case of Nina, whom she felt had high expectations and the determination to succeed. Already, as a Year 9, Nina was working on Year 12 algebra. (Nina's father had deliberately advanced her learning in algebra.) Nina's teacher however was concerned about her welfare.

I also don't want her to get complacent. I do prefer to do both the curriculum, what's in the scheme and take her as far as I can accelerate her....I would like to see her getting involved in more things though, social, and not being so studious....sports are not her thing, she loves drama, but I would like to see her more than just doing studies...add some balance to her life. (*Mrs R, School Js*)

One parent (Lewis' father) had a similar concern about the acceleration process. This was raised in relation to the topic of pastoral care and planned pathways for students and is discussed in Chapter Nine: School Transfer. Both Ryan and Nina were accelerated students and wanted to continue to excel in mathematics at an advanced level. In order to succeed, they recognized a need, at this stage in their schooling, to be good at all branches of mathematics.

The primary school teachers did not talk explicitly about acceleration per se, but recognized the need for the students to be working on mathematics that was in advance of their same-age peers. This was evidenced with the Year 6 students working on Level 4 of the mathematics curriculum; this is commonly the targeted level for Year 7 and 8 students.

7.3.2 Enriching the Mathematics Programme

To ascertain whether programmes were enriched or not was not an easy task. Did teachers use a deliberate approach to provide an enriched programme for mathematically gifted students? Did the students perceive the programme to be enriched and, if so, what were the features of the enrichment programme as experienced by these students? Seven of the eleven schools in the study specifically mentioned enrichment or enriching programmes for gifted and talented students in their policy statements. The enriched or enrichment programme has been described in the Literature Review (Chapter Two), but is essentially one that broadens students' experiences and engages them in high levels of thinking and problem solving experiences.

Different terminology was used by the teachers to describe the type of enrichment programmes that they provided. These included enrichment, extension, investigations, problem solving, research, and projects. Several of the teachers explained that they enriched their programmes through a notion of horizontal

expansion of the curriculum. One teacher explained, with an example of other number systems, how she enriched her mathematics programme for the gifted students.

When we were doing a number unit the children did some work at looking at the old ways that numbers were written so looking at what was used in Egypt what was used in Babylonia what was the Roman, the Greek forms....They also designed ways that you could do maths and looked at what the caveman would do....I've tried to do that sort of extension with them. (*Mrs N, School Ap*)

Mr J (School F₁₅) talked about providing his Year 7 students with enriching mathematics and said, "I call it sideways; we just get into other projects. Escher, I really like him". He went on to explain how he liked to approach things a little differently with these students because the students were "really into the maths side...and other Year 7 classes can't cope with that kind of thing". There was evidence of the Year 6 and intermediate school students exploring mathematics outside of the regular curriculum; usually this was through a project or investigation. The topic was pre-selected by the teacher and a designated period of time allotted for the project. The students were often encouraged to work on these at home; this was the case at School F where projects were part of the homework schedule. Some of the teachers were attempting to differentiate the programme by providing more challenging tasks for these students.

7.3.3 Differentiation and Challenging Tasks

There was an expectation from the students that they should be completing work that was different to their peers. Mia from School B explained: "We have different challenges to the rest of the class and we do different sheets. We are very separate to the rest of the class...we do a lot more challenging or I should say mind bending sorts of things". These comments were reinforced by all of the students from School B. Students from three of the schools described topics, such as, exploring Pythagoras' Theorem, Greenwich Mean Time, and Escher's work. These were examples of enriching topics as they were outside of the regular curriculum; they provided breadth in mathematical content and the potential for work traditionally beyond their year group. This was differentiation of content; the students were

studying topics in mathematics that were more complex or more abstract than their age peers would normally study.

Not all students felt that their programme was differentiated in content and that the topics were instead just as expected, “normal maths, like measurement and statistics”. ‘School mathematics’, for two of the students, was perceived as easy. Two of the students also felt that they should not necessarily be given the mathematics that they liked. They both articulated the need to be exposed to all aspects of mathematics and be encouraged to do topics that were not their favourites. Nina also explained that even though she may not have been as good in a certain topic, it did not mean that she disliked it. She wanted things that were “really outside the square, outside the octagon, ones that challenge you a lot, to think in ways that you wouldn’t normally think in, that are not direct or straightforward”.

The students were adamant that their mathematics programme should be based on a problem solving approach; most students expressed a keen interest in problem solving. The students from School B all felt that the majority of their work was based on a problem solving approach. In this case it was a reality as evidenced in the students’ and teachers’ voices, and validated by classroom observations, and perusal of students’ workbooks. Ryan stated firmly that “if they like problem solving give them problem solving. Make it harder than their abilities so they have to work hard. Usually gifted children get bored because the work is too easy”.

Several students talked positively about investigations; one student explained that they were “good because you get to work out things”. Several of the students also talked specifically about an open-ended approach. Eric explained: “We’ve done quite a lot of open-ended questions...for the open-ended questions we actually had a lot of time to do it”. Most also stated that there should be a certain level of challenge. The word ‘challenge’ occurred repeatedly in the interviews. Students were asked to explain what this meant; it commonly meant “not too easy but also not too hard”. It also meant a more open-ended approach so that students could approach problems in different ways. The notion of challenge was raised by Miss S (School B_p) who explained that her aim was “to challenge them, to make them look at things from different points of view”.

Two teachers talked specifically about the practice of enrichment and acceleration underpinning their planning and as a way of making the programme different for these students. Miss L (School C₁) described it as a “double pronged thing” and how she deliberately planned for this. Mrs R (School J₅) also used a combination of acceleration and enrichment. She explained:

I am always trying to do open-ended tasks. Then I look at how they do the tasks. Then I try and look at different ways of extending them....We do accelerate them so they learn more than the other classes....for every topic I also set a project, maybe do a poster or an article....I invented something they could do that was a bit different....I modify things for them. I make them more in charge of the lesson....My questioning is different with them, it's much more open-ended. I do things differently. (*Mrs R, School J₅*)

The student, who was not identified for the CWSA class at intermediate school until Term Three, was given an individualized programme by his teacher who recognized the need for “extending him”. This was one case where, despite not being in the specially designated withdrawal class, the teacher was making an effort to provide a differentiated mathematics programme. However, the teacher acknowledged that given her limitations in content knowledge of mathematics, there were some topics that she found difficult.

Despite students being grouped according to their abilities, or a class being categorized as an ‘extension class’, eight of the teachers raised the issue of planning for these students. For some, it was resolved by grouping within the class whereas Mr P (School I₅) talked about a specific strategy. His was a streamed secondary school class, but within that class, he recognized a range of abilities. He would pose the initial problem in two formats, work with those students who were struggling, and pose additional challenges for the most able students.

There was a variety of strategies used by teachers to provide a programme with some aspects of difference to regular mathematics programmes. These programmes were not differentiated in terms of responding to the students’ individual needs through qualitative differentiation of content, process, and product. However, there was some acceleration for the students and some enriching experiences planned for groups of students, and recognition of the need for challenging tasks. The teachers appreciated

the need for acceleration, the need to expose the students to different mathematics, and to use approaches such as problem solving and investigations. The programmes were influenced, in part, by the resources available to the teachers.

7.3.4 Resources

The teachers responded specifically to a question about the resources available to support their programme for mathematically gifted and talented students. The findings, related to textbooks, computers, and other resource material, are presented in this subsection. Students provided information pertaining to this topic when talking about their mathematics programmes.

Textbooks

Textbooks were used by all of the schools in the study except School B. School B used a variety of teacher-compiled resources, the Ministry of Education's 'Figure it Out' series, and internet material. In the rest of the schools, a range of textbooks was used, but in differing ways. The textbooks were all based on the national mathematics curriculum current at the time of the study. The titles were: *Alpha Mathematics* (Barton, 1999); *National Curriculum Mathematics Levels 4 and 5* (Catley, Tipler, & Geldof, 1994, 1996); *Dragon Mathematics 5* (Geldof, 2005); *New Zealand Mathematics Book 8* (Kendall, Ramsay, Rodgers, & Ross, 2002); *New Zealand Mathematics Book 9* (Leeuw, Meadowcroft, Ramsay, & Ross, 2002); *Form 4 Mathematics* (Millard, 1997); and *Pearson Mathematics* (Wilkinson, 2004). Three schools (Schools A, C, and K) used textbooks designated for a regular class one year ahead.

The students and teachers held varying views about the use of textbooks. Most of the teachers used textbooks to supplement their programme and to provide independent practice exercises. The students had varying views about the strengths and weaknesses of textbooks. Lewis reflected a positive view:

[Named textbook] is good because they have questions set up, and they also have pictures which kinda help and then there's the answer in the back so once you've done them and you mark and then you look at the ones you got wrong and try and see why you got it wrong. The textbooks are real good. They are sometimes easy and sometimes challenging which I think is rather good.
(Lewis)

Amir was in the same class as Lewis yet had a different view of the use of the same textbook.

It's not that good because we usually just work from textbooks and we don't usually work with the teacher; we work by ourselves and mark by ourselves so we don't learn much. It's like that most of the year. (*Amir*)

Mia worked from the same textbook, but in a different school, and found that the textbook did not provide enough explanation. She had, previously in Year 6, not worked from textbooks and was not used to this teacher's reliance on a textbook. Mia explained that the teacher primarily used a textbook; she listed pages on the board and the students completed designated exercises. This was confirmed in classroom observations and teacher planning. In contrast to Mia's perspective, Nina saw herself as a textbook learner.

Usually, I'm more of a textbook worker not really an oral kind of worker. I think it's easier to learn things orally, but I'm a textbook learner. I like study guides and I prefer learning and only doing exercises if I find it hard to understand. Here we get introduced to new content then you go and do the exercises. (*Nina*)

One of the Year 7 teachers, Mrs O (School D₁), said that she encouraged independent work through the use of textbooks; she selected from a variety of textbooks available in the school. As an experienced teacher, she felt that she knew her "way around" the textbooks and selected material suitable for the mathematically gifted students.

The teacher from School E used two different textbooks for varying purposes. Both students and parents commented favourably on the way in which they were used. One textbook was worked through in order and in the other they "jump around". The latter formed the basis of assignments that the students had a week to work through and then the exercises were either peer marked or marked by the teacher. The in-class textbook was not used very often, maybe once every four or five weeks. This practice was supported by the students in this class who commented that they did not use the textbook much and the work was "normally just up on the board".

The use of a particular textbook and/or homework book (as used by School E) was viewed favourably by the parents. They saw it as a helpful way of finding out what their children were working on in mathematics and to also get a sense of how well

they were doing. However, one parent felt that it did not necessarily match the student's desired level of challenge.

At secondary school, Nina's teacher used textbooks from advanced levels, but was selective about the exercises she chose. Nina verified this:

The textbook, she doesn't ask us to read stuff out of the textbook, she actually teaches us, she uses the board and diagrams and that sort of thing. We use the textbook for exercises, some we do like 'live', she says which one and we say the answer. I've done some from Theta which is Year 12. We've hardly done textbook work from Year 9 curriculum maths. (*Nina*)

The teachers at Schools I and K (both secondary schools) made similar use of a textbook for the students in their designated 'top stream' mathematics classes.

The textbook comes in when we need to, after we've explored the idea. For example in geometry, we didn't do any textbook today....we've got some interesting talk.....Once we've got that done I can say, "okay let's put that into practice, let's do some textbook problems, how does that work, look at some examples"....it's for doing exercises....I use it as a resource not as a teaching tool, there are some good examples, sometimes I use the investigations. (*Mr P, School I_S*)

The schools in this study used a variety of textbooks written by New Zealand teachers for New Zealand students targeted for specific curriculum levels or year groups. These curriculum levels reflected the New Zealand Curriculum Framework (Ministry of Education, 1993) with Levels 4 and 5 commonly aligning with Years 7 to 10. These textbooks were written with the regular student in mind and not designed specifically for gifted and talented students to include qualitatively differentiated learning experiences and challenges. Some of the textbooks emphasized aspects that prevail in the national assessments such as the writing of explanations and justifications, problem solving, and the contextualizing of mathematics in real-life situations. However, the main emphasis of these textbooks is on knowledge and skills-based practice exercises. Many of the students worked with textbooks designed for one curriculum level or one year ahead. The students at School B were the only students who did not use textbooks at primary school; their programmes included a strong focus on problem solving. The rest of the teachers used textbooks in a variety of ways: for practice, homework, and as supplementary material.

Other Resources

The other resources mentioned by the teachers and students were worksheets, the 'Figure it Out' (Ministry of Education) series, Numeracy Project material, and internet sites. Six teachers (including the three secondary teachers) also talked about supplementing their programmes with personal collections of resources. Many of the students expressed a dislike of practice-oriented worksheet material. For example, the Year 6 students were particularly scornful of practising basic facts through the use of worksheets. Any material that focused on merely getting the right answer was also not well received, especially if they had to go back and make corrections. A few of the students (and one parent) commented on how frustrating it was to write out explanations and to show alternative methods for working something out. Two students felt that worksheets were "boring" and given merely to keep them occupied. Lewis complained that "sometimes it's from worksheets. [If we get it wrong] we have to go back and fix them up before we go on and do anything else.... We have to redo it, which is annoying". These reservations about the use of worksheets were reiterated by several of the teachers. Miss S (School B_P) explained: "I think that sometimes they can be time wasters although if there's a concept that needs some practice I make up some or find another way of doing it".

Teachers from School B made regular use of the 'Figure it Out' (Ministry of Education) books, but students had contradictory viewpoints about their use in the mathematics programme. Some of the students talked positively about the resource, whereas others did not enjoy working from them. The teachers from School B believed that they had good access to resources and appeared to be very adept at modifying resources. Of all the teachers in the study, these teachers accessed the greatest variety of material. They were prepared to seek out resources that had a strong problem solving approach and also provided the opportunity for students to work on the material either independently or in small groups.

Differing views were given by the teachers in the study about the use of the internet, for both the teacher in finding material, and for student use. At opposite ends of a continuum on the topic was Mr M (School K_S) who was adamant he did not use them at all and Miss S (School B_P) who specifically used web sites to support her teaching for the mathematically gifted students, although with a few reservations.

The activities are based on web sites that I have found. I'll give them a web site for a specific concept. They have a few to choose from and as you saw the other day they don't always make the best selections. I have to keep an eye on that and they used to have to record that in the back of their maths books so I knew what they were doing and there was some kind of follow up. (*Miss S, School B_P*)

These internet-based resources were quite well received by the gifted and talented students in her class, although Eric expressed some concerns as he explained:

We quite often go on the web and search for sites that [Miss S] has found. She makes up cards; you type in the site and go on it. We do most of it in our books....Most of it has been pretty enjoyable. Some things get annoying if you have to keep doing them over and over. (*Eric*)

Computers were available in the primary and intermediate classrooms where mathematics was being taught, but in the intermediate and secondary schools the students went to a computer suite if the teacher wanted to use computers as part of the mathematics programme. This was observed when the students at School E went to the computer suite for a statistics study. The focus was on the use of spreadsheets and graphing. Where computers were available in class, the gifted and talented students were not observed using them. This was verified by the teachers.

A really interesting thing is that although computers are available; they were very much an interactive group; they wanted to work together. They wanted to share what they were doing, rather than go and sit at the computer. (*Mrs J, School B_P*)

There was little evidence (except for Schools B and I) of a planned approach to incorporating computers in the mathematics programme. Only one school had provision within the class for easy access to several computers in the class. It was evident (except for School B) that the computer was not viewed as an important resource for the mathematics programmes. One class in School B was a designated digitally-enhanced room, so additional resources had been allocated for this reason.

Issues

The teachers raised a few issues associated with finding and developing resources for their mathematics programme for the gifted and talented students. There was concern about the lack of resources readily available and specifically designed for these students in terms of content and how that content was presented. The teachers were

not looking for practice material, but enrichment material. There was also concern about the time needed to access, evaluate, and modify material.

It's really hard sometimes finding material that's challenging for them so that they don't get bored. If they are bored then they get turned off maths. There's gaps with that top maths group....I modify the Numeracy Project material. I look on the internet, talk to other teachers....It would be good to have extra material. (*Mrs J, School B_P*)

I think it would be nice to see more stuff come out for these kids. I don't think we get enough stuff...even with the numeracy games we have to modify all the time. The kids are good at modifying things themselves....but it would be nice for stuff to come out that would just target, just them....that is going to be challenging, that we can pick up and use and not have to continually adapt. (*Miss S, School B_P*)

However, Mr M (School K_H) presented an alternative view regarding the use of resources and suggested that the teacher's knowledge and expertise should not be underestimated.

My attitude is that you can be bombarded with resources, you get teachers showing off all these resources, that's great but what use is it if you can't teach it properly?...I remember a really good teacher that I had at school who walked in with a piece of chalk in hand, textbook in another and never looked at the textbook....He knows his stuff....You don't need a library of resources for that. A teacher can get confused by having too many resources....The best resource is this (points to head) and experience. It means you can do things off the cuff, kids ask a question out of the blue....You need to respond to their questions and it gives you credibility especially with these top guys. (*Mr M, School K_S*)

7.3.5 Group Versus Independent Work

One feature of the learning environment was whether there were opportunities for group or independent work within their mathematics classes. The students were observed working in a variety of situations: independently, in pairs, small groups, and whole class. Most of the teachers used different grouping strategies dependent on their class composition. The Year 6 students were ability grouped and seated together for mathematics lessons. They had many opportunities to work with others except for one student who insisted on working alone (Lily). The Year 8 students (except for Eric) worked in a class of gifted students and worked independently, in pairs, small groups, or as a whole class. The secondary school students were observed working in different situations. Those at the boys' secondary school worked mainly

independently and were seated separately in rows, but there were class discussions and the sharing of solutions. The students at the co-educational secondary schools were seated in rows with other students beside them and were allowed to converse with others as they worked. The teachers determined the seating arrangements and the opportunities for the different ways of working during a mathematics lesson. Did these opportunities match the student's preferences?

The students' preferences were spread across the combinations. Four students (Lily, Lewis, Nina, and Tim) preferred to work independently. Lily liked only to work on her own (Lily was the student with 'twice-exceptionality'), "because it's quieter. I can think more". Tim explained that he could work it out on his own and "so people don't put me off". Two students (Martin and Ryan) liked the combination of independent and work with a peer, but not in groups. The reason given for this was they felt you did not know what people were up to in the groups. They liked to tackle a problem independently first and then come together to work with each other in mathematics as they felt that they had complementary problem solving skills. When they came together with a peer, they felt that they could compare the way that they had gone about solving problems. This relationship of working alongside one another in solving problems had continued to their next school where they were both in the gifted class. Amir's preference was to work with a peer, "a buddy", so that he had someone to share his ideas. These boys (Martin, Ryan, and Amir) did not favour group work; they felt that when there were too many different ideas you could "get all confused". Mia was the only student who always liked to work with a peer.

I like to work with a buddy, because there's a girl and she's a really good friend and she's at about the same level as me. I prefer to work with someone at the same level as me. In the [Named group] we all have special ability, but some of us are a bit better than the others. Sometimes we have to work things out on our own for our portfolios because [Named teacher] wants to know what we can do on our own. It can be really challenging. (*Mia*)

Two students (Nardu and Paul) preferred the combination of independent and group work. Paul explained that he felt he learned more working on his own, but appreciated the social aspect of working with others. The other students (Bob, Eric, Jarod, and Victor) preferred to work in a group for similar reasons especially for problem solving and as long as the group was not too big. Eric explained:

I like working with other people, four or five people in the group. With everything else normally, I like to be independent, but with maths I think working in a group is good, it gives you other peoples' ideas, you can learn other strategies off other people. (*Eric*)

One student (Karen) was not prepared to give a preference. Two of the teachers had differing views about whether the mathematically gifted students liked to work independently or in small groups.

I think they are children who can problem solve, they don't have to be able to articulate what they can do, they often will work completely by themselves, they often don't like working with other children. (*Mrs N, School A*)

This was Lily's teacher who thought that gifted and talented students preferred to work alone, although the rest of the students in her class commonly worked with others in a small group of like-minded peers. They were observed responding positively to group problem solving situations. However, some of the Year 6 and Year 8 students expressed annoyance about the obligatory sharing of strategies (a feature of current numeracy classes) that was part of group or whole class teaching. Mrs J (School D₁) felt that the mathematically gifted and talented students responded well to group problem solving situations. This teacher invariably provided opportunities for group work, but did not recognize independence as a characteristic of gifted behaviour.

What I've found is that those kids tend to be very self motivated as long as they are not working on their own, as long as they are with two or three together, they generate the understanding usually without having to come to me. (*Mrs J, School D₁*)

There were differences of opinion among the students and teachers about preferences for independent, paired, and group experiences during a mathematics lessons. The students had personal preferences, but it seemed that the decision for how a student worked was usually determined by the teacher.

7.3.6 Homework

The teacher also had responsibility for selecting the mathematics homework. This was a regular part of the programme for the intermediate and secondary school students; this was defined in their school policies. One school used the 'Achievement

Challenges' as alternative homework; the teacher felt it appealed to the students because it was self directed. The students who worked on these challenges were ambivalent about them as a form of homework and also questioned the level of challenge. Mr J (School F_{1S}) used a specially-designed commercial homework workbook as a regular part of his programme. He was very much in favour of the homework which was set on Mondays and the students had until Friday to complete it. He supplemented the homework with activity sheets and then he had some "pretty cool projects" that he included as enriching experiences to be completed over the holiday period. A similar workbook was used by Mr P (School I_S) who explained that it was always an issue as to which homework book they would use. Unlike Mr J (School F_{1S}), he was "not a big fan" of a homework workbook. The students marked the work themselves and also recorded their results.

Mr M (School K_S), the teacher at the secondary boys' school, stated that although homework was a compulsory element of school policy, if given the choice, he would still include it as part of his programme. He felt strongly that the homework must be reinforcing, not new material. It was the challenging new material that he wanted to present while they were in class sitting in front of him.

I give them homework that they can do, that supplements what we do in class. I make sure that I do the hard work in class. So when they get home and do the homework and find it relatively easy they feel good about it and it's a positive experience. I'd rather they come back the next day, positive about having done it. (*Mr M, School K_S*)

Most of the students, who were given regular homework, were ambivalent about it. They commented that it was basically practice material with little challenge and just something that you completed "because you had to". Martin specifically mentioned that he did not enjoy homework as it consisted of computations, "lots of basic addition, subtraction, multiplication, and division; they get boring".

For the parents, it was perceived as a key means of being informed about what mathematics their children were studying and also the level of difficulty and/or challenge. Some of the parents expressed concern that the work was not as challenging as that given in preceding years. Victor's and Nardu's parents spoke at length on this issue. Both of them viewed homework as a high priority and expended considerable time in supporting their children with their homework.

Homework was clearly a part of the mathematics programme for the students at intermediate and secondary school. It was favourably received by most of the parents; this is discussed in the following chapter as part of the parents' involvement in their children's mathematics programmes. The teachers had differing objectives for the use of homework: as an opportunity for independent work, to provide different challenges, or as a form of practice. The students raised some doubts about how much this practice was needed when it led to tedium and boredom. There were other more interesting provisions that had greater appeal to the students, such as competitions.

7.3.7 Competitions

Six of the schools stated in their policies that gifted and talented students should be given opportunities to participate in competitions. This opportunity in practice relied on factors such as school and teacher organization. All of the teachers in the study valued the use of competitions (for certain students) as part of their mathematics programme. The competitions subscribed to by the schools included the Otago Problem Challenge, Achievement Challenge, the New South Wales Competition, the Australian Mathematics Competition, National Bank Competition, and teams' competitions run by local mathematics teachers' associations.

The Otago Problem Challenge was valued by some of the teachers and students for its emphasis on problem solving skills. The Achievement Challenge was not so favourably received by students, although the two teachers using the scheme felt it was useful as a voluntary enriching activity and to encourage independent work. The Australian Mathematics Competition was subscribed to by seven schools. There was an expectation that the students in each of the special classes (represented in this study) would compete in the Australian competition each year, although one teacher confessed that in that particular year their entry form had been mislaid. Some students missed out because the teacher or school were late with their entries, or they just did not get around to it in that particular year, and in some schools the opportunity was restricted to only those in the designated 'gifted' class. This was Eric's case where he was initially not allowed to participate in the Australian

Mathematics Competition because he was not in the gifted class and at the last minute was allowed to participate, only because of his mother's insistence.

The students were very aware of what competitions they had or had not been able to participate in. Most of the students were in favour of being able to participate in competitions and had participated in previous years. If their school failed to send in entries or did not participate in competitions that they had previously competed in, the students were not impressed and the parents expressed disappointment. In two cases, the parents intervened because they knew about the competitions (their children had participated in previous years) and they were annoyed when it became apparent their children had not been registered to participate. The parents felt their children enjoyed the competitions (especially the New South Wales competition) as it gave them a chance to compare themselves with not only others in their group at school, but also with a wider set of students. The students who competed in the Australian competition talked about wanting to obtain distinction¹⁴. The Australian Competition results, according to Miss L (School C₁), were results that the school used as a way of monitoring students' achievement levels and checking that "there was no slippage".

There was one case of a student being entered in a mathematics competition that varied to the competitions she had usually competed in. Nina was not impressed with this particular competition. She explained:

We did do this other one which I didn't like, the questioning was so different, it asked pointless questions which didn't test your true academic ability in maths, it asked you strange things....I got distinction, I didn't like it; I'm not doing it again. They were just pointless questions like how many acute angles can you have in a polygon with 2001 sides, it was harsh, no calculators. First questions were real easy Year 6 and last ones were ridiculous. I prefer...[when] it actually asks what you know and what you should know rather than random ones.
(Nina)

All of the schools in the study entered teams in their local competitions. The team competitions were very favourably received by students, parents, and teachers. The students talked about the value of "working together", the preparation, and how when you have been doing it for a few years "you kinda know what to expect". It

¹⁴ The top 5% of students

was an opportunity to represent the school. In some cases, the schools held internal preliminary competitions, so even the process of being selected was viewed with a sense of challenge and excitement. In two of the primary schools (Schools B and H), the principals with interest and expertise in mathematics took responsibility for the training of the teams for this competition. In most cases, there was deliberate coaching and preparation. It was also viewed as an opportunity for the students to work as members of a team; this feature was acknowledged by students, teachers, and parents.

It's good because they have to work within a team and quite often they might be gifted mathematicians who just like to focus on their own and not to problem solve in a group. I think it's good for them as they may not be used to problem solving in a group. (*Miss S, School B_P*)

Although the students and parents shared similar views about the value of competitions, there was a difference of opinion among the teachers. Both teachers in the boys' schools associated competitions with gender. Mr H (School H_{PI}) commented "that determination to get it right. I've noticed that with boys, they thrive on competition". Similarly, Mr M (School K_S) explained that "competition is part of the programme. A lot of this school is about competition; boys like competition....We foster competition".

Mrs R (School J_S) presented a differing point of view and recognized that this was not the case for all students in her Year 9 accelerate class. (Bear in mind that although the class is classified as a streamed class, not all students were identified as gifted and talented in mathematics.)

Not all of the students thrive on competition, so I have to be very careful about how I use them. This class probably 60 to 70% of this class are more extroverts and like competitions. They have to feel safe and comfortable so I don't use them at the start when they are sorting each other out and they are afraid to make mistakes. Now they are really comfortable with each other so I can use competitions more. (*Mrs R, School J_S*)

One of the secondary teachers was ambivalent about competitions. He explained:

Personally, I sit on the fence on it, in some ways I think that it's good because there are some students who thrive on the challenge and like to compare themselves against others in the world and they find that absolutely inspiring whereas there are others that find it a chore....I don't force them, it's upsetting; some just don't enjoy competition at all. (*Mr P, School I_S*)

There was a variety of different competitions referred to by the students, teachers, and parents. Most of the students had experienced the local team mathematics competitions and most had participated at some time in independent national and/or international mathematics competitions. These competitions were viewed favourably by the students and parents. Most of the teachers recognized the benefits of competitions, although two teachers expressed some reservations. The schools that enrolled students each year in the competitions used the results as a form of tracking student progress.

7.4 Tracking Progress

Students' progress was monitored in a variety of ways: teacher or school-designed mathematics tests, examining exercise books, formal interviews (NumPA¹⁵), teacher observations, and competition results. All of the teachers in the study used tests. These were usually school-designed pre- and post-tests (primary and intermediate schools) or common tests (secondary schools). The secondary schools also had formal examinations; at one secondary school the students sat the examination set for the year group one year ahead. Other test results used to track progress were the PAT results and tests developed from AsTTle. Six teachers used NumPA to monitor students' progress. This provided diagnostic information about a student's number knowledge and strategies. Two teachers felt that the interview did not go far enough for these students and the assessment results did not match the true abilities for some of these students. Four of the teachers mentioned day-to-day observations as another method by "keeping lots of records in my head" or making anecdotal notes. One teacher made these notes against indicator sheets with criteria to focus observations. Competition results were used by four teachers to track progress and four teachers regularly examined exercise or homework books.

The common practice of setting a pre-test, then teaching a unit of work and repeating the test as a post-test was not favoured by the students. They usually scored highly on a pre-test and so there was little improvement in a post-test except, for example, to go from 31/34 to 32/34. The students felt that the pre-test results were not used by

¹⁵ Numeracy Project Assessment—the diagnostic interview

the teachers to plan challenging programmes that included material that was in advance of the pre-test material. Results, for the five students in this study from one Phase One school (School C) across five different pre- and post-tests, showed that they improved in their tests on average by only a few marks. These results did not show evidence of ‘significant’ improvement as there was little room for improvement. The tests results were used summatively; there was no evidence of formative usage. The question is whether, as a consequence of these results, the students’ programme was differentiated. In the students’ views, the subsequent programme was not differentiated; there was also no evidence in the teacher’s planning. Paul commented: “It’s sort of boring. If you do well in the pre-test there’s not much to learn. You don’t learn much”. This view was supported by Amir who stated that “with the programme I don’t usually improve from the pre-test to the post-test”. Pre- and post-test data were provided for other groups of students in the study. It was evident that there was a similar situation with little difference between pre- and post-test results for certain strands of the curriculum such as number and measurement, and no supporting diagnostic information.

Parents were questioned about how they knew about their children’s progress in mathematics and what communication there was, in relation to this, between home and school. There were different systems operating in each school, but the parents trusted teachers to contact them if there were any matters of concern. Otherwise, they relied on the schools’ reporting systems to keep them informed about their children’s progress. Several of the parents commented that their children informed them of how they were getting on at school, although most still wanted and appreciated the interview with the teacher.

Yes. I trust that if she’s not doing well then [the teacher] will tell me....because they’re quite good at reporting back with the communications book and things that they use. And I also trust that if [Lily] is struggling she will tell me because she’s quite open about things....I haven’t really had to do anything other than the odd parent-teacher interview thing. (*Lily’s mother*)

Communication was usually through interviews (either parent-teacher or parent-teacher-student) and written reports.

We have missed one teacher interview because we were away....but I know that I can ring up at any stage and talk to them. It’s slightly different at [School F], it’s quite different to what I’m used to because he has his form class teacher

and then he goes to [Mr J] for maths. So I've never met him, I've only met the form teacher... We have school reports, and what I read into it is unless we hear otherwise he's trundling along fine. (*Bob's mother*)

As students moved from one school to the next, the parents grappled with a change in reporting practices. This issue is addressed in Chapter Nine: School Transfer. The systems for tracking student progress varied from school to school with primary schools preferring anecdotal notes and some pre- and post-tests. The intermediate and secondary schools had more formalized methods of testing including common tests and examinations. As part of the acceleration process, students were tracked using tests and examinations for the year level at which the students were working. Competitions provided supplementary results. Parents were informed through systems such as interviews and school reports.

7.5 Out-of-School Provision

Three schools mentioned out-of-school provision in their policies. These included a one-day-a-week programme (School B), withdrawal or pullout programmes within the school or community (School G), and “going beyond the school into the wider learning community” (School K). In practice, only one school (School B) was actively promoting out-of-school provision and that was for a one-day-a-week programme. School D had a section on their School Placement form to indicate if a student had attended an out-of-school provider.

Several of the parents, teachers, and students raised the topic although no research questions were framed to specifically address ‘out-of-school provision’. An out-of-school provision that consisted of a one-day-a-week programme was part of the gifted education programme for two of the students (Lily and Ryan). The aim of the one-day-a-week programme was to provide a comprehensive enrichment programme specifically designed for gifted and talented students. Martin’s mother commented that they had been asked to consider the one-day-a-week programme, but had decided against the need for this out-of-school provision. They felt that Martin was happy at school and the school was meeting both his social-emotional and academic needs.

Lily and Ryan became involved in the one-day-a-week programme through different means. Lily's mother saw an article in the newspaper and after studying the associated web site decided that her daughter was a likely candidate. The cost was a prohibitive factor, but when the parent approached the school she was told by the principal that; "we really have to do something with this child; we can't provide what she needs at the moment. I really think you should follow the idea through". It was also through the educational psychologist's assessment [for the one-day-a-week programme] that the parent was told her child had "very mild but definite symptoms of Asperger's". The parent was not surprised with this diagnosis as she had approached the school when her child was in Year 2 with her concerns, but had received no support. Lily's mother contended that her child really loved this out-of-school provision because she felt a sense of belonging with a peer group who accepted her, but for the other four days of the week she was miserable. Lily was unable to continue in the programme in the following year because of the cost factor. However, Lily's mother was optimistic about the following year because Lily was off to an intermediate school that had a gifted and talented programme.

Lily enjoyed the one-day-a-week programme because she said it was "more fun than school". She believed she qualified for the programme because of her gifts and talents in reading, mathematics, and puzzles. Lily particularly liked the topic approach, although she acknowledged that the topics were not chosen by the students themselves, but by teachers in the organization. However, within a topic there was a choice of tasks. Lily also liked the way you could work on a project for a sustained period of time and not to have to break to do regular subjects. Another feature she appreciated was the reduced requirement for written work compared to her regular class work. The students chose to work on their own or with others, and also had a choice in the final products or outputs from their projects. Lily's description of the programme was validated by Ryan, the other student who attended this school.

Ryan's mother was approached by his regular primary school to make an application for assessment by the one-day-a-week programme. According to his mother, the class teacher wanted to make sure she was catering for Ryan's needs, even though the parent felt the teacher was conscientious and already providing a quality

programme for her son. She explained how it differed from Ryan's regular school mathematics programme:

It's completely different from what he does at school. They don't do maths as such. They bounce ideas off each other, they think outside the square, they come up with something completely different, they don't go in and do school work, they don't do maths as such or English, they come up with these awesome ideas and they create things and he has an absolutely wonderful time; he really enjoys it. He's quite a social kid anyway, but he has enjoyed that extra group of kids. (*Ryan's mother*)

The communication between the one-day-a-week programme and the regular school consisted of a weekly newsletter outlining the topic being studied by the student. It also included goals for the week, but was not individualized. There were no explicit links between the regular class teacher and the teacher of the one-day-a-week programme. The conceptual themes explored by the students were pre-determined and although the students enjoyed the social opportunities, there were no planned approaches to differentiate their programme in a targeted learning area such as mathematics.

7.6 Summary and Discussion

The topics addressed in this chapter collectively related to the mathematics teacher and the mathematics teaching and learning as presented and interpreted by the participants. The qualities of a good teacher, as described by the participants, included factors such as: the teacher knowing the student; having sound mathematical content knowledge, interest and enthusiasm for mathematics; and flexibility. Flexibility was described in relation to time, the ability to respond to individual needs, and to adapt material to meet students' needs, particularly in the level of challenge. These qualities are supported in the literature on gifted and talented education (see, for example, Leppien & Westberg, 2006). However, the literature mainly provides competencies for working with gifted students, rather than specifically focusing on competencies for teaching gifted and talented mathematics students.

The students and parents recognized and respected those teachers with a sound mathematical content knowledge, an interest in mathematics, and knowledge of the

students as individuals. Some of the Year 6 students were taught by teachers who acknowledged their lack of expertise in mathematics. Potentially, this means that the students would not be exposed to aspects of mathematics outside of the curriculum nor would the teachers be able to extend the students' knowledge and make connections with more advanced mathematics. The success of a mathematics programme for gifted students relies on highly motivated and knowledgeable mathematics teachers (Miller & Mills, 1995). Sound mathematical content knowledge is acknowledged as a hallmark of a good mathematics teacher (Ball et al., 2001; Ma, 1999). A teacher of mathematically gifted students needs sound and advanced content knowledge and pedagogical content knowledge to be able to adapt material and provide suitable challenging experiences.

Flexibility with respect to time was a characteristic recognized by a few teachers and one of the students. A teacher with knowledge of the characteristics of gifted students may be more likely to respect a student's desire to work on a project for a sustained period of time. This high level of task commitment is a key trait of gifted behaviour (Renzulli, 1986). Without an understanding of this trait, a teacher may not respond flexibly. Despite timetable restrictions, the teacher should be able to find ways of catering for this need.

It follows that the teacher of mathematically gifted and talented students needs to combine strengths in both gifted education and mathematics education. The probability of a mathematically gifted primary school student being taught by a teacher with knowledge and expertise in both gifted education and mathematics is not high given traditional and present pre-service education programmes. Currently, in New Zealand, there is limited expertise in gifted education and limited opportunities for teacher professional development (Education Review Office, 2008, Riley et al., 2004) although there is some momentum (Education Review Office, 2008). Some primary schools are seeking professional development in the area of education for mathematically gifted students by forming cluster groups in schools. This is a beginning. Meanwhile, students experience a type of Russian roulette as to whether and at what stage in their primary schooling they are taught by a teacher who appreciates and understands the mathematically gifted child and has the subject knowledge, confidence, and enthusiasm for teaching mathematics.

When the students reached secondary school they all had teachers with specialized knowledge and expertise in mathematics. The secondary school teachers had not had formal training in gifted education, but all were experienced in teaching streamed classes with mathematically gifted and talented students. The Year 9 students and their parents spoke highly of the teachers; they respected their knowledge in the field and their teaching of mathematics. However, the programmes experienced by the students varied in the type of learning and teaching approach, and degree of differentiation.

Some of the students experienced a planned accelerated programme at intermediate school or secondary school. This was invariably acceleration of one year, although one student worked on algebra three years in advance. The primary school students were also working on mathematics associated with the level one year ahead, but there was no evidence of a deliberate plan for accelerating these students. The positive benefits recognized by the secondary teachers were the long term advantages in being a year ahead of a school schedule so that in Year 13 the students could begin university studies and the chance to widen their portfolio of subjects. Acceleration in mathematics has many benefits (see, for example, Sowell, 1993; Stanley, 1991; Wiczerkowski, et al., 2000), yet the teachers seemed unaware of many of these. One teacher raised the issue of student welfare, but as acknowledged in the literature (Robinson, 2004), this depends on the individual and the form of acceleration. The students gave little thought to the process of acceleration; they were simply aware that in a gifted or streamed class they worked one year in advance of their age peers. The acceleration process was not sustained in practice. If there was deliberate sustained practice of acceleration, catering for individual students, then it is likely that some of these students would not have continued each year to be working only one year ahead of their age peers.

Enrichment or enriching experiences were provided for *some* of the students, *some* of the time. This was usually in the form of exploring topics outside of the regular curriculum. Teachers talked about enrichment, extension, and challenging tasks; the students talked about studying other “more mind-bending” topics. Enrichment is a difficult concept to talk about with common understandings and so it is included in the summary of differentiation.

Differentiation is usually considered in terms of content, process, and product (Maker & Nielson, 1995). In this study, differentiation of the content was commented on by teachers and students. They identified this difference in content for the mathematically gifted and talented students, but acknowledged that this content was selected by the teachers. If the content had been genuinely differentiated, then it should have been modified to match individual student interests, needs, qualities, and abilities (Renzulli & Reis, 1997). The programmes were differentiated in terms of process, according to some students and a few of the teachers. Some of the teachers recognized the need for these students to be given more opportunities for problem solving, investigations, and a more independent approach to mathematics learning. One teacher talked about the importance of encouraging higher-order thinking and the need for more open-ended questioning. These reflect elements described by Diezmann and Watters (2002) in problematizing a task and thereby increasing the level of challenge. They are consistent with the attributes of differentiated process (Riley, 2004). A few students confirmed their enjoyment and appreciation of a more open-ended approach and an emphasis on problem solving. This interest in problem solving reflects one of the characteristics of mathematically gifted students. It was evident that the pace in one of the streamed secondary school classes was accelerated. In other classes, where the range of abilities influenced the pace, the teachers felt they were not teaching at a desirable pace for the gifted and talented mathematics students. There was little evidence of modification of product; only one example was given.

There was not a planned approach, by the majority of the teachers, to providing a differentiated programme for individual students. There was some acceleration in terms of material, so this could be considered a means of providing a modification of content and process. There was not a deliberate increase in pace; the students merely completed the work set for the students working on a regular programme one year ahead. There was some evidence of differentiation of process and only one example of product differentiation; this was not, however, tailored for individual students. The modifications experienced by most of the students fell short of the notions of differentiation advocated in the literature. Over the two-year period most of the students experienced piecemeal and inconsistent undifferentiated programmes. There

was little evidence of teacher understandings about differentiation and ways in which programmes could be individualized and qualitatively differentiated.

Finding suitable resources for mathematically gifted and talented students provided a challenge for schools and their teachers. This is evident from both an examination of the school policy documents and interviews with teachers, students, and parents. Textbooks were used as the main resource for most of the students in the study. They were used selectively by the teachers, although the textbooks had been pre-determined by the school. The textbooks matched the New Zealand mathematics curriculum (current at the time of the study), although all of the students were working from a textbook designated for one year group in advance of age peers. The textbooks, because they matched the curriculum, provided few examples of enrichment material. Both teachers and parents saw value in using textbooks as part of a mathematics programme. The teachers used the textbook mainly as a form of support, for practice material, and homework. One teacher provided a caveat about over-reliance on textbooks. The parents showed support for the use of textbooks, especially if they formed a basis for homework. For them it was a means of communicating, implicitly, what mathematics their children were studying, at what level, and how well they were achieving. This reliance on textbooks is contrary to the literature that suggests gifted and talented students require more varied resources to build a richer background of content (Kaplan, 2005). Other book resources were accessed for teaching ideas, but there were contradictory views about these. The main limitation was that the resources were not designed specifically for gifted and talented mathematics students so the teachers needed to modify the material. There was a plea for material to be written especially for mathematically gifted and talented Year 6 to Year 8 students.

Only one school did not rely upon a textbook. The two teachers at this school used a variety of resources and internet material, including web sites, to support their mathematics programme for the gifted and talented students. The students found this use of web sites interesting and challenging, although the teachers reported on the considerable amount of time it took to evaluate the sites. Other teachers in the study reported reservations about the use of the internet and computer programmes. The computers were underused in all of the other schools. Teachers seemed unaware of

how these students could effectively use calculators and computers to enhance their mathematics learning (Besnoy, 2006). For example, from an early age many of these students showed an appreciation of large numbers, pattern, and abstract reasoning and would benefit from the use of technology to expand their facility with number (Jones et al., 2002). Technological tools, such as calculators, would enable them to experiment and expand their knowledge and understanding of many topics in mathematics. This limited use of calculators and computers seems contrary to the notion of developing mathematicians and innovators with the knowledge and skills to contribute in an increasingly technological world.

It was evident that the majority of the students had experienced various group interactions, but had personal preferences for different types of groups. The results spanned all combinations, from independent, pairs, to larger groups. Some of the students appreciated different groupings for different tasks, but the common theme when working with others was to work with like-minded peers; this is seen as an essential ingredient when grouping gifted students (Mingus & Grassl, 1999). There was some consideration for individual preferences at primary school, but paired and group work was the norm. Group interactions prevailed in Year 8, but in the secondary classes there was less evidence of group work and a greater emphasis placed on independent work. Most of the teachers were aware of students wanting to work with others, although there were contradictory views about the students' preference for independent work. More consideration could be given by teachers to independent study; a provision that it is strongly suggested in the literature (Clark, 2002; Davis & Rimm, 1998; Gallagher & Gallagher 1994).

Most of the students were ambivalent about homework as long as it was not tedious practice, whereas the parents viewed homework as an integral part of the programme. (This is discussed in Chapter Eight: Parental Involvement.) The parents felt that the homework provided insights into their children's current levels of mathematics and helped them keep track of their children's progress. Many of the teachers were in favour of homework as means of providing practice material for students.

Competitions were recognized as an integral part of the programme from the multiple perspectives. Some, but not all, competitions were well received by the

students. It depended on the particular competition, with the preference for most of the students being an Australian competition and the local mathematics teachers' associations' team competitions. The students found competitions motivating; students and parents appreciated the comparative component. These positive attributes are supported in the literature by Riley and Karnes (1998/99); they should form part of the continuum of provisions (Renzulli, 1994). However, issues were raised about access to the competitions and continued opportunities after a school transfer.

Students' progress was commonly tracked through test results. Tracking students' progress was problematic when a pre-test, post-test approach was taken. The tests, for the students concerned, did not take into account the student's level of ability, so that there was often a ceiling effect. These had a negative influence as students saw little gains and therefore, as a consequence, were relatively unmotivated. If the pre-test was designed for students working at least one year or two years ahead, then it may have been a more useful tool in planning mathematics for the appropriate level. Key issues associated with testing were that teachers showed little awareness of the ceiling effect, the negative perceptions held by students, and the lack of formative use of results to individualize planning. Other methods for tracking student progress included a diagnostic interview (NumPA), observations, and students' work samples. Although multiple assessments were used, as advocated in the mathematics gifted education literature (Assouline, 2003), these were not extensive.

Two students attended an out-of-school programme one day a week and enjoyed the opportunity to work with like-minded peers. The programme content was not tailored for individuals, although the learning environment enabled some individualization of approaches to process and product. There was no planned focus on addressing particular gifts and talents in learning areas, such as mathematics. The communication between the regular school and the one-day-a-week programme was limited. These findings resonate with findings from the United States (VanTassel-Baska, 2006) and New Zealand (Education Review Office, 2008) that found a lack of integration with school-based options and a need for stronger links and improved communication between these programmes and the regular class.

The real challenge for teachers is to provide a suitable challenging programme for the individual mathematically gifted and talented student. It takes a competent, committed, resourceful teacher with sound subject matter and pedagogical content knowledge, and an understanding about gifted education to plan such a programme. The teacher needs to recognize and appreciate individual differences and the exceptionality of the mathematically gifted and talented student. There are other significant people who contribute to the education of mathematically gifted students and they are the parents, the children's first teachers. The following chapter, Chapter Eight, addresses the research question: What roles have parents played in their child's mathematical development?

CHAPTER EIGHT:

PARENTAL INVOLVEMENT

8.1 Introduction

In this chapter, the roles that parents have played in their child's mathematical development are examined. The key roles that are examined are parents as motivators, resource providers, monitors, mathematics content advisers, and mathematical learning advisers. Additionally, the parent's role as an advocate is presented. The data are derived from a parent questionnaire and interviews over a two-year period. The semi-structured interviews included questions to validate questionnaire responses and to gain further information about parental decisions and types of involvement in relation to their children's learning in mathematics. Parents were also given the opportunity to describe any related issues and future aspirations for their children. The chapter concludes with a summary and critique in relation to the most relevant literature.

8.2 Questionnaire Results

Fifteen parents (one parent for each student participant) completed the Parental Involvement Questionnaire (Cai et al., 1999) (See Appendix F). This questionnaire was completed at the start of the main research study period. The questionnaire was designed to assess each parent's level of involvement in their child's learning of mathematics in five different roles. The roles were motivators, resource providers, monitors, mathematics content advisers, and mathematics learning advisers. For each item, the parents had to decide whether they *strongly agreed*, *agreed*, *disagreed*, or *strongly disagreed*. A neutral or middle option was not provided. Most of the questions were written as a positive statement. For example, "I am usually able to motivate my child to learn mathematics well". For those presented in the positive, *strongly agree* was given a score of 4, *agree* a score of 3, *disagree* a score of 2, and *strongly disagree* a score of 1. For those statements presented in the negative such as: "I seldom spend time talking with my child about his/her progress in mathematics",

the converse applied. That is *strongly agree* was given a score of 1, *agree* a score of 2, *disagree* a score of 3, and *strongly disagree* a score of 4. The following table (Table 8.1) shows an Item Analysis for the Parental Involvement Questionnaire (PIQ).

Table 8.1

Number of Responses for each PIQ Item

PIQ Item	Strongly Agree	Agree	Disagree	Strongly Disagree
1. When my child says he/she is having trouble learning mathematics, I tell him/her not to worry about it because everybody has problems with mathematics.		2	6	7
2. At home, I encourage my child to work hard on mathematics problems even though the problems are difficult.	5	8	2	
3. I am usually able to motivate my child to learn mathematics well.	5	8	2	
4. Mathematics plays an important role in my child's future.	8	6	1	
5. I don't know how to motivate my child to do a good job on his/her mathematics assignments.		1	9	5
6. I try hard to have a nice learning environment at home for my child to do mathematics.	6	6	3	
7. I often take my child to the public library.	4	3	8	
8. I often buy mathematics related books for my child.	2	10	2	1
9. At our house, we have a variety of games and puzzles that encourage the development of my child's mathematics skills.	8	4	3	
10. I check my child's homework regularly.	7	7	1	
11. I seldom spend time talking with my child about his/her progress in mathematics.		1	9	5

12. At home, it is important for my child to keep a balance between mathematics and his/her other subjects.	9	5	1	
13. I always try to monitor the amount of time my child spends on mathematics at home.		5	9	1
14. I am always aware of my child's mathematics requirements by checking homework notebooks or through contacting the school.	1	4	10	
15. I feel I can help my child solve problems from mathematics class.	7	8		
16. I think I know enough mathematics to help my child.	3	12		
17. I often discuss with my child how mathematics is used in our everyday life.	2	8	5	
18. I make an effort to understand the mathematics my child is studying.	3	11	1	
19. I don't know strategies for helping my child overcome weaknesses in mathematics.			15	
20. I am aware of the approaches used to teach mathematics at my child's school.	1	9	5	
21. I always try to figure out good approaches for helping my child learn different mathematics topics.	2	8	5	
22. I understand my child's strengths and weaknesses in learning mathematics.	1	11	3	
23. I try to match my expectations with my child's potential.	3	10	2	

Overall, parents in the study had very positive attitudes about parental involvement. They showed a strong acceptance for the important role that mathematics plays in their children's lives. The results for these items are discussed later in the chapter under subheadings for each parental role.

Table 8.2 shows the results from the 23 items for each parent, grouped according to each role. The maximum for each role is either 16 or 20 as indicated after the role designation. The mean score for each category is given followed by a percentage of the possible total for that role; this enables roles to be compared more easily. No

other statistical analyses were performed on the data because of the sample size and the use of a rating scale.

Table 8.2

PIQ Scores for each Parent

Parent	Motivator (20)	Resource Provider (16)	Monitor (20)	Maths Content Adviser (16)	Maths Learning Counsellor (20)	TOTAL
Lily's mother	16	12	15	12	15	70
Bob's mother	14	9	13	12	12	60
Nardu's mother	16	14	15	16	16	77
Joshua's father	16	14	15	12	13	70
Victor's mother	15	10	16	13	17	71
Mia's mother	16	16	17	14	15	78
Eric's mother	13	8	13	11	12	57
Martin's mother	18	11	13	12	13	67
Ryan's mother	20	15	16	14	16	81
Tim's mother	15	11	13	12	14	65
Karen's mother	16	12	15	12	15	70
Nina's father	17	13	16	13	13	72
Amir's father	15	11	15	12	13	66
Lewis' mother	18	12	16	12	18	76
Paul's mother	17	11	13	11	13	65
Mean	16.1 (81%)	11.9 (75%)	14.7 (74%)	12.5 (78%)	14.3 (72%)	

The role that parents assumed the most was that of motivator (81%) followed by mathematics content adviser (78%). Two of the parents commented that it was at this stage in their child's level of mathematics that they could take the role of mathematics content adviser, but acknowledged that this might not be the case in the future with the advancement in the level of mathematics. The mean scores for each parental role are very similar (72%-81%) showing that the parents overall rated all the key parental roles as important.

The parent with the lowest score (Eric's mother) is the parent who eventually had to assume an advocacy role and contact the school about her child who had not been identified in his new school as gifted. The parent with the highest score is Ryan's mother. Ryan's mother continued to provide considerable support in the following year after the school transfer. This parent was also actively involved in the school as a member of the Board of Trustees. The questionnaire results are discussed below and are supported by interview material.

8.3 Types of Parental Involvement

The types of parental involvement are examined using the categories designated by the groupings of questions shown above. They are motivator, resource provider, monitor, mathematics content adviser, and mathematical learning adviser.

8.3.1 Motivator

The parents clearly supported their children by encouraging and motivating them in their study of mathematics. This was by encouraging them when faced with challenges, acknowledging the part that mathematics plays in their lives and will play in the future, and also knowing how to motivate their children. Parents provided this emotional support as evidenced in the responses to Items 1 to 5 in the questionnaire (Table 8.1) and supporting interview comments. For example:

He's happy, he's learning and a lot of the time he's actually extending himself, so when he finds something that he's really interested in we try to build on that and we try to give him the opportunity to do that. (*Martin's mother*)

The role of motivator was also evidenced in the emotional support provided by parents when their children faced the challenge of school transfer; this topic is addressed in the following chapter.

8.3.2 Resource Provider

Most parents made concerted efforts to provide a home environment conducive to learning (80%). Items 6 to 9 on the PIQ (Table 8.1) contributed to this role as resource provider. The majority of parents provided a variety of games and puzzles to encourage the development of mathematical skills and concepts, and 80% bought mathematics-related books for their children. They played the role of resource provider at home by ensuring that their children had an appropriate place to study, relevant books, and/or access to the library, computer programmes and games, and internet resources.

I bought some of the DK maths books and the N.Z. series. That would only have been in the last couple of years. The reason I got them is because [Mia] has always been interested in doing the Australasian competitions and they only have limited time at school so I provided a bit extra. (*Mia's mother*)

He's got really wide interests, he loves his electronics...he'll spend hours going through it and he'll build things in the garage and you know, he's got plans of what he wants to make and how he's gonna do it. You know, they had like a, 'build a solar powered car' thing at [Named University] last year or the year before, you know, you can get all the pieces here and there and go online, well he did that and he went along with a friend to that thing and did their solar powered car, they had a great time. So, he's more interested in extra little projects. (*Martin's mother*)

Nina's father had provided an extensive range of support material for his daughter since she was a young child. This material included his old mathematics textbooks. He also requested additional support material from the researcher and wanted details about the current national syllabus. He took his role as resource provider very seriously and believed that his daughter needed to work on additional material if she was going to achieve to the highest levels and obtain awards and scholarships to support her education. Paul's mother had also bought a variety of additional mathematics textbooks for a number of years. This parental role of resource provider was acknowledged by Miss L (School C₁) who explained that some of the parents of

the gifted students in her class purchased the textbook that she used in her mathematics programme.

8.3.3 Monitor

The role of monitor was derived from Items 10 to 14 (Table 8.1) and related to homework and the monitoring of their children's progress. The majority of the parents (73%) were not concerned about monitoring the amount of time their children spent on mathematics at home. Some parents (67%) were not aware of their child's mathematics requirements by checking homework or through contacting the school. However, 93% of the parents spent time talking with their children about their progress in mathematics. This aspect of the monitoring role was seen as multifaceted: structuring homework activities, motivating children, working with them on their set tasks, and interacting with the teacher about homework. The parents, in this study, (93%) believed that at home it was important for their children to keep a balance between mathematics and other subjects.

The parents were keen to monitor their children's learning and progress at home, but thought that there were limited opportunities for this knowledge to be gained directly from the school. There was a common sense of "not knowing"; they also felt that they knew little about the mathematics curriculum. The schools provided some opportunities to find out about their children's progress through conferences, interviews, portfolios, and reports. Some of the parents stated that they were "very much hands off" and if there were problems they believed that the school would contact them. Another parent explained that she would take a more active role if her son "slackened off with homework" and another relied on her son to keep her informed of his progress. Most of the parents felt that you had to talk personally to the teachers if you had concerns; otherwise you waited for the formal school reporting systems.

Homework was another way in which the parents tried to monitor their children's mathematics progress and to show an interest in what they were learning. The parents appreciated the use of the formal homework books. These were commercially-produced workbooks that were designed specifically for the New Zealand curriculum. The Year 6 parents were involved and interested in their

children's homework, but there was a decrease in the parents' involvement in the mathematics homework as they progressed through the schooling system. Despite this, there was still an expectation that homework should be a regular feature of the mathematics programme.

The parents also liked to monitor their children's learning through participation and results in competitions. The parents strongly supported competitions and when the opportunity was not given, they usually took some form of action such as contacting the school to make inquiries about the competitions. The parents supported their children's participation in competitions in monetary terms; the costs were not high and some schools subsidized this expense.

8.3.4 Mathematics Content Adviser

Parents supported their children in mathematics by specifically helping in this learning domain, especially if they had interest, confidence, and ability in mathematics (Table 8.1, Items 15-18). All of the parents felt that they could help their children to solve mathematical problems, although two respondents added the proviso that it was as "at this stage" of their children's mathematics education. Most parents felt that they had sufficient mathematics content knowledge themselves to be able to do this and to also make links with mathematics to every day life. They all felt that they made an effort to understand the mathematics that their children were studying. Some of the parents talked about their own love of mathematics, and involving siblings and extended family members in mathematics problem solving and investigations. This was the case for both Martin and Nardu who had very mathematically-minded grandparents.

Nina's father was very focused on the role of content adviser and had encouraged her to study algebra at an early age as he believed this was a most important part of mathematics. Paul's mother had supported his mathematics learning from about three and a half to four years of age. She began with numerals and computations and so he went off to school being able to do all four number operations. Paul's mother then continued supporting by setting mathematics regularly for him to work on at home. At the time of Phase Two of the research, she was providing him with problems involving algebraic computations, factorizing, and simplifying. Nardu's mother also

set additional material for him, but was concerned about the time that this involved for her in firstly, locating suitable, challenging, and interesting mathematics, and secondly, in supporting him.

8.3.5 Mathematics Learning Counsellor

The role as a mathematics learning counsellor (Table 8.1, Items 16-23) meant that the parents understood “their children’s current situation, learning difficulties, potential, needs and demands, and provide[d] appropriate support to help their children overcome learning difficulties” (Cai, 2003, p. 89). In terms of their role as learning counsellors, all of the parents felt that at this stage they had strategies to help their children. However, more than half of the parents were not aware of the approaches used to teach mathematics at their children’s school. Most were prepared to figure out good approaches themselves for helping their children learn different mathematics topics and 87% of the parents tried to match expectations with their child’s potential. Lewis’ father explained:

We need to be able to support that part, the psychological side. I want him to mature as a learner, be secure in who he is, where he’s going and if he struggles with a problem he knows what to do, where to turn to get help. I feel that’s the big issue. (*Lewis’ father*)

Lily was the student classified as ‘twice-exceptional’¹⁶. Her mother, a solo parent, assumed the role of learning counsellor in response to a recognized need to help her daughter. Lily’s difficulties had impacted on her learning in the school environment. Her mother explained:

In the last four or five years we have developed a lot of strategies for her just by trying to get her accepted and part of a group. She’s had a hell of time at school quite frankly, she’s counting the days to leave, which is really sad. (*Lily’s mother*)

Lily attended a one-day-a-week programme for gifted students. Her mother felt that this was one way in which she could support her child’s learning.

She loves it; she wants to continue with it. She is starting at a new school; she socially struggles. I will see what Intermediate can offer her; they do have a gifted and talented programme that works apparently. I want her to find a peer

¹⁶ Gifted and Asperger’s Syndrome

group that she's accepted into, she's got one at [the one-day-a-week programme] which is great, but the other four days at school she's miserable, which is very difficult. I don't want another point of difference. (*Lily's mother*)

8.3.6 Parents as Advocates

Three parents described instances where they had to assume an advocacy role. These have been briefly referred to earlier in the thesis in the context of reporting other results. One parent (*Lily's mother*) explained how she had to advocate for her child. Lily was very unhappy at school and had difficulties socializing with her peers. Lily's mother described ongoing instances of bullying and felt that "the school was unsupportive of doing anything with her at that time". In response to advertising for the one-day-a-week programme, this parent approached the class teacher about the possibility of Lily attending the programme. Initially there was no uptake by the regular school and costs prohibited the parent from acting independently. However, in response to the various school test results, the school realized that this child was potentially gifted and talented. The regular school approached the parent and agreed that the one-day-a-week programme might provide a solution for catering for Lily's needs. The assessment made by the one-day-a-week programme also diagnosed Asperger's Syndrome, one of the autism spectrum disorders characterized by difficulties in social interaction. As described in the previous chapter, Lily attended the one-day-a-week programme and this was a positive experience. In the following year, Lily moved to an intermediate school. The parent no longer felt there was a need for the one-day-a-week programme because Lily was "so happy...she bounces off to school every day...and they've [the school] been very supportive of her".

Another parent had to take an advocacy role when her child was not selected (based on a poor test result) for the CWSA (withdrawal gifted mathematics) class when he moved to intermediate school. Eric's mother explained that she waited until parent interviews were scheduled and then raised the matter of Eric's boredom, loss of enthusiasm for mathematics, and desire to be in the CWSA class. His exclusion was justified by the regular class teacher; there was simply no room for Eric in the CWSA class. (The teacher of the CWSA class verified this and said that she was reluctant to have children moved from her class once they had been identified as CWSA. This was despite her recognition that a few students had been wrongly

identified and did not belong in the class.) Eric's mother was very upset, but felt that there was little she could do once she had raised the matter except to maintain his interest and motivation by providing mathematical activities at home. This was another instance where the researcher was asked for support with mathematics resources. The request was for additional material to help maintain Eric's interest and enthusiasm for mathematics. On another occasion, this same parent had to assume an advocacy role when Eric was initially excluded from participating in an Australian mathematics competition. As a consequence of not being in the CWSA class, the school decided he was not eligible to participate in the international mathematics competition. This was a mathematics competition that Eric had participated in, in previous years, as a primary school student. He had previously achieved well, enjoyed the experience, and both Eric and his mother assumed this opportunity would continue. It was only after repeated contacts with the school that Eric was allowed to participate. The school explained that it was because another child had pulled out, thus allowing a space for Eric. The parent reiterated that she contacted the school and advocated on Eric's behalf; he was the one keen to compete.

The third case involved Nina's father. Nina's father, in Phase Two of the study, approached the school and inquired about mathematics competitions. He wanted Nina to participate in an international competition that he had found out about on the internet. The registration had to be completed through the school, but the school had already decided to register for a different mathematics competition. Nina's father explained that he was very disappointed and was also surprised that "no one took responsibility". Likewise, Nina commented on the fact that she did not get to sit the competition of her choice and was cynical about the competition that she did sit. Nina's father had been closely involved with the school in mapping out Nina's study path; she was an accelerated student working beyond her years, particularly in algebra.

These were three specific cases where parents took an advocacy role. Two of the parents had acted in response to specific situations after a period of 'wait and see'. They became involved and advocated on behalf of their children's needs, both social and academic. The third case involved a parent who took a very active role in his daughter's mathematics education.

8.4 Summary and Discussion

Parents with a high efficacy are more likely to have increased levels of involvement (Hoover-Dempsey, et al., 1992); it is therefore important to bear this in mind when interpreting these results. These parents indicated in the first instance a certain level of interest and involvement by agreeing to participate in the study. This positive attitude is then reinforced through the results of the PIQ. The parents assumed an active role because, according to Hoover-Dempsey and Sandler (1995), they construe the parental role as including personal involvement in their child's education. This construct alone is not enough in itself because the parent must then act upon it in order to be involved. It is reasonable to assume that the parents became involved because they believed that they had the skills and, at times, the opportunities necessary for involvement.

Using the roles, as defined by Cai and associates (1999), it was possible to categorize and compare the types of involvement the parents played in their child's mathematics education. Parents selected the type and level of involvement and, for the parents in this study, it was anticipated that this would change as their children progressed through the schooling system. The parents explained that this was due to two factors. The first was age-related; as their children progressed through the school system and in to the adolescent years, they wanted to be more independent and to rely less on parental involvement. The second factor was the parents' awareness, in most cases, that their understanding of mathematics would be challenged as the level of mathematics increased in difficulty. The specific roles of motivators, resource providers, monitors, mathematics content advisers, and mathematical learning advisers were all assumed by the majority of the parents.

As motivators, they recognized the importance of mathematics and in most cases recognized their children's mathematical talents from an early age. They then supported this interest through providing additional resources. These roles for parents of mathematically gifted students are reported elsewhere in the literature (see, for example, Lupkowski-Shoplik & Assouline, 1994), so it is no surprise that the parents in this study provided additional resource material. It is interesting that textbooks were seen as an important means of resource support. By purchasing the school textbooks, the parents then took on the role of monitor. This role, for these parents,

was not about monitoring the mathematics at home, but more about trying to track progress of the school mathematics. The parents used existing school systems of reporting through parent interviews, written reports, worksheets, competition results, and portfolios to track their children's progress. The parents did not actively seek additional information through other means and some relied on their children to communicate their progress. There were conflicting views from the parents about this role. Many were not concerned about monitoring the amount of time spent on homework yet they valued the importance of mathematics homework. Some parents provided additional problems for their children to work on because they felt that the homework was not substantial enough. Further detail about the role of homework was addressed in the previous chapter.

In the role of mathematics content advisers, these parents felt knowledgeable enough about mathematics to help their children, although for a few, it was for the current level that their child was working at. Several of the parents also expressed their own love of mathematics. Most of the parents were not very familiar with the approaches used to teach mathematics at school, but if necessary were prepared to help in their children's learning of mathematics. These findings support those of Hoover-Dempsey and Sandler (1995) who found that the specific domain of a parent's skill and knowledge influenced the level of involvement in their child's education.

Three parents took an advocacy role. This was in response to specific instances where the parents acted on their children's behalf. These parents could not be considered 'pushy parents', as two of the parents took a 'wait and see' approach. This myth of the pushy parent has been reported elsewhere (Bicknell, 2006a; Lupkowski-Shoplik & Assouline, 1994); the parents in this study acted as advocates on their children's behalf when they observed negative behaviours from their children. Despite one of the parents recognizing her gifted child's points of difference, it took nearly five years of schooling before there was positive action from the school. This was the case of the child with twice-exceptionality, a gifted and talented child with Asperger's Syndrome. In this case, there was a lack of understanding by the school of the twice-exceptional child who may "think very differently to other gifted children" (Neihart, 2000, p. 223). The concept and identification of twice-exceptionality was not supported in school documents and is

also lacking in the national literature. Twice-exceptional students face barriers to identification and provision (Baum, 2004); little will change without awareness through increased attention by educators, researchers, and policy makers.

Collectively, the results show that the partnership between the parents and school did not appear to be strong. The parents assumed multiple roles, but as Radaszewski-Byrne (2001) suggests “parent as instructional partners” in the education of gifted children is a more “succinct description of a role currently evolving for parents of learners” (p. 32). The parents were responsive to their children’s interests and abilities in mathematics, spending time, providing resources, supporting homework, and taking an interest. If the concept is moved from involvement to partnership then some of the issues raised by these parents are more likely to be addressed. The levels of parental involvement and support changed as their children moved through the school system; these changes were sometimes influenced by a school transfer.

School transfer is examined in the following chapter. Chapter Nine explores the transfer process for the two groups of students, those transferring from Year 6 to Year 7 and the Year 8 students’ move to secondary school.

CHAPTER NINE:

SCHOOL TRANSFER

9.1 Introduction

In this chapter, school transfer is examined from multiple perspectives to answer the research question: How is school transfer managed for mathematically gifted and talented students? At a macro level, what are the major changes confronted by students when transferring from one school to another? Students confront two different types of ‘institutional discontinuities’. The first of these is organizational, including change in school size, number of year groups, class groupings, departmentalization, streaming, teacher expectations, teaching approaches, and student autonomy. For a special population such as the gifted and talented it could also mean a change based on school policy, definition, and identification. The second type is social discontinuity; this includes the diversity of the student population, relations with teachers, and sense of belonging.

In this study, there was a change for the Year 6 students from primary school to intermediate school (n=4), Years 7 to 13 school (n=5), and Years 5 to 8 school (n=1). The Year 8 students (n=5) transferred from an intermediate school to various secondary schools, single sex or co-educational. In making this move to another school, the students faced new challenges. This transfer process was examined using Anderson and colleagues’ (2000) conceptual framework for understanding and improving school transition and support. This framework contains three major concepts: transitional success or failure (which is implicit and based on achievement, conduct, and effort); preparedness; and support. Using this framework, the focus was refined to the micro level to include school choice factors; systemic and academic preparedness; and support from peers and friends, parents, and teachers. The chapter includes a focus on the students’ aspirations and concludes with a summary and discussion.

9.2 School Choice

The choice of school for most of the students was made by their parents and all of the students were accepting of that choice. They accepted that their parents had made a choice based on factors such as siblings either having been to the school or still attending the school, their children's friends attending the same school, zoning, organizational structure, and a school's reputation. The students' main focus was on having friends who were going to be attending the same school.

One parent, Lily's mother, explained that her choice of school was based on two factors: moving her child away from her peer group, and the school's recognition of academic abilities. This parent had also carried out "a lot of research" before sending her daughter to the intermediate school. In her view, another positive feature was the combined grouping of Year 7 and Year 8 students in the one class at the intermediate school.

Four of the parents of Year 6 children felt that their decisions were based on different factors from what they would consider if their children were Year 8 students and moving to secondary school. They considered intermediate school to be an interim period before secondary education and that it was more important their children remained with established friends from primary school.

We didn't worry too much about choosing a school. I think because it is intermediate, I think when he is 11 or 12 and getting into high school then he would probably have established what he would prefer doing and we felt because [Nardu] is still undecided, he is still enjoying doing different things....I'm aware that he might need to move. (*Nardu's mother*)

Two parents were adverse to intermediate schools, hence the option of a Years 7 to 13 school appealed.

The biggest thing for us was friends. I know it sounds terrible, but in a lot of ways myself and my husband are quite anti-intermediates and we feel that in a lot of ways, it's really just a growing up time between primary school and high school and a lot of new opportunities, but it always seems a two year block that you never get a lot of grounding in; it's not like they've been there for six years and they love it and belong with the school, you can see that right through, like the Parents' Association and things. A lot of parents don't want it, two years, been and gone, was it worth getting involved? We thought, having said that, if our local intermediate had been a disaster we would have looked elsewhere. But, going to a local school with children that he spends time with and for us

the main thing is it's a stepping stone to high school...we felt it's really important that he has good, solid friendships because high school could be a roller coaster...we just thought, you can go to a great school and get a bad teacher or a bad experience, you can go to a bad school and have a gem. (*Martin's mother*)

Ryan's mother also felt that friends were important. Despite being in a zone for one of the other intermediate schools, Ryan's parents chose a school that a sibling had attended and his friends were going to. Ryan's mother also acknowledged the importance of choosing a school that she considered addressed the challenges of catering for gifted and talented students like her son.

All [Ryan] friends are going to [School E]; we are going for a continuation since we know the school. I have spoken to the principal, who is quite excited about having him and she has been absolutely marvelous and is doing her bit to accommodate these kids [gifted and talented] who are going to be quite challenging I think. I have a lot of faith that she will work something out that will suit him, but I will keep him at [one-day-a-week programme] just to make sure he has that extra. I'm very happy with [School E] as a school and I think [Ryan] will fit in very nicely there. He's also very young; he's only ten so going with his friends is quite important. (*Ryan's mother*)

Two parents, with children moving from a primary Catholic integrated school, wanted their children to remain in the Catholic school system although they explained that they had considered other factors such as siblings and the school's reputation. These parents were also open to the idea of their children making another move for their secondary schooling, even though the school catered for Years 7 to 13.

Mia was in an unusual situation. She was unable to get in to the intermediate school of her first choice because of zoning. Mia was offered a place in another school, an independent full primary (Years 1 to 8) girls' school. This school was her mother's preference because of the specialist science and mathematics teachers, but her mother expressed reservations "about it being an all girls' school, particularly since [Mia] seems to be more competitive with boys in the class". She was also concerned about the level of challenge and explained that; if Mia was in an all-girls group, "she tends to be a bit laid back". Mia was ambivalent about attending this school and eventually made a decision based on where one of her friends was going, a co-educational Years 7 to 13 school. Mia admitted that she too had reservations about

whether this school was going to provide enough challenge. She appeared to have no basis for this opinion. It is a school without a high public profile, one that receives little media attention, especially in relation to academic achievements.

The three Year 8 boys in the study all transferred to a boys' secondary school. The three boys each had siblings attending the school and all three parents mentioned this as one reason for selecting this school. All of these parents expected their boys to be in an accelerated Year 9 class although Lewis' father had a few reservations about the suitability of the accelerated programme for his son. Interestingly, these reservations manifested and are discussed later in the chapter under the topic of pastoral care.

The reputation of a school was another factor influencing school choice. This was articulated by several parents and two of the students believed that it influenced their parents' decisions. This reputation was based on experiences with siblings at the school, comments from friends, publications such as the school prospectus, and public knowledge and perception gained from media coverage. There was also awareness of special provisions for gifted and talented students in mathematics. The parents made the decision for most of the students in the study, and all of these students were positive about the choice.

9.3 Preparedness and Expectations

What were the changes experienced by the students and how well prepared were they for these changes? The Year 6 students faced a change from being 'at the top' of their primary school to Year 7, 'the bottom' of an intermediate school or the reception year of a Years 7 to 13 school. The Year 8 students moved to secondary schools, either single sex or co-educational. For the Year 8 students, there was a change from essentially one class teacher for all core subjects to subject specialist teachers. There was also a change for most of the students (n=11) to a bigger school. Given that the students and their parents were aware of these systemic changes, they were asked to articulate their expectations in Phase One of the study and then to reflect on these aspects in Phase Two. These expectations related to systemic and

academic preparedness. The teacher's role in preparing students for the transfer was also examined.

9.3.1 Systemic

The students felt that they were prepared for the systemic and/or organizational changes through school visits to the reception school, prospectus information, or siblings answering questions. Nardu, like many of the students, explained that he found the transfer quite easy and believed that he was well prepared for the systemic changes. He had made a visit with his mother "to look around" and said that he "knew that it was a very good school, one of the best...and that they had very good teachers and a good library".

Victor was in the minority and did not feel well prepared for the change of school. He explained:

I don't think I was that prepared because it was really scary on the first day because you could hardly find anywhere because everyone was standing round so you couldn't see any of your friends from last year. (*Victor*)

For most of the students the systemic change was seen as "not too hard" because of the visits to the school and the information provided.

I was prepared enough, I mean as much as anyone else...But not many things came as much of a surprise. I knew about most of the things, the changes...there was orientation night, an open night for parents and also the test that you did here, but that wasn't a tour or anything, it was just a test...The only information they sent out was that I was in the accelerate class and no other information...they gave us a booklet on the orientation night...We didn't really need much more information...On the test day they gave us paper with the timetable for the first few days with...they said where to meet for form classes and all that stuff. (*Amir*)

The placement of students in classes is a key part of the transfer process. The issue of identifying students in the reception school was raised in Chapter Six. With limited identification methods (for example, tests only), not all students experienced a smooth transfer to their new schools. Eric, for example, was not selected for the gifted and talented mathematics programme in his new school (School E). This school practised a 'fresh start' policy and did not refer to information from the sending school. The teachers from the other reception schools outlined liaison

activities (such as school visits) and the sharing of records as part of their transfer processes. All of the teachers from the sending schools passed on written information to the reception schools. The teachers from the reception schools were, on the whole, less interested in the transfer process than the sending school, although the majority of the reception schools conducted interviews with teachers from the sending schools. One of the smaller schools (School H) followed this up with an interview with the student and parent, guided by a rigorous interview schedule that the principal completed to aid with student placement. One of the intermediate schools (School D), as described in Chapter Five, had two Placement Forms, one completed by the parents and one by the student. It seems, however, that not all messages from the sending schools were understood, trusted, or acted upon when you consider the placement results for one student in particular (Eric).

9.3.2 Academic

Academic preparedness assumes that students possess the knowledge and skills necessary to succeed at the next level. In the case of mathematically gifted students, it would be expected that reception schools would acknowledge the student's level of mathematical knowledge and skills and place them in appropriate classes. There was an expectation from parents and teachers that there would be an exchange of academic information between the sending school and the reception school and this would aid in the transfer process.

Most of the students sat tests, either on their visits to the school in the preceding year or early in the year at their new school. They were then placed in classes based on these academic results. There was hope from the parents that, given the students had come from enriched and/or accelerated programmes in mathematics, they would achieve 'good' results in any pre-selection tests, and that special teaching programmes would ensue. The parents expected a continuation of challenging programmes, that their children would be seen as high achievers and continue to grow in their mathematical development. Lewis' father and Nardu's mother also explained that they hoped their sons would not lose their love for mathematics.

Most of the students believed that academically they were well prepared, no gaps in mathematical knowledge had surfaced, and they were coping well compared to other students in their classes. The teachers from the sending schools expressed clear expectations for the students in their new schools including a continuation of advanced levels in mathematics, open-ended topic work, and an encouragement for self-directed learning. Miss L (School C₁) explained that she outlined to her Year 8 students moving on to secondary school her expectations that they should be in accelerated programmes and that their pathway was to go on to university. Although Miss L (School C₁) saw her role as giving her students a good grounding and a “kick start to high school”, she also believed that these students had a vision for themselves. Mrs J (School B_p) expressed concern at the number of gifted and talented mathematics students that she had previously taught who returned to express disappointments at their new school. These disappointments included the low level of the mathematics and the teachers’ disinterest in mathematics.

The majority of the students anticipated with enthusiasm the prospect of having more than one teacher. Those students moving to secondary school, in particular, expressed a keenness for being taught by a mathematics specialist teacher. These students talked primarily about the subject, the teacher, and the level of academic challenge. Some of the students were concerned about subject continuity and how well prepared they felt in certain topics such as algebra and geometry. The teachers (Phase Two schools) also expressed an interest in whether and to what degree students had covered particular topics in mathematics. One teacher said that he could usually tell what schools some of the students came from because of their understandings in certain strands of mathematics; for example, he cited one school that he felt prepared students well in algebra.

Many of the parents acknowledged how smoothly the transfer to a new school had gone for their children in mathematics and that, from their point of view, no problems had arisen.

I’ve found the transition from primary to intermediate really easy and [Ryan] doesn’t seem to have had a problem....as far as maths goes, he just seems to have continued on, which is really good. And I mean he’s still really interested in it. That’s what he likes. He’ll make graphs and stuff on the computer for no particular reason, just because he can. (*Ryan’s mother*)

A few parents also acknowledged the sending teachers' contributions to this smooth transfer. These included helping students develop skills in setting goals, maintaining consistent work standards, and clarifying expectations.

Lily's mother was one parent who did not feel that the sending school effectively assisted the transition. One contributing factor, she believed, was that Lily was going to a different school from the majority of her peers.

I think [School A] could have done a better job at getting kids ready for the transition. Well, firstly we were almost ostracized for choosing [School D] over [School F] and very little help was given...The transition could have been handled by the school a bit better. We could have been more supported in our decision. There were lots of reasons we chose [School D]...the social one being one of them...the fact that I couldn't afford the fees...the location of the school...and I thought that, from discussion with the principal and the head of the Year 7s...they had a good extension programme. (*Lily's mother*)

Two parents, with children also from School A, believed that their sons were not well prepared in mathematics for the year ahead. They felt that there were gaps in their children's mathematics, particularly in algebra.

9.3.3 Little Fish, Big Pond

Some of the students were not prepared for the feeling of being a 'little fish in a big pond'. With a move, in most cases, to a larger school, the students found themselves in a bigger pool of mathematically gifted and talented students. This realization that they were among higher achievers than themselves was expressed by both the students and parents. Some of the students were also challenged more in their knowledge and skills in mathematics; the work was not so easy. Mia explained that it was quite a lot harder and that she had gone from being in "the top group in the class" to a class where "I'm at the bottom". The parents of boys at School K recognized the pressure that their sons were under at the boys' secondary school; they were with "the cream of the cream" and were under pressure to perform well and maintain their place in the top streamed accelerate class. These were students who were used to getting very high scores in tests, and were very confident in their abilities in mathematics. Suddenly, their numerical scores had dropped and they were with a wider pool of gifted and talented students. This was also the case for one of the Year 8 students. His mother explained:

Because he's always been good at maths and now that he's become a kind of part of class, he is not standing out, in the past, yes, he has stood out in maths. But he never had to ask questions. Now he is in bigger class and he has to learn how to ask. (*Nardu's mother*)

9.4 Support

Support from others is an important aspect of a successful transition or transfer. This support may come from one or more of the following sources: peers, friends, and siblings; parents; teachers and the school system.

9.4.1 Peers, Friends, and Siblings

The support source cited most by students and parents was peers, specifically their friends. The majority of the students acknowledged the importance of having friends from their previous schools for support with the transfer. Three sets of students from Phase One of the study moved to their new school with fellow students they identified as not only their friends, but academic peers who shared their interest and abilities in mathematics. Bob is one such student; his mother explained about the role of his friends in relation to the transfer.

There were no problems because lots of his friends went with him and a few of his close friends and they are with him, in the extension class. He sees it as a status symbol to be in that class and is quite proud of the fact...He's not seeing it as not fashionable or as a nerd. (*Bob's mother*)

The three boys from School C who went on to the secondary boys' school, found themselves together in the top stream class and all three commented on how important their friends were. Despite making some new friends, they still "stuck mainly with old friends". Amir explained how his friends supported him with the transfer process.

It [the transfer] hasn't had much effect, as most of my friends came to this school and two of them are in my class. So there wasn't as much of a change as I thought. I thought that we'd be in different classes....Yeah, I haven't made new friends. Well, I've made friends, but not really like my other friends...It's a lot better here if you've got them [friends] at a new school because they offer you that support, so it's a lot harder if you don't actually have any friends with you. So I think I'm quite lucky to have friends in my class. It's just important to have them in your class and in your school. (*Amir*)

Nina provided a different perspective on the role of friends.

I'm finding more and more that friends aren't a necessity. I shouldn't really. I have people to talk to at break times and in class and I generally have a good time in class, but I'm just different to other people because I've moved around so much I just know, not to make too many too good friends because if I have to leave it's just too hard and I am very selective about people I call friends too. There's a lot of people who consider me as their friend even if I don't really consider them so much of a good friend. (*Nina*)

Mia took a while to settle in to her new school. This was acknowledged by Mia, her mother, and her teacher. She had moved with no friends from her previous school. Nardu's mother also felt that the transfer for him had not gone as smoothly because of the loss of friends from his class. As a consequence of losing the support of his friends, her son sought help from school guidance staff. Tim, meanwhile, moved to a new school with none of his former friends and experienced no problems with the transfer.

[Tim] made the transition really well, it was something he wanted to do, it was his idea not ours, it was a school that he wanted to go to. He settled in well. He knew students that had gone there already. The students are allocated a godfather when they get there, someone who takes them under their wing, shows them where everything is. So there were no problems at all. He went with no friends directly from [School B] but...he wanted to go there, he chose...but he was very positive about it, the whole way through. (*Tim's mother*)

Five of the students transferred to schools where they already had a sibling in attendance; both the parents and the students acknowledged that this helped with the transfer particularly with matters pertaining to the school's organization, uniform expectations, and homework.

There's been no problems at all; not even in maths. It's been a good transition. She was presumably well prepared....I think having an older sister helps with your expectations....You know about moving from class to class....you are familiar with folders, logbooks, homework, signing off, and all the words that go with high school. (*Karen's mother*)

Peers, in particular friends, other students in the school, and siblings helped many of the students in the study make a relatively smooth transfer to their new schools. Other significant people who were involved in this process were the parents.

9.4.2 Parental Support

The parents acknowledged that with the move away from primary schools there was less parental involvement, but they also felt less informed about school programmes. Several parents expressed a desire to be more involved, but accepted that as their children moved through the school system they had to take a more “hands-off approach”. Their children were less interested in sharing school experiences and they also “want to do things on their own”. One of the parents explained:

Ok, definitely a culture shock after a primary school to an intermediate. I think the parents have this huge step backwards in terms of involvement and although we've got less involved, as the boys get older, we have found that a huge step back. Parents don't tend to go to assemblies; they don't go to sports things, so we just haven't either. (*Martin's mother*)

Karen's mother commented that she was there to encourage and support, but if Karen showed signs of boredom in mathematics then she would talk to other parents before approaching the school. She was very aware of the challenges teachers faced in addressing a range of abilities within a class, but expected Karen to be placed in an ability grouped class where she would have a few gifted students to work with.

Two parents, with some concerns about their children's mathematics programmes, took an initial ‘wait and see’ approach. They were aware of school systems in place such as the parent interview as a formal opportunity to raise any issues regarding their children's transfer, and were prepared to wait until this time.

We weren't quite sure of what he was doing or when he was doing and things like that...being new parents at the school we didn't want to jump up and down “What's happening?” But at this stage, Term Three now, with the next lot of interviews coming up, we'll probably would say; “He's really not feeling challenged in maths”...he's in the math extension group...there are children there that can really help him stretch his understanding....[we would like] a little bit more detail of what are you doing or how you are doing it...he really seems to be wanting. We actually know very, very little. (*Martin's mother*)

Most of the parents were keen to offer their children support with the transfer, although in terms of mathematics at the new school, as explained in Chapter Eight, the role of content adviser diminished. The parents of Year 9 students felt that their children could take greater responsibility for their mathematics learning in this new phase of schooling.

I feel like, after Year 8, I have done what I can for him, and really he needs to take responsibility. And if he mucks up it's his, it's his responsibility. My maths is limited....The calculus is beyond us, there's a limitation as to how much parents can help. (*Paul's mother*)

There were two students who did not experience a particularly happy transfer, but were well supported by their parents. Both Nardu's mother and Lewis' father stepped in to offer support with the move to the new school. Nardu's mother felt that her spare time was limited because of work commitments, but tried to provide additional support at home. Lewis' father felt that as parents they had "to do a lot of propping up". He felt, however, that some of this support was the school's responsibility.

9.4.3 Teachers and School Support

Seven of the parents acknowledged the positive support their children had received from the reception school and in particular the students' form and/or mathematics teachers. The parents appreciated approachable, supportive teachers who recognized their children's talents. As noted previously, not all of the parents felt that the school had aided the transfer process. Lewis' father and Nardu's mother were not impressed with the level of pastoral care and guidance provided for their children especially in relation to the accelerated programmes. Lewis' father explained that although the students were "doing serious level maths", they were "tender in years in maturation" and so maybe there should have been more initial pastoral care to support the adjustment to secondary school.

I question whether they have a clear concept of pastoral care for the elite group....There were no triggers within that elite system to say, "hello this kids needs a tap on the shoulder, a "how're you going?"....They actually chuck them in the deep end. They are fairly immature, but they are doing the senior stuff that requires a bit of maturity. They haven't got the maturity....The school tries to prepare, but on-going pastoral care is required. (*Lewis' father*)

Explicit school systems to help with the transfer were limited. Peer support systems and vertical form classes operated in only one of the schools (School F). However, the students at this school saw little to be gained from these systems once the initial phase of learning about organizational matters had passed. Mentoring was a strategy experienced by only one student in the study at School J. This student, as part of a

Year 9 extension group for gifted and talented students, met regularly with the Year 13 gifted and talented students.

There were clearly different levels of support given to the students from the teachers and school. Some of this support has been previously described in relation to preparedness—systemic and academic. However, the social-emotional support for a few of these students, from the teachers at the receiving schools, was given little attention. Once the students had settled in to their new schools, the parents were interested in monitoring their children’s academic progress. The level of preparedness and the support systems have the potential to impact on students’ academic progress in their new school.

9.5 Academic Progress

Parents were questioned about how they were informed of their children’s academic progress in their new schools and what communication there was between home and school. The schools all had regular reporting systems. Early in the year, for most schools, it was one-way information sharing, essentially a ‘meet the teacher’ opportunity. However, several parents commented that they felt comfortable about approaching the teacher or school if they had concerns about how well their children had settled in to the new school.

Yes. I trust that if she’s not doing well then [Mrs J] will tell me....because they’re quite good at reporting back with the communications book and things that they use. And I also trust that if [Lily] is struggling she will tell me because she’s quite open about things like....I haven’t really had to do anything, other than the odd parent-teacher interview thing. (*Lily’s mother*)

We have missed one teacher interview because we were away... but I know that I can ring up at any stage and talk to them. It’s slightly different at [School F], it’s quite different to what I’m used to because he has his form class teacher and then he goes to [Mr J] for maths....We have school reports, and what I read into it is, unless we hear otherwise, he’s trundling along fine. (*Bob’s mother*)

Five parents, out of the fifteen parents in the study, were not impressed with their children’s progress in mathematics at their new schools. They seemed reluctant to step in and question this lack of progress and the level of challenge in the mathematics programmes. They were not acting as ‘pushy’ demanding parents, but

took a ‘wait and see’ approach. This ‘wait’ was usually for the interviews later in the year where they felt they had an opportunity, supported by a written school report, to raise their concerns. These concerns were based on their children’s attitudes, and decreased levels of effort, motivation, and enthusiasm for mathematics. A few of the parents felt uninformed about their children’s progress and the curriculum as reflected in the following comments from a Year 7 parent.

He’s sort of found, work wise, that he almost feels intermediate is easier than primary....so he’s finding it less challenging and with us as parents not having that same sort of involvement, it’s sort of hard to know exactly what he means and the reporting process at intermediate is different....the parent-teacher interviews, there’s a three way conference with the children which is great...but the quantity of information about what they actually do is heaps less than we’ve had in the past....It tends to be more about goal setting for the future, as opposed to “Here’s what they’ve done this term”. (*Martin’s mother*)

The schools clearly had systems in place to inform parents on a regular basis, but the quality of information communicated about students’ progress and the mathematics curriculum was limited. Formal written reporting occurred later in the year when teachers had accumulated a reasonable amount of assessment data. The parents wanted earlier opportunities to communicate with teachers and for this to be initiated by the school. Once the transfer to the new school had been made, how far ahead were students, teachers, and parents considering the mathematics education pathway?

9.6 Looking Ahead and Pathways

The teachers from the Phase One schools had clear expectations about their students and their move to a new school. They understood that there would be an information sharing process so the reception schools would know that the students had been identified as gifted and talented and would place them in appropriate classes. They expected that the level of mathematics would be suitably challenging and the teaching approach encourage open-ended investigations. There was also an expectation that the students would be encouraged to take greater responsibility for their learning and “keep on pushing themselves”. One of the primary school teachers explained:

I hope that there will be extension work for them and that they will be recognized as being proficient mathematicians and that possibly they get a little bit more say in what they do in maths. I think the better children can actually start taking a lot more personal responsibility for their maths and maybe they need to be given more of that open-ended topic work where they can do their own exploration, a little bit like the...group doing one on time. So it's open ended they have to choose which activities they are going to do; they have to choose how they are going to display it; they have to be able to come to the class at the end of the unit or the end of the activity and tell the class what they have done with it. So they are having to take responsibility for their own learning. (*Mrs N, School AP*)

Miss L (School C₁), the teacher of the fulltime CWSA class in the intermediate school, was very clear about the expectations for these students. She explained that she articulated to her students that she expected them to be in accelerated programmes at secondary school and that their pathway was to go on to university. Although Miss L saw her role as giving her students a good grounding and kick start to secondary school, she believed that these students had a vision for themselves.

I think too, some of the children then go on to study part-time at varsity through their sixth and seventh form equivalent years and I think that's another opportunity for them. They can do more subjects, they can extend out, most of the kids are quite content to do that, it keeps them inspired....It gives them the tools, I suppose, so that they can choose the pathway, rather than have the pathway choose them. (*Miss L, School C₁*)

Not all of the schools informed the parents about the intended pathways for their children who were in accelerated programmes or specially designated 'extension' mathematics classes. The Year 7 students (at intermediate schools) and their parents assumed that the next transfer would be in to streamed accelerant classes at secondary school. Most of the parents with children at School F had no understanding of the intended pathway for their children after Years 7 and 8.

When we asked "What will happen now?" because this is Year 7, Year 8, and I think [School F] themselves are still trying to figure it out. Once you're trying to extend a class, do you extend it forever or do you then ultimately bring people to a point....In regards to maths, I don't think I'd have an answer, specifically what is going to happen. (*Nardu's mother*)

Ryan achieved well ahead of his age peers in mathematics and was placed in a Year 7 and 8 CWSA class. His mother acknowledged that "he should provide challenges for the school if they are really going to meet his academic needs and continue the

acceleration process". However, his mother was also focused on his social activities and his wide-ranging extra-curricular activities. Ryan's mother outlined the situation.

He's already in the extension course, he's obviously going to make it again next year, and of course he's now in Year 7....So I'm not quite sure how it's going to work next year. Personally I do have some concerns...next year because he is going to be the top of the school and he's already virtually that at Year 7....he's a kid with high expectations of himself and he's a perfectionist....he's younger...so I really think if he can have a really good social year, if he can get involved in all the sports he's playing...then that might be better for him than actually making him work academically really, really hard...so I don't have a problem with him doing that. I mean he's got a lot on his plate. He's just made the hockey reps...and he's got competitive gym and he speed skates. He plays music at school and he just hasn't got time for anything else, so I really think that perhaps next year he could...work less hard perhaps. (*Ryan's mother*)

This parental concern about the social versus academic was not raised by other parents, yet relates to the notion of pastoral care and students' social-emotional welfare. It also relates to previous discussion about students' motivation and levels of happiness at school. (See, for example, the case of Lily in Phase One of the study and Nardu's transfer to a new school.) There was concern from the parents about those students already in accelerated secondary school programmes and questions were posed about what happens when they reach Year 13. The secondary boys' school had a system in place, but this was not articulated to any of the students. One of the boys knew that they would sit National Certificate of Educational Achievement (NCEA) the following year, but the rest of the boys stated that they had no idea what happened in subsequent years.

I don't actually know much except that in seventh form the math splits into calculus and statistics, and I'll probably take both. But I don't actually know much about it. (*Amir*)

Likewise, the parents of students at the secondary boys' school were not informed from the beginning about the school's plans for the accelerated students. The parents who were aware of the intended pathway were informed only because of siblings who had been in accelerated programmes at the same school.

We have a reasonably clear idea mainly because of his brother. We went to a meeting for Year 11, doing Year 12 work and so we know about that path to Year 13 and [university] papers. So we understand the path from that meeting. If we didn't have the other son on this path then we wouldn't have a clue. As a Year 9 parent, we wouldn't know, except have a vague idea that they'd be a

year ahead and the long term possibility of doing [university] papers...If this is their elite group of students then they should have some tight procedures and systems, and they should have a lot of communication with the parents. (*Lewis' father*)

Nina was treated as an individual case by her school (School J); her parents had worked very closely with the school right from her enrolment. Nina's father had been involved with the Head of Mathematics to plan a pathway, not only in mathematics, but in other curriculum areas. They had looked ahead to the following two years. Nina had also been involved in these discussions and was aware of the opportunity to sit national examinations earlier than was the norm. Nina's father outlined the pathway:

They are keen for her to do NCEA at level one and he has given us a flow chart to show subjects that can be taken in advance. Economics and accounting are not offered at this school; they are close learning to maths, so Year 11, she may take those if offered then...We haven't looked that far [Year 13]. But Year 10, Cambridge, and NCEA, at least one year in advance. (*Nina's father*)

The students were asked not only if they had knowledge of intended pathways in their study of mathematics, but also about their future aspirations. The reasoning for asking about their aspirations was to see if their future plans included mathematics, and if there was any commonality among the group as a whole. Five of the students (four boys, one girl) spoke of specific professions where a high level of mathematics would be needed. These included engineering, medicine, an economist (this student thought he would like to be Head of the Reserve Bank), a vet, and a computer-related profession. Three students wanted sports or art-related careers and one student wanted to be a zoologist. Three students wanted to do something that would require mathematics but had not considered specific careers, and the remaining three students were unsure of future careers. This was a topic that, according to the students, had not been given much attention. This is despite some of their teachers articulating aspirations for these students, and career education and guidance a mandatory component of the curriculum.

It is expected that all students, from Year 7 onwards, have career education and guidance integrated into learning programmes. Given that the majority of these students are mathematically gifted students, it would make sense that educational

pathways that require mathematics would be given consideration. A few of the parents were aware of their children's aspirations. As described in Chapter Eight, they supported their children's continued interest in mathematics and acknowledged that their future success and interest in mathematics would probably influence career choice.

9.7 Summary and Discussion

Different types of transfer were experienced by students in this study. For each student it meant a move to a new school with different systems, students, and teachers. The students changed from being the oldest students in a school to the youngest in the new school. For the Year 8 students, this was their third move in the schooling system. A three-tiered approach to a child's schooling (primary-intermediate-secondary) can be problematic (Galton, et al., 2000). In the New Zealand school system, it commonly means an additional transfer to an intermediate school for Years 7 and 8. Parents presented positive and negative points of view about the intermediate school system. Some parents accepted intermediate school as an interim period where as parents they would possibly be less involved, but recognized that the school offered a chance for their children to continue to be with their established friends. In contrast to this, one parent saw it as an opportunity for her child to move away from her peer group and to establish new friends. The move for some students to a Years 7 to 13 school eliminated the intermediate school experience although a few parents noted that they would re-evaluate their children's schooling at the end of Year 8. These systemic moves raise questions about the cumulative effect of transfers and age appropriateness (Galton, 2000).

Parents invariably made the choice of schools for their children. These choices were based on a variety of factors. The structural factors included the type of school and organization within the school such as the ability grouping of gifted and talented students. Other factors included siblings, the children of parents' friends having attended the school, zoning, and a school's reputation. The students were all accepting of their parents' choice of new school.

Students were prepared for this transfer in a variety of ways. The majority of the students had been given information about their new schools and some had attended an orientation visit. These visits, prospectuses, and discussions with peers and teachers meant that the students felt reasonably well prepared for the organizational aspects of the new school. The students knew to expect the systemic changes and possibly different teacher expectations. Those with siblings attending the same school were particularly confident. This supports the findings of other studies where the number of siblings having attended or attending the reception school was found to be positively related to successful systemic transfers (Anderson et al., 2000). The siblings clarified transfer-related information that alleviated many anxieties associated with the unknown. They discussed with siblings matters such as uniform, hair length, textbooks, lockers, and other school routines and expectations. The students in the study all experienced some form of inter-school communication such as school visits, liaison visits by teachers, and information booklets which according to Simpson and Goulder (1998) go some way towards enhancing the transfer process.

The academic focus of ensuring curriculum continuity and the learning and development of individual pupils was not evident for all students in this sample. The practice of 'fresh start' was evidenced in three schools that based placement on their own selection tests and did not take into account the previous schools' records. This 'fresh start' policy has been argued, according to evidence reviewed by Galton et al. (2000), on the reasoning that a secondary school's objectives are more academically specific and the secondary specialist teachers can better ascertain a student's ability in a subject such as mathematics. Galton and Hargreaves (2002) write that it is questionable whether curriculum continuity is taken seriously and is an achievable goal.

There was an expectation, by the majority of the teachers in the study, that as gifted and talented mathematics students they would be independent learners and therefore programmes designed for these students would encourage independent work. However, one child's parents felt that the expectations were unrealistic. Their child had experienced initial problems in making the transfer to secondary school and took nearly half the academic year to settle. Only one of the teachers from the sending schools spoke specifically about helping students, as part of their coping

mechanisms, develop skills in self and time management, studying, gathering, and using information, communication, decision-making, and conflict resolution. There was little evidence, in this sample of students, that they were specifically taught skills for coping and being independent learners. These skills are recognized as making a transfer across systems more successful (Schumaker & Sayler, 1995). This lack of focus on preparedness by teachers concurs with Hawk and Hill's (2001) study that found "many teachers are so focused on curriculum coverage that they do not take the time to incorporate these [self-management, time management, study skills etc.] into the programme" (p. 31). Similarly, an Education Review Office (2006) report identified a lack of preparedness by schools for students to make the transfer to secondary education.

The students were supported in these school transfers by three main groups of people (friends and siblings, parents, teachers) and the school system. The students acknowledged that friends were an important part of the support system for assisting a successful transfer; this was confirmed by the parents. This result is not surprising and reflects findings in Whitton and Perry's (2005) Australian study in which parents and students saw the keeping of friends from the previous school, as well as the making of new friends, as contributing to the success of the new experience. The students expected, and wanted, to be with like-minded peers who had similar interests and abilities. This is an important component of suitable programming for gifted and talented mathematics students (Assouline & Lupowksi-Shoplik, 2003; Robinson, 2004).

The parents in this study, interviewed before and after the transfer, showed interest and support for their children in ensuring a smooth move to their new school. Parental interest and support is also recognized as a key factor in enabling students to make successful transfers (Dauber, et al., 1996). Two parents had some reservations about the school to which their children were about to transfer, but were prepared to take a 'wait and see' approach. The parents all felt that they were less involved in the new schools and that it was part of the progression through the school system. However, one parent in the study had to take on an advocacy role as a consequence of the transfer process. The parent had initially taken a 'wait and see' approach, but seeing her child's increasing dissatisfaction and boredom in mathematics eventually

led to her intervention. As interested and supportive parents they are more likely to contact a school to influence placement decisions (Dauber, et al., 1996).

The school systems provided limited forms of support for these students. Only one school used a peer support and vertical class system and one school a mentoring scheme. These support systems are viewed as worthwhile practices (Casey & Shore, 2000) and culturally appropriate for gifted and talented Māori students (Bevan-Brown, 1993, 1996). The message is sometimes conveyed that the post-transfer year is a less important year (Demetriou, et al., 2000) compared to later years in schooling, and few schools have systems such as mentoring schemes in place for their younger students. The characteristics of good systems include collaborating with and considering information from all stakeholders (Leppien & Westberg, 2006). This was not evidenced in all cases in this study. The types, quality, and quantity of support from teachers also varied for the students. The parents and students articulated few comments specifically about support from teachers. Yet the teacher, as shown in other studies (Pietarinen, 2000), can be a “central transformative force in bridging the gap between primary and secondary school” (p. 383). In this context, this finding does not undermine those teacher qualities acknowledged in Chapter Six, but is recognition that the teachers made little impact on the transfer process for these students.

Students faced challenges in making a transfer at two levels—the macro level of the school’s physical structures and organization and at a micro level in the classroom with a new teacher who is a subject specialist and who may use different teaching approaches. Successful transfers occur when reception schools make every effort to create a sense of community and belonging, and where students, teachers, and parents are involved (Smith, 2001). The majority of the students in this study were well prepared for the transfer by teachers and parents, and reasonably well informed through school systems. They received support from peers, parents, and teachers. Two students did not experience a smooth transfer. For one student it was the result of a lack of friends and for the other it was the policy of *tabula rasa* or fresh start. The level of support from reception schools was lacking for some students.

With their children moving to a new school, the parents wanted to monitor not only their children's social-emotional well-being, but also their academic progress. This is most important given that the literature has shown that most students experience dips in achievement post-transfer (Anderson, et al., 2000; Galton & Morrison, 2000). Most parents found this difficult; there was limited opportunity for communication, and progress reports and interviews came later in the school year. The parents were reluctant to be involved in the new schools; reasons for this were presented in the previous chapter on parental involvement. However, some parents expressed concerns about children's attitudes, efforts, motivation, and levels of achievement. The provision of academic continuity in pupils' experiences is viewed as a vital component in a successful transfer (Simpson & Goulder, 1998); yet, it is disconcerting how many of the students and their parents mentioned the lack of challenge in their new programmes. This result was also surprising given that the students were taught post-transfer by teachers who had greater expertise in mathematics than their previous teachers in either primary or intermediate schools. There were expectations from the parents related to identification and recognition of interest and abilities, a desire for a teacher who continued to challenge their children, and to be informed of their children's progress.

Most of the students were unaware of the intended educational pathways in their study of mathematics. A few of the students knew the pathway for one or two years in advance and most parents had vague understandings. A few of the teachers articulated clear views about their aspirations for the students; they would continue studying mathematics and continue on to university. Some of the students had considered future careers and for five students these required successful achievements at higher levels of mathematics. The students had not discussed future careers and pathways at school, although some parents were aware of their children's aspirations. This result supports the Education Review Office's (2006) findings that for diverse groups of students there were "limited or no opportunities to develop awareness of their strengths and abilities and of the possible educational pathways open to them" (p. 35).

Students experience several transfers during their years of schooling; each one of these is important. However, just because a student has successfully negotiated one

transfer does not mean that he or she will successfully negotiate the next one. The nature and extent of change is dependent on many factors as previously described. For the majority of students in this study, the transfer was relatively smooth and unproblematic although there are several implications to be considered from the findings which will be presented in the following chapter.

The following and final chapter draws together the findings from the preceding five results chapters. The findings are summarized in response to the six questions posed at the start of the thesis. These conclusions endeavour to address the gaps identified in the literature on the education of mathematically gifted students, particularly in the New Zealand context. Finally, the chapter examines some implications posed by the results of this study, and provides directions for further study and what should happen next.

CHAPTER TEN:

CONCLUSIONS AND IMPLICATIONS

10.1 Introduction

This chapter presents the conclusions from the study. It shows how the study has clarified and extended the knowledge base reviewed in Chapter Two: Literature Review. The literature review presented contrasting views and models about giftedness and talent, the characteristics of mathematically gifted and talented students, identification processes, and provisions. This examination revealed theoretical and methodological gaps and challenges in the field. Specifically, in the area of mathematical giftedness, there was no common understanding about the definition, most studies focused on mathematical levels of achievement (outcomes) rather than processes, multiple perspectives (students', teachers' and parents' voices) were missing, few studies reported on qualitatively differentiated programmes, many studies (excluding SMPY) were short range, and the contribution of parental involvement was overlooked. The field of study is fragmented—based on varying conceptions of giftedness (not always defined) and differing methodological viewpoints (Ziegler & Paul, 2000).

In the New Zealand context, there was a paucity of research examining issues in gifted and talented education (Riley et al., 2004). For example, the study by Riley and associates contributed to general knowledge regarding identification and provision for all gifted and talented students across a range of areas, but the research did not examine the subset of mathematically gifted and talented students. This study begins to address some of the identified gaps and is *unique* in that it *combines* five key features; it:

1. simultaneously explores multiple perspectives of the education of mathematically gifted and talented students;
2. examines past, present, and intended experiences in mathematics education of a group of students;
3. uses a variety of data gathering tools to validate findings;

4. combines two different age groups, both of whom experience a school transfer; and
5. is longitudinal.

The lack of a comprehensive view about the mathematical experiences of students identified as mathematically gifted and talented led to the formulation of six research questions. A multiple-case study employing predominantly qualitative methods was used to answer these questions. The questions were:

1. What are the characteristics of mathematical giftedness recognized by school policies and procedures, teachers, parents, and students?
2. How are mathematically gifted and talented students identified?
3. What provision for the students' education in mathematics has been made within the classroom and school contexts?
4. What are the characteristics of an effective teacher of mathematically gifted and talented students?
5. What roles have parents played in their child's mathematical development?
6. How is a school transfer managed for a mathematically gifted and talented student?

Section 10.2 presents the limitations for the study. These are presented at the start of this chapter as an acknowledgement that all concluding statements are made with these factors in mind. The conclusions (Sections 10.3 to 10.8) are presented in response to the six research questions, based on the detailed findings reported in the preceding chapters. Although the findings are presented in this way, there are connections among the subsections. In Section 10.9, theoretical perspectives are addressed. A set of questions (Section 10.10), generated by the conclusions from this study, are then posed as considerations for policy and practice. This is followed by suggestions for further related research. The chapter and thesis is brought to a conclusion with 'Final Words'.

10.2 Influences and Limitations

Whilst the research contributes to knowledge in the field, like any research, it has its limitations. Case study research methodology, with its study of the particularity and

complexities of a case, combined with the personal views of the researcher, and the varying researcher's roles, led to decisions throughout the research (Stake, 1995, 2005). These decisions influenced processes such as the posing of questions and data analysis. The researcher provided sufficient detail about the research study for it to be replicated. The study used 'thick descriptions' (Geertz, 1993) so that we can learn from the multiple cases, although it is acknowledged that it is not possible to make generalizations from a small number of cases. However, the amount of detail and raw material provided should help readers to understand the basis for these conclusions and to form key ideas of their own.

The sample was limited to a manageable number of sites and participants to enable the collection of data during a two-year period. The original sites (Phase One) were chosen because of the researcher's knowledge that the schools made provisions for gifted and talented students in mathematics. The Phase One sites were two primary schools and one intermediate school. The participants had been identified by their schools and teachers as students gifted and talented in mathematics. This meant that there was no consistency across the three school sites in identification processes and no common definition. The parents of the student participants could be labelled a biased group as it is more likely that parents with high levels of involvement in their children's education would volunteer to participate in research in the first instance. The study was limited to a two-year period because of time constraints. A study of longer duration would have enabled tracking of students through further transfers and transitions (class to class) with a focus on their continued study of mathematics and levels of motivation, interest, and achievement.

The following sections (Sections 10.3 to 10.8) present conclusions and contributions of knowledge to the field. These are based on the findings detailed in Chapters Five to Nine. They are presented as responses to the six research questions.

10.3 Characteristics of the Mathematically Gifted

What are the characteristics of mathematical giftedness recognized by school policies and procedures, teachers, parents, and students?

The participants in this study recognized that mathematically gifted and talented students have a unique blend of defining characteristics that include interests in things mathematical (spatial and numeric), advanced abstract reasoning abilities, and problem solving skills. The development of these skills and abilities was hindered by a lack of recognition in school policies and procedures. The schools' policy documents attempted to define 'giftedness' in generic terms, but did not provide information (or supporting references) for teachers and parents about the characteristics of the mathematically gifted and talented.

Most of the teachers did not have a comprehensive, articulated concept of mathematical giftedness. Their knowledge about some of the characteristics was based primarily on teaching experience. The two younger, less experienced teachers had limited knowledge and confidence in the area of gifted education, especially the mathematically gifted. Only two out of the thirteen teachers had recognized and appreciated differences in mathematical giftedness. An operational definition of mathematical giftedness should be based on a quantitative view (what students know) and a qualitative view (how students think) (Wieczerkowski, et al., 2000). Together these reflect Krutetski's (1976) view of the "mathematical cast of mind" (p. 350). Potentially, it means that many students could be overlooked in the identification process if teachers do not have knowledge about these different types of mathematical giftedness.

The parents articulated many of the characteristics of mathematical giftedness, but some were unaware that these traits and behaviours reflected gifts and talents specifically in mathematics. The parents recognized these characteristics in their very young children. It was also evident from the parents' voices that their children from an early age showed different types of mathematical giftedness.

The students became aware of their advanced abilities in mathematics when they began formal schooling, although for some students this was not until they had been at school for a few years. This recognition was as a consequence of comparing themselves to age peers and competing successfully in competitions. Most of the students were interested and at times motivated in mathematics. However, levels of motivation varied in the different phases of the study and were not as high as could

be expected from gifted and talented mathematics students. Many of the students found mathematics easy and attributed their success to sustained effort and a recognized need to work hard to be successful.

It is evident, from this study, that there is awareness by stakeholders of *some* of the characteristics of mathematical giftedness, but not an articulated, comprehensive view of mathematical giftedness based on theory and research. This is a shortcoming in policy and teacher knowledge; a definition or conception of mathematical giftedness provides a key link to the identification process.

10.4 Identification of Mathematically Gifted Students

How are mathematically gifted and talented students identified?

Most schools documented a multiple method approach, but in practice they relied primarily on testing. The need for multiple sources for identification (Davis & Rimm, 1998; McAlpine, 2004a; Ministry of Education, 2000; Riley, et al., 2004) is undisputed. Some teachers acknowledged that their schools had flexible policies and stated that their schools practised a multiple method process of identification that included observations and problem solving abilities. This was not evidenced when students made a school transfer. One of the intermediate schools used parent nominations as part of the identification process for giftedness and all of the secondary schools used testing. Most of the schools did not put identification policy into practice. Their identification practices were not underpinned by sound principles of identification. They were indefensible and exclusive (Gubbin, 2006).

Not one primary school's gifted education policy had a process for identifying gifted students on entry to school. This is evidence that schools are not identifying young gifted mathematics students early in their schooling. This practice was further supported by the students and parents who stated that the year of schooling in which their mathematical giftedness was recognized by the school was Year Two or Year Three.

Scant attention was paid to the impact of context and culture on identification of gifted and talented students in the school policy documents. This is problematic given that policy underpins a school's approach to the education of gifted and talented students. There may be groups of students neglected in the identification process because of unrecognized cultural or socioeconomic barriers.

Students and parents were marginalized in the identification process. Student information, such as that obtained from the Mathematics Interest and Attitude Inventory (Rogers, 2002) and talking with students about hobbies and leisure activities, provided information that could help with the identification process. The students gave personal views that could be effectively used by a teacher to highlight aspects such as boredom, lack of challenge, and the level of interest and commitment to mathematics. This information could be obtained early in a child's schooling to reduce the likelihood of non-identification. Such tools could also be useful later with school transfer and supports Freeman's (2000) notion that children's interests provide clues that could help in the identification process. Parents, despite their knowledge and understandings as children's first educators, were not (except for one case) included in the identification process. Parents can accurately recognize a gifted child (Rogers, 2002) and so should be included in the identification process.

This study raised two issues of concern in relation to identification. These issues were the exclusion of a student (non-identification) and the inclusion of students who were not gifted and talented in mathematics (misidentification). In Phase Two of the study, a student was not identified by his new school, post transfer (despite school documentation), as mathematically gifted and talented. Two students were included in the study because they had been identified as gifted and talented in mathematics. These students had been identified based primarily on teacher judgment. Their teachers had been influenced by the students' previous teachers and observed behaviours. They did not, according to the researcher's classroom observations and perusal of student work, show characteristics and behaviours of mathematical giftedness. This was confirmed by their parents who were surprised that their children had been included in the study, although they felt that this involvement was a positive experience for their children.

A concept or definition of mathematical giftedness affects the identification or selection process which then influences the educational provisions made for students. Teachers need to know not only what it is they are looking for, how to identify it, but what it is they are fostering. They then need to seek and use ways of providing learning experiences that foster mathematical giftedness. Such teacher capacity is restricted when there is ambiguity surrounding the definition of mathematical giftedness and its identification.

10.5 Provisions

What provision for the students' education in mathematics has been made within the classroom and school contexts?

There was a limited range of provision in mathematics for the students. Some of these provisions were favourably received and other practices presented areas of concern. Enrichment was offered on limited occasions. The students appreciated and enjoyed the challenges of an enriched programme that offered different material, that is, material outside of the regular mathematics curriculum. This enriched work included the use of problem solving and investigative work, but the topics were invariably selected by the teacher. Student input and choice is an important feature of a differentiated classroom (Tomlinson, 2001) and was an element missing from these students' programmes.

Students, teachers, and parents acknowledged the need for mathematically gifted and talented students to be accelerated. Nevertheless, there was a lack of planned approaches and pathways for most of the accelerated programmes. One school (the secondary boys' school) had a clearly defined pathway, but this was not articulated to the students or parents. One student in the study had been accelerated by a parent and was working three years in advance of her peers in algebra. For most students, this acceleration was planned so that they worked only one year ahead of their age peers. They continued to work one year ahead in the following year in which they had been tracked. The questions have to be raised: Why do students accelerated by one year in mathematics in primary school continue to be accelerated by only one year throughout the rest of their schooling? What might this rate of progress suggest

about the effectiveness of such programmes? What knowledge and understandings do teachers (and school leaders) have about giftedness and rates of learning?

There was a lack of planned differentiation of content, process, and product (Sak & Maker, 2006) that was responsive to the individual student's mathematical learning needs. A few students experienced differentiation in some, but not all, of these possibilities. Some, but not all, of the teachers showed an understanding of how they could change the learning environment for their students by differentiating these elements. Wide-ranging suitable learning activities in mathematics for the students in this study were limited especially with respect to the opportunities for process and product differentiation.

Provisions for students were not individualized. The issue, not dealt with by any of the provisions previously outlined, was finding the right programme for individual participants. The programming was not individualistic, not (for many students) of a high quality, and not differentiated in a variety of ways. The learning environment should promote cognitive and non-cognitive knowledge and skills. The study showed that, for many students, there was limited focus on the development of other aspects such as independent and goal setting skills.

There was confusion over the terms associated with provisions. Terms were used without a shared understanding in both school policy and practice. For example, policies listed options such as differentiation, extension, enrichment, and acceleration. Furthermore, teachers were not given definitions and supporting material such as descriptions and exemplars. Many schools and teachers used the term extension; this is problematic. This term is overused in the New Zealand setting given that there is no common understanding of what extension means. Extension referred at times to an organizational approach (the extension class), acceleration, or enrichment (different work). It would be helpful if this term was either dropped from documents and discussions or well defined by schools.

There was no systematic evaluation of the provisions made for the gifted and talented students. Despite opportunities such as gifted classes, acceleration practices, aspects of differentiation, and use of competitions, these provisions were not evaluated.

Evaluation is seen as pivotal in determining the effectiveness of provisions for gifted and talented students (Callahan, 2006; Education Review Office, 2008) and must therefore be taken more seriously.

There was a lack of professional development in gifted education, and more specifically the education of the mathematically gifted and talented. Opportunities for professional development are dependent on many factors including a school's priorities, and a teacher's personal interest and commitment to further studies. There should be provision for ongoing school-wide professional development in gifted and talented education (Education Review Office, 2008); this was not evident. The teachers in this study were responsible for teaching an identified class or group of mathematically gifted and talented students, yet the research showed that the majority had received no specific education in gifted education, let alone the teaching of mathematically gifted students.

Teachers have limited resources written specifically for mathematically gifted and talented students. The students, teachers, and parents recognized the issue of accessing appropriate resources. The use of textbooks dominated programmes and these did not accommodate the critical differences among students. The use of Information Communication Technologies (ICT) was minimal. Gifted and talented mathematics students should have ready access and be encouraged to use calculators and computers to support their learning in mathematics (Jones, et al., 2002).

This study affirms the importance of competitions for gifted and talented students (Karnes & Riley, 1996) and argues that both individual (national and international) and group mathematics competitions are an important component of any programme for the mathematically gifted and talented. As with other provisions, they should not be utilized in isolation or without careful identification (Riley & Karnes, 2007).

No consideration was given to students' preferences for grouping practices in their mathematics programmes. Grouping practices in mathematics were determined by the schools and the teachers. The students had different preferences for how and with whom they worked in mathematics. This was either independently, in pairs, or in small groups. Given the contradictory literature in the field about grouping practices,

it makes sense to give students choice, at times, in the grouping arrangements when working in mathematics. This responsibility rests with the teacher. What teacher qualities were recognized and appreciated by the participants?

10.6 Teacher Qualities

What are the characteristics of an effective teacher of mathematically gifted and talented students?

This study concludes that the teacher of mathematically gifted students needs knowledge and competence in two domains—mathematics and gifted education. The qualities of a good mathematics teacher includes sound mathematical content knowledge (Ball et al., 2001), and pedagogical content knowledge (Ma, 1999). The teacher of gifted students requires specific knowledge, competencies, and dispositions (Leppien & Westberg, 2006) such as knowledge of characteristics, identification procedures, educational and psychological needs, and principles of a differentiated curriculum. The qualities, shown in this study to be of prime importance by the students, teachers, and parents were: mathematics content knowledge; interest, enthusiasm, and passion for mathematics; flexibility and adaptability; awareness of individual student differences; and the ability to provide the ‘right’ level of challenge. These findings reflect qualities from the literature focused on teaching in mathematics, and teaching gifted students.

There was little recognition given to people in the community, including parents, in policy documents and practice. Community and parents deserve stronger recognition (especially given the role they play in fostering the interests and talents of their gifted children) than was evidenced in this study. The next section addresses this topic.

10.7 Parental Involvement

What roles have parents played in their child’s mathematical development?

The parents of the mathematically gifted and talented students were motivators, resource providers, monitors, mathematics content advisers, and mathematics learning advisers. The parents’ most favoured roles were that of motivator and

mathematics content adviser. Parents acknowledged that their role as content advisers would diminish as their children moved through the education system. This diminishing role was influenced by two factors: one factor was age-related and the other factor related to the parent's content knowledge in mathematics. As students moved into the adolescent years, they were less inclined to talk with parents about schooling and mathematics. The parents felt their knowledge was likely to be challenged and would be inadequate for supporting their children as they progressed in their study of mathematics.

Parents were not recognized by the schools as "instructional partners" (Radaszewski-Byrne, 2001). The parents were keen to monitor their children's progress, but felt that there were limited opportunities via home-school communications. Parents acknowledged strategies such as interviews and portfolios but felt that these could be strengthened with respect to mathematics. Parents believed that they were not well informed about approaches to teaching mathematics. They placed considerable emphasis on the importance of homework. They articulated clear views about the role of homework in their children's mathematics education. Parents and teachers did not share a common understanding about the role of homework. Parents used homework as a means of keeping informed about what mathematics their children were learning and as a means of tracking progress. In contrast, the teachers used homework (especially the commercially-produced homework books) to reinforce learning. There needs to be an articulated justification by teachers for the use of these homework books. Limited use (except by one teacher) was made of homework as a means of enriching students' learning in mathematics. Consideration needs to be given to the purposes of homework and there needs to be a shared view of the role of homework.

Three parents had to take a strong advocacy role for their children. They assumed this role because they recognized the needs of their mathematically gifted children (Assouline & Lupowski-Shoplik, 2003). Even then, the parents did not take action until after a period of 'wait and see'. This should not be the case if there are appropriate policies and practices for the identification and provision for gifted and talented students. Moreover, the school policies and procedures did not create a comfortable pathway for the parents to take action. This is further evidence that the

home-school partnership needs attention. This partnership is also essential in supporting a successful school transfer process.

10.8 School Transfer

How is a school transfer managed for a mathematically gifted student?

This work confirms school practice of *tabula rasa* or fresh start. As a result of this practice, not all students experienced a smooth transfer. Based on a single case study, the practice of fresh start impacted on a student's academic and social-emotional well being. This case was subject specific; it centred on mathematics. The unhappiness and distress for the student and parent was a result of inadequate processes for the identification of giftedness in mathematics. The reluctance to use previous schools' records and the 'fresh start' approach poses a dilemma for the teachers sending students on to the next school. Why should they expend precious time and effort on compiling and refining the accuracy and detail of records, if there is a lack of confidence that they are going to be used in the placement of their students? Why is there distrust or negligence on the part of a reception school to use this information? This practice may be justified in the literature (see, for example, Galton, et al., 2000), but if it disadvantages a student then the conclusion from this study is that it should not be practised. Schools should at least take the information from the sending school in to consideration as part of the multiple method approach to identification.

Curriculum continuity was not achieved for all students in this study. This conclusion further supports the need for closer attention to be paid by reception schools to information passed on from sending schools. Sending schools were not, in all cases, advised on what information to send that would then be considered in student placement and be used to assist with curriculum continuity. The detail of information was not focused on students' achievements in all strands of mathematics. This information should be used to assist reception teachers in providing suitable levels of challenge and targeting areas that may have received less attention such as measurement and geometry.

Students were not explicitly taught coping systems that could have helped them with the transfer process. There was no documented evidence of this in school policies or teacher planning to address skills such as self-management, time-management, decision making, and conflict resolution. Preparedness in these areas should help students continue this educational journey without serious interruption (Hawk & Hill, 2001). Preparedness for coping with school transfer should begin at primary school and continue for each transfer that students make in our system (Education Review Office, 2006). A few parents also believed that the level of pastoral care for their children was inadequate. One student had sought counselling assistance and one parent was seriously concerned about his child's coping mechanisms at his new school.

This study concludes that the main source of support for students in the transfer process was their friends. For most of the students, these friends were like-minded mathematically gifted and talented peers. Parents were aware of the importance of their children's friends in assisting with the school transfer and this was one of the factors influencing the parents' choice of school for their children. Siblings also provided support in clarifying anxieties related to unknown elements associated with the new school. The number of siblings familiar with the school is positively related to successful school transfer (Anderson et al., 2000).

School systems to support the transfer process were limited. There was some sharing of information, visits, and teacher conferences, but post-transfer only one school had formalized systems of support. These formalized systems contribute to enhancing the school transfer process (Galton, 2000). Parents had little opportunity to contribute to the transfer process through the school systems. They were interested in and wanted to provide support, but apart from one school, had little opportunity to contribute to the transfer process. This is another situation that supports the strengthening of home-school communications.

10.9 Theoretical Perspectives

This study has been influenced by a variety of theoretical perspectives. As outlined in Chapter Four: Methodology in Practice, the study was predominantly interpretive. The ethos of the interpretive study has meant the voices of the participants within the case studies have been strong. These case studies were all centred on a set of research questions related to the experiences of a group of students identified as mathematically gifted and talented. The context for the research was predominantly in the students' schools and based on lived experiences, past and present. The naturalistic, ethnographic material presented in this thesis has led to propositional and experiential knowledge (Stake, 2005).

This study was entered into with knowledge about certain events, organizational structures, and possible issues. However, the researcher could not know the resultant perceptions, issues, and final conclusions. Conclusions have been presented based on the researcher's interpretive skills and validated through multiple data generation sources. The limits for generalizability from the results were established earlier in the thesis. The cases within the case study have been well represented so that the researcher could use these to inform and refine theory in the field rather than formulate new theory.

In the field of gifted education, different concepts and models influence the definition and subsequent identification of giftedness. The concept or definition used to underpin this study has been that mathematically gifted and talented students are those students who from an early age display attitudes, behaviours, advanced abilities, and interests in 'things' mathematical. The operational definition was influenced primarily by the enduring work of Krutetski (1976), but takes account of the work of Renzulli (1986), Gagné (1985), and Gardner (1983). The following 'big ideas' in relation to the identification and education of mathematically gifted and talented students are proposed from this study:

1. Students must be placed at the heart of all decisions related to identification and programme provisions for the mathematically gifted and talented.

2. Policy and practices related to the education of mathematically gifted and talented students must be initiated early in a child's schooling, be cyclic and ongoing, and supported by professional development.
3. Students, teachers, and parents together play a pivotal role in the sustained academic achievements of the mathematically gifted and talented.

To support these propositions, a set of questions has been formulated as implications, important considerations for policy and practice.

10.10 Implications

The implications, drawn from the conclusions of this study, are posed as guiding questions. These questions are designed to provide important considerations as 'food for thought' for the stakeholders in the education of mathematically gifted and talented students. A brief rationale is given for each question. The stakeholders include the students, teachers, parents, school leaders and managers, teacher educators, and policy makers. These questions have been raised in the context of mathematics education, but they could also be used to inform developments in other areas of giftedness.

What are the characteristics of mathematically gifted students?

The characteristics of mathematically gifted students should be included in school documents to assist teachers in the identification process. Parents, as children's first educators, were aware of many of these mathematical characteristics displayed by their children from an early age. It would be expected that an awareness of the characteristics of mathematical giftedness would benefit students' educational experiences from the start of their schooling. If parents and teachers know what to look for, then success for mathematically promising students can be maximized. The implication is that professional development for teachers (including early childhood teachers) should include a focus on the characteristics, and the different types of mathematical giftedness. There is no purpose in a school having a gifted and talented education policy that includes a definition and identification practices without teachers knowing what they are actually looking for. Furthermore, if a focus is placed on knowledge and skills in numeracy (which is likely given the current political and educational emphasis), students with strong geometric and spatial capacities could be ignored.

Who is involved in the identification process and what systems are in place to include all stakeholders?

Parents need to be considered as a key source of information in the identification process when their children enrol at early childhood centres and schools. Schools should consider the practice of early identification and ensure their policies provide for an ongoing identification process. Without an articulated system for ‘catching’ students on entry to school and an ongoing identification process, students may be excluded from targeted provisions. Students may also be misidentified. Misidentification, whilst possibly providing positive benefits for a student, may also impose strains or expectations that the student could be ill-equipped to handle. Greater attention should also be paid to the issue of cultural and contextual factors, and twice-exceptionality in the identification process. It is widely recognized that multiple methods should be used in the identification process; this needs to be more than mere rhetoric, but move from policy to practice.

What ongoing contributions are parents actively encouraged to make with respect to their children’s mathematics education?

The home-school partnership is critical and could be strengthened so that parents are better informed about their child’s mathematics education, the topics being taught, learning and teaching approaches used, and provisions being made to cater for their child’s special interest and ability in mathematics. The findings, related to decreased levels of parental involvement as children progress through the school system, also support the strengthening and importance of this rapport. The school could take more interest in some of these parental roles (motivators, resource providers, monitors, mathematics content advisers, and mathematical learning advisers) and assist parents in retaining their levels of involvement. Tensions between parents and schools could be removed, or at least minimized, if there is a clear advocacy process.

What school systems support mathematically gifted and talented students in the transfer process?

School transfer can be a daunting process for any student; these students showed that they had high expectations in terms of teacher qualities and curricular challenge. Dips in academic achievement commonly occur post-transfer and consideration needs to be given to those factors identified in this study so that schools eliminate

any hiatus in progress. Aspects related to pastoral care could also be raised earlier in the school year rather than parents waiting until formal reporting systems later in the year. Students need to have opportunities to raise their concerns in a safe and supportive environment early in their days at the new school. Schools should also consider strengthening their contribution to students' transfer with access to mentors and learning counsellors. An earlier three-way conference (student-teacher-parent) might go some way towards capturing sooner, concerns about students' motivation, interest, and academic progress in mathematics post transfer.

It is important for sending and reception schools to consider preparedness, support systems, and other factors that contribute to academic and social success as part of the school transfer process. The most successful transfers occurred when there were programmes in place that explicitly addressed students' preparedness, support systems, and academic orientations and when these programmes involved an inter-related student, parent, and staff focus. If we are to help young people sustain an enthusiasm for the learning of mathematics, confidence in themselves as learners, and a sense of achievement and purpose, then we should pay more attention to the transfer process.

What specialized resources does a school have to support the education of mathematically gifted and talented students?

Resources were mentioned by all groups of participants in response to different questions. Essentially, there was a plea from students, teachers, and parents for resources tailored to meet the needs of the mathematically gifted and talented. This matter is on the Ministry of Education's agenda. However, time and expertise in resource development is always in short supply; this study has shown a gap and need for further book resources and web site evaluation. Teachers also need to develop the knowledge and skills to be able to evaluate and modify resource material. This could be developed through targeted professional development and working groups led by experts to address the development of material for students working at an advanced level in mathematics, but contextualized for their age levels.

What provisions are available for pre-service and in-service training of teachers in the area of mathematical giftedness?

Pre-service educators should acknowledge and address not only the topic of gifted education as a base, but extend this to specific learning domains such as mathematics. It follows that pre-service education in the teaching of mathematically gifted and talented students should be coupled with ongoing teacher professional development. Together, this would ultimately mean that all practising teachers could develop greater expertise and confidence in identification, and the planning of appropriate teaching and learning programmes for mathematically gifted and talented students.

10.11 Further Research

This study has added to the research base on the education of mathematically gifted and talented students. It is important that we continue to develop this research base through further investigations. Subsequent research could include a focus on special populations such as gifted underachievers and twice-exceptional students. Given that New Zealand is first and foremost a bicultural country and an ever increasing multicultural society, it would be worthwhile to explore whether there are equitable opportunities for mathematically gifted students regardless of ethnicity; studies could focus on under-represented groups such as Māori and Pasifika students.

The impact and influence of the Numeracy Development Projects on the education of mathematically gifted and talented students could provide the impetus for a worthwhile study. Although the influence of the Numeracy Development Projects was not a focus of this study, students, teachers, and parents commented on aspects of this in relation to the impact on mathematically gifted and talented students. These unprompted comments indicated an interest by the various stakeholders.

Differentiated practices for mathematically gifted and talented students could be examined through design-based research (Barab, 2006) or action research for teachers (Arhar, Holly, & Kasten, 2001; Elliott, 1994). This could lead to the examination and development of challenging learning opportunities in mathematics that are differentiated in a variety of ways.

A study of longer duration could track mathematically gifted and talented students through their schooling from early childhood to graduation from secondary school. There is interest in longitudinal research as evidenced by one parent in this study who invited the researcher to continue to track his daughter's progress. These are a few suggestions. Hopefully this study provides ideas for what should happen next, the impetus for further questions to be posed, and motivates others to conduct research in this field.

10.12 Final Words

This thesis explored the education of a group of students identified as mathematically gifted and talented. The perspectives from the students, teachers, and parents addressed the questions posed at the start of the thesis and reiterated in this final chapter. The study was augmented and evidence validated with supporting material from policies, planning, student workbooks, and observations. The researcher was privileged to have access to a wealth of material and to hear the views of many people. The students provided information-rich cases from which it has been possible to learn about issues of central importance to the topic.

This study showed the interrelatedness of the various components that contribute to the education of mathematically gifted and talented students. The child was placed at the centre of the study as the primary unit of analysis. The parents (their roles and levels of involvement), the teachers (influenced by professional expertise and experience), and the schools (policies and practices) all determined to some extent the experiences and levels of achievements for these mathematically gifted and talented students.

This study showed that a group of children entered school with knowledge, skills, and an interest in mathematics that should have set them apart from others. It was not until after a few years of formal schooling that they received some differentiation of curriculum and instruction. They 'craved' challenge in their mathematics learning and sustained opportunities to work with like-minded peers. Parents provided support to some degree, but this decreased as their children progressed through the school system. Policy and practice in identifying and catering for mathematically gifted and

talented students was variable. This is a special population who, like all students, deserve the best that we can offer. We need to provide assurances that children gifted and talented in mathematics are not overlooked and are given the best possible chance to realize their potential.

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Appendix A: Student Interviews

Phase One

Introduction

1. Tell me about your interests and hobbies.
2. When do you first remember being interested in maths?
3. How well do you think you are doing at maths?

The Programme

4. Why do you think you are in this group/class?
5. Tell me about your maths programme this year.
6. What have been the best parts of the programme?
7. Are there any parts you haven't enjoyed? Why not?
8. Do you have a preference for individual or group work?
9. What do you think of the competitions?
10. What do you think makes a good maths programme for gifted kids?
11. What do you think makes a good teacher of mathematics for gifted kids?

Assessment

12. How do you know how well you are doing in maths?

The Future

13. How was it decided what school you will go to next year?
14. What do you hope your Maths programme will be like next year?
15. Do you think you will continue to study mathematics? Why/Why not?

Phase Two

Transfer

1. What are the main differences between this school and your previous school?
2. How well do you think you were prepared to make the move to this school (prior visits, meet the teacher, school liaison)?

Friends

3. What changes (if any) in friendships have you made since your transfer to this new school?
4. How important are your friends in class (maths/other)?

Maths Class

5. Tell me about your maths class. (Prompt re: grouping, teaching approach, use of textbook, recording, calculator use, computers, homework, competitions).
6. What are the main differences between this school and your previous school's maths programme?
7. How challenging have you found the work?
8. How well do you think you were prepared for the maths this year so far?
9. How enjoyable to do you find maths compared to your other subjects?
10. How hard do you have to work compared to your other subjects?
11. What does it feel like to be in a group/class identified (labelled as No.1, accelerate, top group etc)?
12. How important do you think it is to be grouped in this way? Why?

Progress

13. How well do you think you are doing in maths?
14. How do you know how well you are progressing?

Future

15. What consideration have you given to mathematics in your future (schooling/career)?
16. Has the school talked to you about future classes in mathematics?

Appendix B: Teacher Interviews

Phase One

1. What do you think are the characteristics of a gifted mathematician?
2. How are students selected for this class?
3. What input do you have in this process? Do you think the process works? Could it be improved? If, so how?
4. What are your aims in providing for students who are gifted and talented in mathematics?
5. What are the challenges that you have faced in providing a programme for these students?
6. What do you believe are the key features of your mathematics programme?
7. What have been the strengths/ weaknesses (if any) of the programme?
8. How do you measure the students' mathematical progress?
9. What consideration (if any) do you give to their attitude towards mathematics?
10. What are your aspirations for these students as they go on to Year 7/Year 9 and to the intermediate/secondary system?
11. Do you prepare the students for this transition? If so, in what way?

Phase Two

Background

1. How long have you been teaching?
2. How long have you teaching the gifted/accelerate class?
3. How was it decided that you would take this class?
4. What professional development and support in gifted and talented education have/do you have?

Programme

5. What academic information was made available to you about the students(s)?
6. How much was this information used to inform your planning?
7. What other factors inform your planning? (school long term plans, gifted policies, individual profiles etc)
8. What resources are available to support your planning and teaching?

9. In what way do you modify (differentiate) the programme for this class?
10. Do you use competitions as part of the programme?
11. How do you monitor the student(s)' progress?

Future

12. What are your goals and aspirations for this student(s)?
13. What are the school's long term plans for the student(s)?
14. What career and course (NCEA) information do students receive and when is this addressed?

Appendix C: Parent Interviews

Phase One

1. Tell me about your child's early mathematical development as you recall it. Did you identify your child as gifted in maths? If so, what were the early indicators?
2. Tell me about your child's maths experiences in the school system.
3. What is your understanding of how your child was selected for the special class/programme?
4. What do you think the special class/programme has provide mathematically for your child?
5. What involvement have you had (if any) in your child's mathematics programme this year?
6. What factors did you/your child consider in choosing a school for next year?
7. What are your future hopes for your child, specifically next year and then beyond that?

Phase Two

1. How well do you think your child has made the move to their new school?
2. Have there been any issues (social/academic) that you have had to address since your child began at this school?
3. What do you know about the mathematics programme? How have you gained this information?
4. What do you know about the future plans for your child's maths?
5. What have been the significant changes that you've noticed in terms of the mathematics programme?
6. What role does homework play?
7. What opportunities are you aware of for your child to take part in maths competitions?

Appendix D: Transcriber Consent



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**DETERMINANTS OF THE DEVELOPMENT OF MATHEMATICAL
TALENT**

TRANSCRIBER’S CONFIDENTIALITY AGREEMENT

I (Full Name - printed)

agree to transcribe the tapes provided to me.

I agree to keep confidential all the information provided to me.

I will not make any copies of the transcripts or keep any record of them, other than those required for the project.

Signature: **Date:**

Appendix E: Student Questionnaire

Mathematics Interest and Attitudes

Name _____ Age _____ Year _____

Gender _____ Date _____

Please check the box that best describes your feelings about the statements below.

	Very True	True	Sometimes True	Untrue
1. Mathematics is my favourite subject at school.				
2. It is important to work hard to be successful in mathematics.				
3. I am very good in mathematics.				
4. I plan to study advanced mathematics in high school and college.				
5. Learning new ideas in mathematics is the most interesting part of class.				
6. Solving mathematics story problems is the most interesting part of class.				
7. I love to work on mathematics assignments.				
8. I try to learn more about mathematics outside of school time.				
9. Mathematics is easy for me.				
10. I try to do my best work in mathematics and on mathematics tasks.				
11. I work on mathematics problems and puzzlers outside of school.				
12. I enjoy finding out more about mathematics on my own.				
13. I would like to be some sort of mathematician someday.				
14. I wish I could have more than one mathematics lesson each day.				
15. I could learn anything about mathematics I wanted to if I worked hard enough.				
16. I wish most mathematics classes could be longer.				

Adapted from Karen B Rogers (2000)

Comments:

Appendix F: Parent Questionnaire

Parent Questionnaire				
Name _____ Gender _____ Date _____				
<i>Please check the box that best describes your feelings about the statements below.</i>				
	Strongly Agree	Agree	Disagree	Strongly Disagree
1. When my child says he/she is having trouble learning mathematics, I tell him/her not to worry about it because everybody has problems with mathematics.				
2. At home, I encourage my child to work hard on mathematics problems even though the problems are difficult.				
3. I am usually able to motivate my child to learn mathematics well.				
4. Mathematics plays an important role in my child's future.				
5. I don't know how to motivate my child to do a good job on his/her mathematics assignments.				
6. I try hard to have a nice learning environment at home for my child to do mathematics.				
7. I often take my child to the public library.				
8. I often buy mathematics related books for my child.				
9. At our house, we have a variety of games and puzzles that encourage the development of my child's mathematics skills.				
10. I check my child's homework regularly.				
11. I seldom spend time talking with my child about his/her progress in mathematics.				

	Strongly Agree	Agree	Disagree	Strongly Disagree
12. At home, it is important for my child to keep a balance between mathematics and his/her other subjects.				
13. I always try to monitor the amount of time my child spends on mathematics at home.				
14. I am always aware of my child's mathematics requirements by checking homework notebooks or through contacting the school.				
15. I feel I can help my child solve problems from mathematics class.				
16. I think I know enough mathematics to help my child.				
17. I often discuss with my child how mathematics is used in our everyday life.				
18. I make an effort to understand the mathematics my child is studying.				
19. I don't know strategies for helping my child overcome weaknesses in mathematics.				
20. I am aware of the approaches used to teach mathematics at my child's school.				
21. I always try to figure out good approaches for helping my child learn different mathematics topics.				
22. I understand my child's strengths and weaknesses in learning mathematics.				
23. I try to match my expectations with my child's potential.				

Adapted from Cai et al. (1999)

Comments:

Appendix G: Information Sheet and Consent Form



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Determinants of the Development of Mathematical Talent

Information Sheet – Principal/Board of Trustees and Teacher

My name is Brenda Bicknell and I work at Massey University's College of Education as a senior lecturer in the Department of Technology, Science, and Mathematics Education. As part of my doctoral research, I want to examine the factors that influence gifted and talented students' interest and achievements in mathematics.

For this study, I would like to access school documents about gifted education and students' assessments. In order to obtain more detailed information I would also like to interview students, the class teacher, and specialist teacher. I would also like to talk to parents about their attitudes and experiences related to their child's mathematics. The interviews will be arranged at a time suitable for the participants and for the students at a time approved by their teachers. It is expected that the interviews will take no longer than half an hour and will be taped for subsequent analysis. I would also like to observe students during Term 4 in the mathematics classroom or in any specialized gifted education programme. The parents will be asked to complete a Parent Questionnaire and students to complete an Interest Inventory. These questionnaires are attached for your information.

The teacher, students, or parents will have the right at any stage to terminate their involvement in the project.

I will be seeking the written consent of the students as well as their parents/caregivers to be involved in this pilot study. The following points will be adhered to:

- Any student can withdraw from being involved at any stage, without having to give the teacher or me any reasons.
- There will be no reports written in which any student, teacher, parent or the school could be identified.
- My supervisors or I can be contacted at any stage (details are below) with any questions about the study.

This project has been reviewed, judged to be low risk, and approved by the researcher and supervisor under delegated responsibility from the Massey University Human Ethics Committee. If you have any concerns about the conduct of this research, please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, email humanethicspn@massey.ac.nz.

If you would like further information about the study, you can contact me or one of my supervisors:

Brenda Bicknell, Department of Technology, Science and Mathematics Education, ph. 350 5799 ext 8862, e-mail b.a.bicknell@massey.ac.nz

Dr Tracy Riley, Senior Lecturer, Department of Learning, College of Education.

Phone: 350 5799 ext 8625, e-mail: T.L.Riley@massey.ac.nz

Dr Jenny Poskitt, Institute for Professional Development and Educational Research (IPDER) Phone 350 9293 ext 8293, e-mail: J.M.Poskitt@massey.ac.nz

Determinants of the Development of Mathematical Talent

Information Sheet – Principal/Board of Trustees and Teacher

My name is Brenda Bicknell and I work at Massey University's College of Education as a senior lecturer in the School of Curriculum and Pedagogy. As part of my doctoral research, I am examining the factors that influence gifted and talented students' interest and achievements in mathematics.

In 2005, I worked with groups of students from Years 6 and 8 who had been identified by their teachers as mathematically gifted. These students now attend intermediate or secondary school. I have interviewed the students and their parents and observed the students during mathematics lessons. In order to obtain more information I would like to observe the students in their mathematics classes this year (preferably in Term 2) and re-interview them. I would also like to talk with their mathematics teacher and have access to any school policies relevant to gifted and talented education. The interviews with the students will be arranged at a time approved by their teachers and teacher interviews at a convenient time for the teacher. It is expected that the interviews will take no longer than half an hour and will be taped for subsequent analysis. The teacher and students will have the right at any stage to terminate their involvement in the project.

I will be seeking consent from the school and written consent of the teacher. I would also appreciate access to any school policy documents related gifted and talented education. The students and parents have already given permission for their continued involvement in the study. The following points will be adhered to:

- Any student or teacher can withdraw from being involved at any stage, without having to give the teacher or me any reasons.

- There will be no reports written in which any student, teacher, parent or the school could be identified.
- My supervisors or I can be contacted at any stage (details are below) with any questions about the study.

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher named above is responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, email humanethicspn@massey.ac.nz.

If you would like further information about the study, you can contact me or one of my supervisors:

Brenda Bicknell, School of Curriculum and Pedagogy, Massey University College of Education, ph. 350 5799 ext 8862, e-mail b.a.bicknell@massey.ac.nz

Dr Tracy Riley, Senior Lecturer, School of Curriculum and Pedagogy, Massey University College of Education, Phone: 350 5799 ext 8625, e-mail: T.L.Riley@massey.ac.nz

Dr Jenny Poskitt, Institute for Professional Development and Educational Research (IPDER) Phone 350 9293 ext 8293, e-mail: J.M.Poskitt@massey.ac.nz

Determinants of the Development of Mathematical Talent

Consent Form - Teacher

I have discussed the research project with Brenda Bicknell and I fully understand the purpose and extent of the project and accept the intended level of my involvement.

This entails:

- Allowing Brenda to observe during mathematics lessons for the term.
- Providing a copy of planning associated with the gifted education programme and the mathematics programme and assessments for the students in the study.
- Being interviewed (and audio taped) in relation to the programme for the students involved in this study.

I give my approval to be involved in the research project on the conditions outlined below:

- The Principal/Board of Trustees has given written consent for the project to be carried out.
- I may ask Brenda or her supervisors any questions about the study.
- I may ask at any time for the tape recorder to be turned off.
- The tape recordings will be treated confidentially and stored securely.
- There will be no reports written in which the school, students or I could be identified.
- I can withdraw from being involved at any stage, without having to give any reasons.

Name:.....

Signed:.....

Date:

Appendix H: Information Sheet and Consent Form



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Determinants of the Development of Mathematical Talent

Information Sheet – Students

My name is Brenda Bicknell and I work at Massey University's College of Education as a senior lecturer in the Department of Technology, Science, and Mathematics Education. As part of my doctoral research I am looking at factors that influence gifted and talented children's interest and achievements in mathematics.

If you are interested in being involved in this study I would like you to complete a questionnaire about your interests in mathematics and I would like to spend some time during Term 4 in your mathematics class. I would also like to be able to talk to you about your experiences in mathematics and to tape record our conversation. This interview should take about 20 minutes. I would also like to be able to spend time next year (if your new school approves) in your mathematics class and to interview you once again.

To do this I require you and your parents' signed approval. If you agree to be involved, the following procedures will be followed:

- You can withdraw from being involved at any stage, without having to give your teacher or me any reasons.
- You can ask at any stage for the tape recorder to be turned off.
- The tape recordings will be treated confidentially and stored securely.
- There will be no reports written in which you would be able to be identified.
- You can ask my supervisors or me (details are below) any questions about the study.

To give your consent to be involved, the attached consent form must be signed by you and your parent/caregiver and returned to your teacher.

This project has been reviewed, judged to be low risk, and approved by the researcher and supervisor under delegated responsibility from the Massey University Human Ethics Committee. If you have any concerns about the conduct of this research, please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, email humanethicspn@massey.ac.nz.

If you would like further information about the study, you can contact me or one of my supervisors:

Brenda Bicknell, Department of Technology, Science and Mathematics Education, ph. 350 5799 ext 8862, e-mail b.a.bicknell@massey.ac.nz

Dr Tracy Riley, Senior Lecturer, Department of Learning, College of Education.

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Dr Jenny Poskitt, Institute for Professional Development and Educational Research (IPDER) Phone 350 9293 ext 8293, e-mail: J.M.Poskitt@massey.ac.nz

Determinants of the Development of Mathematical Talent

Consent Form - Student

I, have read and understand the Information Sheet about the research project to be carried out by Brenda Bicknell. I give my approval to be involved in the study, on the conditions outlined below:

- I can withdraw from being involved at any stage, without having to give any reasons.
- I can ask to have the tape recorder turned off at any time.
- I can ask Brenda Bicknell or her supervisors any questions about the study.
- The tape recordings will be treated confidentially and stored securely.
- In any reports written about the pilot study it will not be possible to identify me.

Student Name:.....

Signed Date:

Parent(s)/Caregiver(s)

I/We, have read and understand the Information Sheet about the research project to be carried out by Brenda Bicknell. I/We give approval for to be involved in the research study based on the conditions outlined above.

I/We agree to be involved in the study as outlined in the Information Sheet and based on the conditions outlined above.

Parent/caregiver name(s):..... Phone:

Signature(s): Date:

..... Date:

Appendix I: Information Sheet and Consent Form



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Determinants of the Development of Mathematical Talent

Information Sheet – Parents/Caregivers

My name is Brenda Bicknell and I work at Massey University's College of Education as a senior lecturer in the Department of Technology, Science, and Mathematics Education. As part of my doctoral research, I am examining factors that influence gifted and talented students' interest and achievements in mathematics.

For this study, I would like your child to complete a questionnaire about his/her interest in mathematics. I would like to observe in your child's mathematics lessons during Term 4 and also in Term 1 next year. I would also like to conduct two interviews with your child, one this year and one next year to find out about your child's interest and experiences in mathematics.

As the child's parent/caregiver I would appreciate it if you would complete a questionnaire and would also like to be able to interview you about your child's experiences in mathematics. The questionnaire should take about 10 minutes to complete and the interview would be for approximately 30 minutes. I would appreciate it if the interview could be taped; this recording will be treated confidentially.

I would like to ask for your agreement to participate and also for approval for your child to be involved in this study. If you agree to this involvement, the following procedures will be followed:

- You may withdraw at any stage, without having to give reason.
- You may ask for the tape recorder to be turned off at any stage.

- Your child can withdraw from being involved at any stage without having to give the teacher or me any reasons.
- Your child can ask at any stage for the tape recorder to be turned off.
- The tape recordings will be treated confidentially and stored securely.
- You or your child can ask my supervisors or me (details are below) any questions about the study.
- There will be no reports written in which you or your child could be identified.

To give your consent to be involved in the study and for your child to be involved, the attached consent form must be signed and returned to your child's teacher.

This project has been reviewed, judged to be low risk, and approved by the researcher and supervisor under delegated responsibility from the Massey University Human Ethics Committee. If you have any concerns about the conduct of this research, please contact Professor Sylvia Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), telephone 06 350 5249, email humanethicspn@massey.ac.nz.

If you would like further information about the study, you can contact me or one of my supervisors:

Brenda Bicknell, Department of Technology, Science and Mathematics Education, ph. 350 5799 ext 8862, email: b.a.bicknell@massey.ac.nz

Dr Tracy Riley, Senior Lecturer, Department of Learning, College of Education.

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Determinants of the Development of Mathematical Talent

Consent Form - Parent

I give my approval to be involved in the research project on the conditions outlined below:

- The Principal/Board of Trustees has given written consent for the project to be carried out.
- I may ask Brenda or her supervisors any questions about the study.
- I may ask at any time for the tape recorder to be turned off.
- The tape recordings will be treated confidentially and stored securely.
- There will be no reports written in which the school, students or I could be identified.
- I can withdraw from being involved at any stage, without having to give any reasons.

Name:.....

Signed:..... Date: