Engagement or alienation: The transition to secondary school mathematics

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"Just as eating against one's will is injurious to health, so study without a liking for it spoils the memory, and it retains nothing it takes in"

Leonardo da Vinci, c1500

"The important thing is not so much that every child should be taught, as that every child should be given the wish to learn"

John Lubbock, 1897

"What avail is it to win prescribed amounts of information . . . to win the ability to read and write, if in the process the individual loses his own soul: loses his appreciation of the values to which these things are relative; if he loses the desire to apply what he has learned, and, above all, loses the ability to extract meaning from his future experiences as they occur?"

John Dewey, 1938

Table of Contents

Chapter 6: Cross-sectional comparisons

Chapter 7: Longitudinal comparisons

Chapter 8: Trajectories of perceived control

List of Tables

List of Figures

Abstract

Transition to secondary school is one of the critical periods in a student's life, occurring as it does at the junction of childhood and adolescence. A number of government reports have called for a greater emphasis on these middle years of schooling, proposing that attention to these periods in a student's life may prevent some of the alienation with learning that is often seen in the later years of secondary school. In mathematics, transition entails the change to a more formal and abstract curriculum, and it seems that student disaffection occurs more frequently in mathematics than in other subjects. Very few longitudinal studies have examined transition to secondary school in mathematics; none in the last few years when there have been enormous changes to the school system.

The lens that was chosen through which to view transition was that of perceived control. The perceived control model examines the amount of control students believe they have over the learning process, and in this study the effect of a number of other variables such as beliefs about self, coping strategies and self-regulation were also examined. The outcome measured was engagement in learning; cognitive, emotional and behavioural. Prior research indicated that engagement in learning promotes metacognition and self-esteem, and can help make mathematics meaningful and enjoyable for all students, not just those who achieve at the highest levels.

The study followed several cohorts of students from late grade 6 to the middle of year 7, using a survey methodology. At each stage of the study students completed a survey measuring aspects of perceived control, beliefs about mathematics, coping, self-regulation and perceptions of the classroom environment. Students were also asked to comment on aspects of primary school and the transition to secondary school, and asked to reflect on their own ability in mathematics and others' perceptions of that ability.

Traditional forms of analysis of longitudinal data revealed few changes to beliefs either during the grade 6 year or over the transition to secondary school. However did this reflect a situation of no change, or were there changes masked by the method of data analysis? In order to address this question, cluster analysis was employed to investigate trajectories of change in the perceived control construct over transition. This analysis was successful, finding four distinct patterns of transition.

A highly successful group of students took transition in its stride, while a poorly engaged and unmotivated group continued to struggle. A third group, whose members were unsure and not highly engaged in primary school, seemed to find their feet in secondary school and show higher levels of engagement. The fourth and largest group of students would not have been identified by their primary teachers as potentially having problems at secondary school, and yet they suffer a decline in perceived control in combination with a decline in engagement, coping skills, self-regulation and perception of self. These children are particularly at risk of disaffection in mathematics, and a number of recommendations are made to help identify these students and to address some of their common problems.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other institution. To the best of my knowledge this thesis contains no material previously published or written by another person, except where due reference is made.

Sue Fullarton

Approved by the Monash University Standing Committee on Ethics in Research on Humans: Approval number E3.13/95

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Chapter 1

Introduction to the study

1.1 Transitions

The move from primary to secondary school is one of many transitions that people will make in their lives. As we move through childhood, we also move from pre-primary to primary school and later in various combinations from secondary school to tertiary education and to the labour force. Many of us change jobs or careers more than once in our lifetime, and hence the concept of transition is not alien to any of us.

Connell and Furman (1984) explained that "human lives appear to be characterised by periods of relative stability and periods of marked change or transition. These transitions are thought to be the times when major reorganisation or discontinuities may occur" (p. 153). Clarke (1985, 1989) also discussed discontinuities, and proposed "a general theory of transition … [which] must confront those phenomena most frequently associated with the transition experience" (p. 390). The key phenomena that Clarke argued contribute to this model of transition are *discontinuity, adjustment, challenge and regression*. The first two of these can be explained as:

> … discontinuity is an inevitable (and defining) characteristic of transition and … personal discontinuity is experienced … as a challenge to established roles and behaviours. The consequent (and essential) process of adjustment may be realised through either acquiescence by the individual to the expectations and judgements of others, or through a process of self-realization in which individuals accept responsibility for their own learning behaviour and assert that responsibility through conscious choice. (Clarke, 1989, p. 391).

Acquiescence, Clarke argued, leads to regression, while self-realisation leads to personal growth. It is the aim of this study to identify beliefs held by students that either encourage self-realisation and hence facilitate engagement over transition, or that lead to acquiescence and hinder engagement and adjustment over transition.

1.2 Calls for research on the middle years of schooling

Transition is seen as a key stage in development by diverse bodies. Most recently the *Suicide Prevention Task Force*, established in January 1997 by the Victorian Government to investigate the high rate of youth suicide, reported on several themes relevant to this study. The first of these themes was the development of improved self-esteem among young people; the second was support for individuals during key periods, including the transition from primary to secondary school.

The report on the middle years of schooling conducted by the Schools Council of the Australian National Board of Employment, Education and Training (1993) argued that the middle years of schooling have received insufficient attention. They stated that:

> the primary - secondary paradigm, so clearly reflected in terms of the universal organisation of facilities, administration, curriculum, teacher training, teacher registration and professional development, has become so entrenched that this arbitrary division rarely tends to be questioned. (p. 3)

Implicit in this is the premise that the middle years of schooling need to be treated more as a whole, with perhaps the merging of the two school systems, or at least more of a blurring of the boundaries between them.

The Schools Council further expressed the view that the middle years of schooling are highly significant because of their intrinsic value in the development of adolescents. This intrinsic value is reflected in areas such as self-esteem and valuing of learning, and in beliefs about learning that will impact on students' educational outcomes.

Following the review by the Schools Council, the Australian Department of Employment, Education and Training (DEET), funded a Project of National Significance, the *Student Alienation during the Middle Years of Schooling Project* (Australian Curriculum Studies Association, 1996). It was noted that the focus of a considerable amount of recent research had been on the problems of older adolescents and students in post-compulsory education. The intention of the *Student Alienation Project* was to focus on the "hidden alienation of years 5 - 8" (Australian Curriculum Studies Association, 1996, p. 1) in order to attempt to *prevent* some of the problems seen in the later years of schooling.

This 'hidden alienation' encompassed students "whose behaviour was rarely problematic, but who appeared to be 'switched off', 'tuned out' or simply not achieving" (Australian Curriculum Studies Association, 1996, p. 1). Students' problems with engagement in learning could remain undetected by teachers, as some students might conceal their lack of engagement and be reluctant to seek help. Other students who appear bored or rebellious may feel this way because they lack an understanding of how to learn effectively. The report pointed out that even alienated students still want to succeed in areas of the curriculum that they value, but they may need these areas dealt with in a different manner.

The Victorian Board of Studies, also concerned about transition problems, recently formed a working party to address issues of discontinuity of curriculum. It was argued that transition should be seen as part of the curriculum, presumably for both primary and secondary schools. Recent reports from the Education Committee of the Victorian Government, as yet unpublished, have pointed to the possible need for a complete restructuring of the school system so as to focus more attention and financial support to the middle years (Curtis, 1997).

1.3 Changes in mathematics

In mathematics in particular, where transition entails the change to a more formal and abstract curriculum, problems students have with beliefs about learning can critically affect their self-confidence. It has been shown that a lack of self-confidence affects achievement and, one could argue more importantly, learning (for example Eccles (Parsons), 1983; Gottfried, 1985; Wigfield, Eccles, MacIver, Reuman, and Midgley, 1991).

Mathematics has been referred to as a critical filter for employment and tertiary courses (Boomer, 1987; Sells, 1992), with Sells elaborating that

> Ours is an increasingly technological society in which those who have no training in basic computation and the use of numbers and symbols will become the virtual "illiterates". (p. 79)

High youth unemployment rates combined with more competitive entry to tertiary study add more pressure for students to do well in mathematics or opt out. Comments from students in Grade 6 indicate that they are aware that entry to Year 7 "puts them on the treadmill" towards the VCE, and so the pressure to achieve is felt all the way down the school.

1.4 The present study

This study focussed on the transition of students from primary to secondary school, at the significant stage of development we label puberty. It is at this point in young people's lives that two major transitions occur simultaneously; transition to a new learning environment and transition to young adulthood. Some argue that it is precisely this combination that causes many of the problems that are seen with transition, as students try to cope with two such major changes at the same time. Others argue that the timing of the transition is not the key, the environment at either end of the transition is more important.

In Victoria, Australia, students start school at the age of approximately five years. They generally attend primary school for seven years then transfer to secondary school for a further six years, culminating in the Victorian Certificate of Education (VCE). In the government school setting, primary and secondary schools are usually physically completely separate, and primary schools are generally much smaller than secondary schools. Obvious changes over transition then are the physical and social changes involved with moving to a new, large and often complex setting, and re-establishing oneself within a peer group composed of students from many different feeder schools.

Transition programs in secondary schools initially involve visits by the secondary transition co-ordinator to the primary school and visits to the secondary school by the primary students. After the transition, orientation camps help to socialise children with their new peer group, and most schools employ a home group program, where one teacher works closely with a small group of children within a pastoral care paradigm. While all of these programs are worthwhile for the emotional and social well being of the students, far less emphasis is given to different ways of learning that will become necessary in secondary school. While transition is seen by all involved in the process as more significant than simply a change of schools, it should also be seen as more than forming a new social group.

The focus of this study is on perceived control and engagement with learning, rather than with the more traditional achievement. It will be argued that engagement is a more fundamental construct than achievement, since learning should be the primary goal of educators. The participants in this longitudinal study were a group of several hundred students from diverse backgrounds who were surveyed over the period from early Grade 6 through to the second term of their Year 7 year in secondary school.

The perceived control model was chosen for this study because it presents a rather different view of students' beliefs about mathematics. This model focuses on three aspects of beliefs about learning; control, strategy and capacity beliefs. Briefly, control beliefs describe how much control students feel they have over learning outcomes, strategy beliefs describe students' beliefs about whether particular strategies are effective in producing outcomes, while capacity beliefs describe students' beliefs about whether they are personally able to enact the particular strategy.

Perceived control has been described as "a flexible set of interrelated beliefs that are organized about interpretations of prior interactions in specific domains" (Skinner, 1995, p. 4). It is important to think of the perceived control system of beliefs as flexible, so that interventions can be effective. Skinner and her colleagues (see for example Connell, Halpern-Felsher, Clifford, Crichlow, and Usinger, 1995; Connell and Wellborn, 1991; Skinner, 1990b; Skinner and Belmont, 1993; Skinner, Wellborn, and Connell, 1990) have stressed the importance of this cyclical model, and many of their studies have examined reciprocal relationships between perceived control and the other related constructs within the broad educational context. The present study makes the "specific domain" of the educational context even more specific by narrowing the focus to the particular context of mathematics.

1.5 Outline of this thesis

Chapter 2 of this thesis examines the issue of transition to secondary school, with the focus on mathematics. There have been very few quantitative longitudinal studies examining children's beliefs about mathematics, and this part of the literature review examines these longitudinal studies as well as other relevant cross-sectional studies. Chapter 3 examines the psychological model that underpins this study. The particular framework using a model of perceived control has not been used within a specific subject context such as mathematics, nor in a longitudinal design over two separate grades that span the transition to secondary school. It was believed that by using this model, particular beliefs could be isolated that would contribute to our understanding of engagement and disaffection in the learning of mathematics.

Chapters 4 and 5 detail the methodology used in this study and the validity of the instruments used. The study was a longitudinal panel design, and students were surveyed either two or three times. The main instruments were found to be valid and reliable, however the classroom environment scale was found to have some problems with factor structure. The consequences of this are discussed.

Chapters 6, 7, 8 and 9 deal with the analysis of the data obtained from the surveys. Chapter 6 deals with the cross-sectional data analysis while chapter 7 presents and discusses a longitudinal analysis of the data. Traditionally, such data have been analysed using repeated measures analysis of variance, or path analysis. While repeated measures analysis of variance and other more traditional analyses were carried out and are reported in Chapters 6 and 7, further research questions examining the issue of differing trajectories of perceived control required the application of a more innovative approach. Cluster analysis was found to provide a more detailed picture of groups over the transition to secondary school. The rationale behind the use of cluster analysis and the results of this analysis are discussed in Chapter 8. Chapter 9 examines the validity of the cluster solution derived in Chapter 8. This validity is examined by looking at the means for other variables based on the previously defined cluster groups.

The data used in these chapters were able to be analysed in a number of different ways, because of different groupings that could be made. Longitudinally there were three groups:

- One for the students who completed all three surveys: two in Grade 6 and one in Year 7
- One containing students who had completed surveys at the start and at the end of Grade 6
- One containing students who completed surveys at the end of Grade 6 and the beginning of Year 7

Analysis of each of these groups provided a broad picture of perceived control, coping and autonomy beliefs over the transition to secondary school, as well as indications of children's beliefs about themselves and about mathematics.

The aim of this study is to look at ways of facilitating transition and encouraging systems of beliefs about learning that will contribute to higher retention rates in mathematics and greater student satisfaction and motivation. Broadly, the major focus of this research study will be on the following question:

> *Are there identifiable groups of students whose beliefs about learning mathematics could be recognised as indications of potential problems with motivation in secondary school?*

In order to address this question, several subsidiary questions will provide specific points of focus for the research:

- *Can the perceived control model be used to identify these groups?*
- *What are the profiles of students at risk of alienation in secondary school mathematics?*
- *What are the profiles of students who maintain high engagement with learning mathematics?*

Other research questions will be dealt with as they arise.

1.6 Summary

This chapter described the perceived problems with transition to secondary school. Many national and state bodies have called for further research to be devoted to the middle years of schooling, to try and prevent some of the problems seen with alienated students in the post-compulsory years. In mathematics in particular, with a change in emphasis from the concrete to the abstract, further research is essential to try and understand the complexity of cognition, beliefs and attitudes that children take with them from primary to secondary school. Theoretically underpinning this particular study is the perceived control model, which examines students' beliefs about learning. By understanding these beliefs, it is hoped that identification of groups of students with maladaptive beliefs about learning mathematics may be facilitated.

Chapter 2

Jumping the first hurdle: Transition to secondary school mathematics

2.1 Introduction

The prime concern of this research was to investigate whether identifiable changes were apparent in students' engagement and beliefs about learning mathematics over the transition from primary to secondary school. The debate about transition, whether it is a problem and what can be done to alleviate students' difficulties, is one that has simmered for many years. Mathematics is seen as a particular area of concern during transition, as there are perceived discontinuities between primary and secondary school mathematics content and teaching method. Despite this, few studies have examined the motivational orientations and beliefs of students on both sides of this major transition point. This chapter examines the literature pertaining to issues about transition to secondary school in general, and about mathematics in particular.

2.2 Alienation or engagement

Schooling in Australian schools is divided into three stages, corresponding approximately to the education of the child, the education of the adolescent and the education of the adult. While primary education, the education of the child, is perceived as being child-focussed, secondary education is seen as being subject-oriented and driven more by pressures from employers and tertiary institutions. Transition from primary to secondary school is now an experience shared by all members of our society, yet it is an area that is largely neglected in terms of research and school funding in comparison to early childhood and post-compulsory schooling. Table 2.1 provides an overview of the literature examining transition within the specific context of mathematics.

Table 2.1
Studies Examining Transition From Primary to Secondary School in Mathematics

Author/s	**Sample**	**Focus and Method or Instruments**	**Findings**
Gottfried (1985)	3 cross-sectional studies. Study 1: 141 students in Grade 4 at an elementary school and Grade 7 at a junior high school. Study 2: 260 students in Grades 4 to 7 at an integrated public school. Study 3: 166 students in Grades 5 to 8 at a private school.	**Academic intrinsic motivation**. The *Children's Academic Intrinsic Motivation Inventory (CAIMI)* was used to measure motivation in reading, maths, social studies and science. Achievement measured with standardised achievement tests used in the schools. Anxiety was measured with *Children's Academic Anxiety Inventory,* and students were asked about their perceived competence.	Positive relationship found between academic intrinsic motivation and perception of academic competence. These were distinguished by subject area, showing the importance of measuring academic intrinsic motivation separately in subject areas. The maths subscale of the CAIMI was found to be a unique predictor of maths achievement and motivation a significant predictor of achievement.
Ellerton and Clements (1988)	90 students in a longitudinal study. Data collected during Grade 6 and Year 7 (Australia).	**Attitudes, confidence** Pen-and-paper maths problems, attitudinal instruments, including a confidence scale, and interviews.	Two case studies presented in this article illustrated how students rated as similar in ability can have very different reactions to transition.
Clarke (1985, 1989)	Ten students studied through Grades 6, 7 and 8 (Australia).	**Mathematical behaviour**. Clinical interviews and classroom observations used, three achievement tests and questionnaires examining teacher, student and parents' attitudes and beliefs.	The impact of school on a student's mathematical behaviour may be determined during the first year of secondary school.

Table 2.1 (continued)

The next group of studies describes a variety of results from a sample of 2,500 students and their teachers who participated in a two year, four-wave longitudinal panel study. Data for this study, the *Transitions at Early Adolescence Project*, later renamed the *Michigan Adolescence Study*, was collected twice during Grade 6 and twice during Grade 7.

Author/s	Focus and Method or Instruments	Findings
Midgley and Feldlaufer (1987)	**Perceptions of opportunities for student decision-making**. Student and teacher actual and preferred decision-making questionnaire	At both pre- and post-transition levels students would like more decision-making power than they feel is available to them. The group of students who expressed an increasing discrepancy between the amount of decision making that they had (not enough) and the amount they wanted to have (more) were those who showed the most negative changes in the value they attached to maths.
Feldlaufer, Midgley and Eccles (1988)	**Classroom environment**. Student, teacher and observer classroom environment measures.	Students in secondary school given fewer opportunities for autonomous learning. Use of social comparison and ability self-assessment increases. Secondary teachers characterised as less caring, warm and supportive than primary teachers.
Reuman (1989)	**Ability grouping**. Maths grades and results from the Michigan Educational Assessment Program (MEAP, a statewide testing program) measured achievement. Student survey examined self-concept of maths ability, expectancies for success and perception of difficulty of maths.	An abrupt drop in achievement expectancy was found with students who moved from a heterogeneous Grade 6 class to a homogeneous high-ability Grade 7 classroom. A sharp increase was found in achievement expectancy for students moving from a heterogeneous Grade 6 classroom to a homogeneous low ability Grade 7 classroom.
Midgley, Feldlaufer and Eccles (1989a)	**Teacher efficacy, student beliefs about success and maths difficulty.** Scales were used to measure students' expectancies for success in maths, perceptions of their performance and perceptions of the difficulty of maths. Student achievement in maths measured with MEAP.	Students with more efficacious teachers were found to have higher expectancy for success and higher perception of their performance in maths, also rated maths as less difficult. Higher achieving students seemed more impervious to teacher efficacy, but low achieving students were particularly vulnerable.
Midgley, Feldlaufer and Eccles (1989b)	**Student-teacher relationships, value of maths.** Scales measured student perceptions of the quality of the student-teacher relationship, teacher support, and student achievement in maths measured with MEAP.	Decline was found in valuing of mathematics, however if students moved to a teacher perceived to be more supportive, valuing of mathematics increased. This study showed that students are vulnerable to positive and negative influences.

Table 2.1 (continued)

Author/s	Focus and Method or Instruments	Findings
Wigfield, Eccles, MacIver, Reuman and Midgley (1991)	**Self-concepts of ability** Harter's General Self-Worth Scale, items assessing beliefs, attitudes and values about mathematics, English, sport and social activities. Mathematics ability rated by Grade 6 teachers.	Self-concept of ability in mathematics became more negative immediately after transition and continued to decline, especially for high and average-rated students. Girls and boys expressed equal liking for mathematics.

What is evident from this summary is that surprisingly little research has been conducted in the particular area of transition changes in mathematics. Two major studies in Australia, Clarke (1985; 1989) and Ellerton and Clements (1988) have found that reactions to transition vary, however the methodology of these two studies is different to that employed in the study reported in this thesis. The United States studies reported under the umbrella of the *Transitions at Early Adolescence Project* generally concluded that there were changes in perceptions about a variety of issues particular to mathematics and learning mathematics during the transition to secondary school.

Despite great changes to the mathematics curriculum over the last ten years, the area of transition has been largely neglected over this period. In Australia in particular there have been calls from national bodies and government committees for a renewed examination of this area of schooling, however this has not elicited a great response among researchers.

2.3 Individual responses to transition

Many students have described moving from primary to secondary school in negative terms such as "*Being the bottom of the ladder again*", and "*Being the babies of the school again*". Students move from an environment where they had status as senior members of the student community and they knew the environment and school routines well, to an environment where they have the least status and everything is new and different. Other students see the move to secondary school as a part of the maturation process, and are excited by the broad range of new opportunities for learning. That there are varying responses to transition was aptly summarised by Nisbet and Entwistle;

> One headteacher suggested that 'the sharp division between primary and secondary education which exists at present imposes a severe strain on some pupils – probably more than we realize – and provides for not a few a traumatic experience from which they hardly recover'. Another headteacher saw transfer as a stimulus: 'I found that, while the sudden switch upset one or two, the vast majority of youngsters, irrespective of ability, liked it. It was a stimulant. Youngsters who came up with rather unflattering reports about their attitude to work (not their ability) became revitalised'. (Nisbet and Entwistle, 1969, p. 29)

The authors concluded that students most likely to suffer from the primary – secondary transition were "those from poorer homes, where parents have had limited education and fail to give the support and understanding needed for adjustment to secondary school work" (p. 95). While Nisbet and Entwistle used achievement as their main outcome measure, they acknowledged that this provided only a somewhat superficial examination of the issues involved.

> Our data does not take us much beyond mere speculation on the issues involved. They do indicate points which should be examined in any evaluation of middle schools: for example, do problems of adjustment to transfer affect certain categories of students more than others? (Nisbet and Entwistle, 1969, p. 99)

To move beyond mere speculation researchers need to examine other facets of transition than achievement. As transition usually coincides approximately with puberty, a number of studies have examined psychological aspects of children's behaviour before and after transition to secondary school.

2.4 Transition and adolescence

Large scale studies carried out by Simmons and Rosenberg (1975) and by Simmons, Blyth, Van Cleave and Bush (1979) compared the effects of different types of school organisations on children of comparable age. The purpose of these studies was to investigate the relative effects of age, maturation and transition into secondary school on students' declining self-evaluations. Their findings suggested that it was the transition to secondary school that was the primary cause of this decline, and they argued that this was because society forced children of this age to make two major transitions simultaneously. They argued that major transitions, such as the transition to puberty or the transition to secondary school, could precipitate a reappraisal of oneself, and when two such major transitions occur at a similar time the likelihood of such a reappraisal is much higher. Reappraisals may involve a decline in self-esteem and motivation as children attempt to find their niche within a new peer group and within a new school environment.

When the current primary – secondary system of education was devised, the transition to secondary school did not occur at the same time as the onset of puberty, but with this latter age declining, the two are usually coincident. The pressures on students because of this transition are therefore made more complex and difficult because of changes due to puberty.

2.5 Pressure from above

Power and Cotterell (1981) studied transition in Queensland schools (which occurs between Grade 7 and Grade 8), and discussed the perceived "transition problem" (p. 5). They found that transition was seen as a time with competing demands on the student; demands that were seen as largely driven by societal expectations. The societal expectations that were felt by teachers to drive the curriculum came from tertiary institutions, employers and parents' own aspirations for their children. Sixteen years later, the same societal pressures are perhaps magnified, as the unemployment rate for the eighteen to twenty-four year old age group remains at approximately 30%. The pressure on students to achieve at a high standard in Year 12 begins to be felt at the start of secondary school, in order that they can continue their education or find an adequate job. Power and Cotterell argued that it is these societal pressures that handicap secondary schools which attempt to cater more adequately for students for whom transition is a traumatic experience.

2.5 Transition and mathematics

In mathematics in particular, Power and Cotterell (1981) found that there were discontinuities in student attitude, with a moderate decline (decreases in *z* score between 0.4 and 0.8) over the transition period. Large gains in positive attitude and confidence in English suggested that in some areas transition could be seen as facilitating students' progress; however the authors warned that "there is evidence of unfulfilled promises and shattered expectations in several areas of the curriculum" (p. 24). That mathematics is seen as one of these areas is evident as students were likely to "experience unnecessary stress, confusion and boredom". Curriculum was also seen as exacerbating the problem, as "areas of overlap and mismatch creating particular difficulties at one or both levels seemed to exist in … the Grades 7-8 mathematics program" (p. 36). A decline in motivation and in self-esteem has also been found to be more characteristic of mathematics than English in other studies (Eccles (Parsons), Midgely, and Adler, 1984).

In 1982, the *Report of Inquiry into the Teaching of Mathematics in Schools* was published in Great Britain (Cockroft, 1982), and again transition to secondary school was flagged as an area of concern. The committee discussed transition primarily in terms of continuity between educational sectors, stating that "We believe the greatest problems exist on the transfer to secondary or upper school" (p. 125). Cockroft also briefly discussed attitudes to mathematics, pointing out that a student's attitude will most likely be fixed by the end of the primary school years and will thus have an effect on the way in which the student approaches mathematics in secondary school.

Clarke (1985) conducted an intensive study of ten students over the transition from primary to secondary school mathematics in Victoria, arguing that "if transition creates problems in a student's mathematics education it is equally true that mathematics contributes significantly to the difficulties of the student in transition" (p. 231). Some students, he found, successfully overcame academic and social challenges and found transition to secondary school mathematics to be a positive and rewarding experience. For others however it could be "destructive and personally-restricting" (Clarke, 1985, p. 255).

"Darren", a student in Clarke's study for whom transition caused a decline in self-concept and achievement in mathematics seemed to suffer from a decrease in engagement combined with increased attributions to ability. This student believed that he was not smart at mathematics, and according to motivational theory the combination of believing ability to be an important strategy but not believing oneself to be smart at mathematics is particularly debilitating for engagement in learning. Clarke described this student "at the end of his first year of secondary schooling, whose response to a non-routine mathematical task was conformist, defensive and pessimistic" (p. 247). It is difficult to see this student continuing to do mathematics past the compulsory level without intervention.

Ellerton and Clements (1988) studied over 500 students in the transition from primary to secondary school and argued that many children seemed to be very positive about the move to secondary school mathematics. Two case studies presented in their article portray students who appear to be coping well with the early stages of secondary school mathematics. These two students had performed at a similar level in mathematics in Grade 6, and had been taught by the same teachers at both Grade 6 and Year 7.

For one of these students the transition to secondary school presented an opportunity to 'start again', to have a new beginning in mathematics and an opportunity to prove that she was capable of doing well at mathematics. For the other student however, the transition became a lost opportunity, and Ellerton and Clements (1988) ask the readers to consider whether it is likely that the student's mathematical decline would be reversed. They felt that it was unlikely. Some students may even believe that they do cope with transition well, but those students who have faulty belief systems in mathematics may only start to encounter difficulties later in secondary school. This case study in particular underlines the necessity of intervention. It is difficult for teachers to decide just what problems each student has without some sort of examination of their belief systems.

In mathematics, affective and motivational issues are seen as fruitful areas for research. Asking students for an evaluation of their mathematical ability usually elicits emotive responses, as explained by McLeod:

> Affective issues play a central role in mathematics learning and instruction. When teachers talk about their mathematics classes, they seem just as likely to mention their students' enthusiasm or hostility towards mathematics as to report their cognitive achievements. Similarly, inquiries of students are just as likely to produce affective as cognitive responses; comments about liking (or hating) mathematics are as common as reports of instructional activities. (McLeod, 1990, p. 575)

de Abreu, Bishop and Pompeu (1997) argued however, that while learners do experience mathematics in both the cognitive and affective sense, the school environment generally encourages the cognitive aspect. It is further suggested that differences in mathematical cognition may be attributable to interactions between cognition, affect and beliefs; "beliefs and attitudes may constrain the adoption of particular forms of mathematics in specific contexts" (p. 237).

2.7 Transition and other variables

Gottfried (1985) used the *Children's Academic Intrinsic Motivation Inventory* (CAIMI) to examine the relationship between academic intrinsic motivation, achievement and anxiety in both primary (elementary) and secondary (junior high) students in specific subject domains, including mathematics. Perceived competence was also assessed in two of the studies, and indicated that there were strong correlations between students' perceived competence and their intrinsic motivation. A consistent trend was also found for the correlations between corresponding subject areas to be higher than the correlations between subject areas. An example of this was the correlation between perceived competence in mathematics and the mathematics subscale of the CAIMI, which was found to be higher than the correlation between the mathematics subscale and perceived competence in areas of reading, social studies or science. Similar patterns were seen for each of the subject areas, indicating the importance of measuring perceived competence separately for different subject areas.

Similar patterns were also seen between the CAIMI scales and anxiety, where children with high academic intrinsic motivation in a specific subject area generally exhibited low anxiety in that area. This study also found that intrinsic motivation was correlated to achievement as measured by both standardised achievement tests and teacher grades. In mathematics, it was found that intrinsic motivation was consistently a significant unique predictor of mathematics achievement. Gottfried hypothesised that this is because "children with higher intrinsic motivation in math may therefore be better able to master challenging and difficult math tasks and show higher academic achievement in this subject" (p. 643). It may be that for subjects such as mathematics, with a perceived high difficulty, it is important for students to have high intrinsic motivation in order for them to persist at challenging tasks.

Kowalski, Harter and Whitesell (1986) examined perceptions of self-worth, competence and motivational orientation in order to investigate differences between grade-change and school-switch. They argued that much of the available research does not differentiate between the advancement in grade and the change to the secondary school, and so their longitudinal study was designed to explore this issue. The lowest levels of perceived competence and intrinsic motivation were reported by the students who had moved from primary to secondary school. The authors also found that not all students' self-perceptions declined, and that there was a need for "further research identifying the characteristics of individuals and school environments related to positive school transitions" (Kowalski *et al.*, 1986, p. 10).

A major source of data examining transition from primary to secondary school has been published under the umbrella of the *Transitions at Early Adolescence Project*, later known as the *Michigan Adolescence Study*. This study was a two year longitudinal project examining the impact of change on adolescents' beliefs, motives, values and behaviours. Originally the study looked at the areas of English, mathematics, sport and social activities, however prior research by some of the authors (Eccles *et al.*, 1983), indicated that the greatest motivational declines were to be found in mathematics, and so later studies focussed on this subject.

In a report on a subset of data from the *Michigan Adolescence Study* examining students' relationships with their teachers and attitudes towards mathematics over the primary – secondary transition, Midgley, Feldlaufer and Eccles (1989b) also found that it was not inevitable for students' perceptions of mathematics to decline over transition. The study indicated that the quality of student – teacher relationships was more powerful in the first year of secondary school than in the last year of primary school, and therefore moving to a supportive learning environment facilitated transition in mathematics. The authors recommended that "less attention needs to be paid to the timing of transition … and more attention needs to be paid to the nature … of the environment" (p. 988).

In another report on data obtained from this study, Wigfield, Eccles, MacIver, Reuman and Midgley (1991) found that self-esteem declined after transition to secondary school, and that boys reported higher self-esteem than girls at all four stages of the study. The decline was only temporary however, and as students adjusted to the new school surroundings and gained in confidence, self-esteem increased.

It was also found in this study that mathematics and English self-concepts of ability declined over transition and continued to decline towards the end of the first year in secondary school, however other studies have shown that students' valuing of mathematics decreases after transition while their valuing of English in general increases (Eccles *et al.*, 1983). The authors have argued that these results demonstrate the importance of examining self-perceptions in specific subject domains. In the cross-sectional study conducted by Harter (1982), students' perceptions of their cognitive competence did not differ by age, however the studies reported by Wigfield *et al.* (1991) and Gottfried (1985) demonstrate that it is possible that while students' general sense of competence may remain stable their beliefs about specific subject areas may become more negative.

2.8 Changes in curriculum and teaching over transition

Movement to secondary school also generally involves the move from a largely integrated curriculum to an entirely departmentalised curriculum. For example, the primary school student is taught most subjects by a generalist classroom teacher, while after transition students are taught by an array of specialist teachers in separate curriculum areas.

Differences in the environments of the primary and secondary schools were the focus of a longitudinal study reported by Cotterell (1992). This study found that "changes in school size *may accentuate the degree of discontinuity* between different kinds of schooling" (author's italics, p. 42). The findings from this study indicated that smaller primary schools are more organised and cohesive, while secondary schools' focus is more academic and abstract. For students from smaller primary schools then, there is a heightened contrast between the two emphases, causing greater discontinuity. In the study reported in this thesis, schools were chosen to represent a range of both feeder and receiver school sizes, with the average primary school size being 413 students (range 230 – 710) and average secondary school size being 840 students (range 400 – 1200).

Other aspects of the changing classroom environment were discussed by Feldlaufer *et al.* (1988). This study showed that at the same time as children are entering puberty and showing a desire for more control over their lives, they are also entering into an environment in which they are provided with fewer decision-making opportunities. Students of this age also have a need for more positive relationships with adults other than their parents, and yet secondary teachers are typically characterised as less caring and supportive than primary teachers are.

In mathematics, transition involves the beginning of a move from computational to more abstract concepts, for example algebra and calculus. Carol Dweck described the differences between changes in the mathematics and language curricula:

> These new skills and concepts [in mathematics] are not only different from but are often more difficult than the child has mastered in the past. In the verbal areas, however, once the basic skills of reading and writing are mastered, one does not as typically encounter leaps to qualitatively different tasks, tasks requiring mastery of completely unfamiliar verbal skills. Increments in difficulty appear to be more gradual, and new units or courses often simply ask the student to bring existing skills to bear on new material. (Dweck, 1986, p. 1044)

While there is a large overlap with that taught in primary school, entirely new conceptual frameworks are developed in mathematics in the early years of secondary school. The introduction of an area that is qualitatively different can be illustrated by the introduction of the Algebra Strand in Level 5 of the Curriculum and Standards Framework (CSF, Board of Studies, 1995), which pertains to the start of grade seven in Victorian schools. In this strand, work involving number patterns and relationships in previous levels provides a basis for the introduction of pronumerals and algebraic notation to represent general rules and relationships, and yet there is a leap from one to the other. Students who could cope with computational mathematics tasks at Grade 6 may find that they have conceptual problems that are highlighted with the increasing complexity of the subject. Dweck argued that:

> It may be that only in subsequent school years will these maladaptive tendencies have their impact on achievement, when children with these patterns may elect to avoid challenging courses of study, drop out of courses that pose a threat of failure, or show impairment of performance under real difficulty. (Dweck, 1986, p. 1044)

Students who are engaged with learning may be able to make adjustments and thus cope with problems; those who are already disaffected will almost certainly give up at this point.

2.9 Systemic responses to transition

While the implementation of the CSF in Victoria formalised the view of the mathematics curriculum as a continuum through primary and into secondary school, there is still a perceived discontinuity between the two. In a recent attempt to address this, the Victorian Board of Studies formed a Year 5-8 working party to examine the overall process of transition in all key learning areas. Howard Kelly, Chairperson of the Victorian Board of Studies, expressed concerns that a gap had been created between primary and secondary school, and that a more holistic view of the curriculum needed to be developed. This would necessitate closer work between schools, and he argued further that "many schools have transition programs, but transition must be more than a program. It must be part of the curriculum" (Kelly, 1994).

At present however, transition programs typically consist of orientation days for primary students at the secondary school, year 7 camps and other measures designed to socialise students and familiarise them with the secondary school. Home groups, with a particular teacher responsible for the pastoral care needs of a specific group of children, are also common in secondary schools. However, changes such as lower self-esteem, lowered perceptions of ability, decreased motivation and confidence continue to be found in relation to transition to secondary school mathematics in particular. Why is it that this happens? What is it about mathematics that some children just founder for no apparent reason? Clarke recommended in 1989 that

> The same effort which secondary schools expend in developing familiarity as an aid to social adjustment must be exerted in presenting new mathematics content in ways familiar to the student, drawing on

> instructional techniques and cognitive strategies with which the student is already confident. (Clarke, 1989, p. 405)

Ten years later, it could be argued that this recommendation has been largely unheeded by the educational community.

In an increasingly technological society it is argued that mathematics is essential for understanding the world as it is the language of science (Nicholls, Cheung, Lauer, and Patashnick, 1989). We encourage as many students as possible to continue with mathematics past the compulsory years of schooling by tailoring courses of study to suit students of varying ability levels. Mathematics is the only subject in which this is done at the secondary school level, which highlights the value society places on mathematics education. However despite curriculum changes and transition programs, some students still have difficulty adjusting to secondary school mathematics, and some students still drop out of mathematics as soon as they are able to.

Since the studies by Power and Cotterell (1981), Clarke (1985) and Ellerton and Clements (1988) there have been many changes in curriculum and instruction in mathematics, particularly in Victorian schools. Mathematics curriculum has moved from largely school based to centrally prescribed and statewide testing in mathematics (Learning Assessment Project, or LAP) is carried out with grades three and five students and is soon to move into secondary schools. The LAP tests, however problematical, present parents and schools with a result in which each student is situated on a scale of achievement compared both to their peers and to the expected level as prescribed by the CSF (see Figure 2.1).

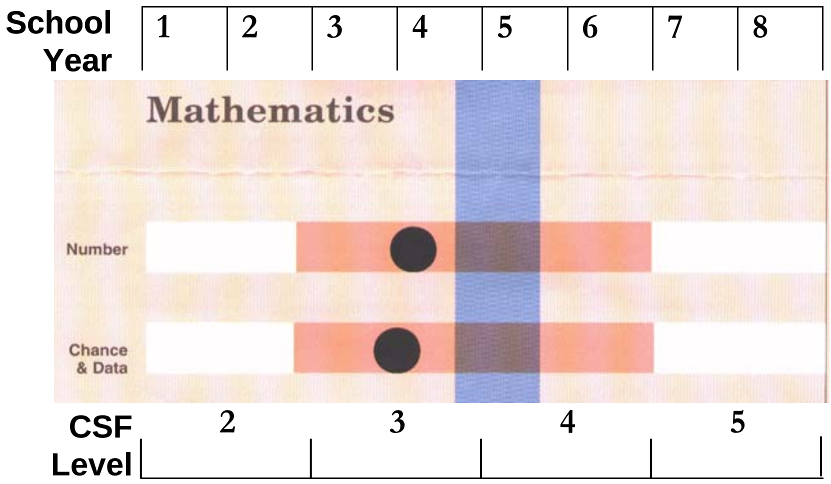

Figure 2.1 Learning Assessment Project Results for a Grade 5 student

In this chart, each orange horizontal bar represents the range of results in a particular strand of the curriculum achieved by Grade five students in Victoria, excluding the highest 10 percent and the lowest 10 percent of the results. The vertical blue band shows the expected level of achievement for a Grade 5 student early in the school year, which is linked to the scale of CSF levels at the bottom of the chart. The black circle shows a particular child's learning achievement in mathematics. The child interpreted this chart as having "failed" mathematics compared to her peers. Affective issues may be particularly important in mathematics when comparative testing is used.

Despite changes to the way mathematics is taught at both the primary and secondary level there are still perceived problems with transition. In the popular press, for example, such problems are frequently highlighted:

> Peter, now 14, enjoyed primary school because he knew the teacher and felt he belonged. At high school, he found the classwork hard and the environment bewildering. The only way to get a teacher's attention, it seemed, was to act up. (The Sunday Age, 5.2.95, p. 4)

Reports are also emerging (as yet unpublished) that recommend changing the structure of the Victorian school system. The draft report from the Education Committee to the Education Minister (reported in the Sunday Age, 24.8.97) argued that there was "compelling evidence to support the restructuring of schools", and recommended the introduction of a three-stage structure with junior (Prep to Grade 4), middle (Grades 5 – 8) and senior schools (Grades 9 -12) (Curtis, 1997).

These continuing government-funded investigations into the middle years of schooling indicate that there are many avenues open for investigation in this area. A re-examination of beliefs about mathematics over the transition to secondary school would seem to be timely.

2.10 A motivational approach to the study of transition

The approach taken in many studies is to use academic achievement as a measure of success, reflecting a general societal view of academic achievement as the primary indicator of success in school. There are other aspects to education however, and some educational researchers have argued that research can be used to help make education meaningful to all students, not just those who achieve at a high level. John Nicholls presented the argument that:

> The framework and dimensions researchers employ are likely to reflect concerns expressed in the society of the day. In one sense this is as it should be. Researchers should have something to say to citizens who are concerned about education. But if researchers merely reflect the popular preoccupations, they are unlikely to help citizens confront the contradictions in their aspirations for their children or in the ways the schools function. (Nicholls *et al.*, 1989, p. 64)

The research study presented in this thesis aims to confront some contradictions in that the major focus is on motivation and engagement with learning, not achievement scores. A goal for researchers should be to "ask whether there are situational and personal qualities that enable even those students who recognize that they are at the bottom of the heap in terms of ability to be favourably motivated and find learning meaningful" (Nicholls *et al.*, 1989, p. 68).

Although not considered as frequently nor probably as visible, students who are at the top of the heap may also suffer motivational problems, leading to underachievement. Dweck (1986) proposed that high achievers with maladaptive motivational patterns may still achieve at high levels in primary school when choice of subject is not possible and the work presented is not difficult enough to create debilitating failure situations. However in later secondary school, when work becomes more complex and failure is possible, motivational problems may

> have their impact on achievement, when children with these patterns may elect to avoid challenging courses of study, drop out of courses that pose a threat of failure, or show impairment of performance under real difficulty. (Dweck, 1986, p. 1044)

While underachievers do not present the most pressing problem for the classroom teacher, they are a group of students whose potential is largely wasted, and it should be recognised that problems do exist in this area. Research should aim to identify *all* students with dysfunctional motivational patterns.

2.11 Summary

This chapter examined the literature pertaining to the many issues involved in transition to secondary school, with a particular focus on mathematics.

In general, primary education is seen as being child-focussed and as a caring comfortable place. In contrast, secondary school is often characterised as being subject oriented and driven by external forces such as employers and tertiary institutions, while students try and cope with the twin pressures of parental expectations and a high youth unemployment rate. At a time when students are seeking more autonomy, it was found that they are given fewer opportunities for autonomous learning and decision making, and that this results in a lower valuing of mathematics. At a time when students have a need for closer relationships with role models such as teachers they are thrust into an environment where their teachers are seen as being more impersonal and less supportive than their primary counterparts.

Intrinsic motivation was examined in relation to anxiety and perceived competence and it was found that high intrinsic motivation was significantly correlated with low anxiety and was a significant predictor of achievement. However lowest levels of intrinsic motivation and perceived competence were found for students immediately after the transition to secondary school. Self-esteem was found to decline temporarily after transition, but self-concepts of ability in mathematics declined and continued to decline. Several studies have proposed that these negative trends may be a result of students making the double transition, the transition from primary to secondary school and the transition from childhood to adolescence, at the same time.

Other affective and motivational issues have been examined with regard to the primary – secondary transition. Some studies found that attitudes towards mathematics deteriorated, while attitude towards English improved after transition. The study conducted by Gottfried (1985) found that correlations between various measures were generally much higher within subject areas than those between subject areas, and this indicated the importance of measuring constructs separately in different subject areas. Similar findings were obtained for other constructs such as self-perceptions about mathematics and competence. These studies demonstrate the importance of examining perceptions in specific subject domains. Maladaptive beliefs may not have a short-term effect, but if in the long term they lead to problems with self-confidence and lower perceptions of efficacy they will affect course or subject selection or even continuance of mathematics. At the same time it may be difficult for classroom teachers to identify students with particular dysfunctional motivational patterns until these students are totally disaffected. Motivational problems often manifest themselves as behavioural problems in the classroom, and so relevant interventions may not be seen as appropriate without underlying knowledge about beliefs.

Nisbet and Entwistle (1969) foreshadowed the major focus of this thesis when they asked whether certain categories of students were more negatively affected by transition than others. Several other studies have also alluded to there being groups of students who react in different ways to transition. This thesis examines whether these groups are identifiable in the specific subject domain of mathematics, as mathematics has usually been shown to elicit an emotive response and there are perceived to be major curriculum changes in the early years of secondary school. There have been few Australian studies that have examined this period of transition in mathematics, and none in the past few years, during which time the Victorian state school system has undergone massive changes. New longitudinal research is needed to examine changes in beliefs students hold about mathematics over the transition to secondary school.

Perhaps too great an emphasis is placed on achievement in mathematics in the early stages of secondary school. Students may encounter competitive assessment for the first time in Year 7, and without a framework of beliefs that can sustain their self-concept, may make debilitating comparative judgements about their own ability. Researchers need to push the boundaries by using facets of education other than achievement as a measuring stick, and the framework used in this study is that of the psychological construct of perceived control. Motivation should be of primary importance to educators, since increased motivation can help all students. Students high in ability may suffer motivational problems that lead to underachievement, while low achievers should always be motivated enough to find something meaningful in learning.

The major focus of this study is on motivational aspects of learning and in particular the constructs of perceived control and engagement. One aim is to identify possible subgroups of students whose engagement in mathematics changes after transition to secondary school.

In the next chapter, the conceptual framework for this study will be presented and discussed. This model provides some interesting insights into children's beliefs about learning, and presents a global view of how attitudes may have an indirect effect on academic and behavioural outcomes through the construct of engagement.

Chapter 3

A Motivational Framework

3.1 Introduction

The previous chapter indicated that further longitudinal research was needed examining transition in mathematics. While other studies have tackled this problem using a case study approach, there is a need for a large-scale survey study examining attitudes and beliefs about mathematics over this period of change. This chapter deals first with a global view of motivation in the classroom and its links to metacognition and constructivism, then describes the particular model used in this study.

3.2 Motivation

A motivational approach to learning has the potential to improve outcomes for all students. Brophy (1983), for example, argued that "students who are motivated to learn will not necessarily find classroom tasks intensely pleasurable or exciting, but they will take them seriously, find them meaningful and worthwhile and try to get the intended benefit from them" (p. 200). Henderson and Dweck (1990) argued that motivation is more than simply a desire to do well, it helps determine what goals a person will pursue and how effectively they will be pursued. They argue that motivational factors predict

> academic achievement over and above actual academic ability … a student who is less bright than others but who has an adaptive motivational pattern … may turn out to be a high achiever. In contrast, some of the brightest students who have maladaptive motivational patterns … may fall considerably behind and fail to fulfill their potential. (Henderson and Dweck, 1990, p. 309)

Teachers and parents value motivation in its own right as well as for the long term contribution it makes to children's learning and self-esteem. Skinner and Belmont (1993) described highly motivated students as:

> enthusiastic, interested, involved and curious. These students try hard and persist, and they actively cope with challenges and setbacks. These are the students who are most likely to stay in school longer, learn more, feel better about themselves and continue their education past secondary school. (p. 571)

Not all students can excel at mathematics; nevertheless, mathematics has value for all participants in a technological society. This value should be seen as "essential for the vitality of society and the well-being of individuals within it" (Nicholls, 1984b, p. 226), and not merely as a means to achieve occupational status. Nicholls contended that when education is seen as the means to an end, such as getting a good job or gaining entry to tertiary study, it has no inherent value, making it less meaningful to those who do not believe their ability to be high. Students of all ability levels should be able to find something intrinsically and personally meaningful for them in the study of mathematics.

Dweck (1985) argued that by focussing on learning goals rather than performance goals, it is possible for all students to participate meaningfully in mathematics education. Dweck described learning goals as a manner of learning in which the goal is to expand or develop competence, while performance goals focus on the documentation or validation of competence. Put succinctly, she described the difference as "with performance goals, an individual aims to look smart, whereas with learning goals the individual aims at becoming smarter" (1985, p. 291).

Nicholls (1983) used a similar construction to describe the effects of different conceptions of ability on students' motivation. He argued that students can have different reasons for wanting to learn, and that the solution to motivational problems lies in the development of the "right type, not just the right level of motivation" (p. 212). Dweck's performance goals are those of Nicholls' ego-involved students, while learning goals are the product of the task-involved student. Nicholls described ego-involvement as being "preoccupied … with avoiding looking stupid – rather than with learning, understanding, or finding out … learning is not valued … [it] is not an end in itself" (Nicholls, 1983, p. 213). Both ego-involvement and performance goals focus on the learner's preoccupation with appearance: appearing smart or not appearing stupid.

Students' motivation for learning can have a bearing on their conceptions about effort, ability and learning. For students who are task-involved, mastery through the expenditure of effort leads to feelings of competency, because learning is an end in itself. For students who are ego-involved, however, greater effort will only imply high ability if other students learnt the same amount with an even greater expenditure of effort. These students will put in the required effort only as a means of demonstrating high ability. For task-involved students, effort is seen as the most important strategy for learning, whereas for ego-involved students, ability is the focus since effort is simply a means of showing oneself to be better than others.

Studies examining performance attributions in competitive and non-competitive situations (for example Ames, 1978; Ames, Ames, and Felker, 1977) have supported this view, contending that ego-involved students will only make effective attempts to learn if they believe that their attempts will show their superior ability. In other research supporting the benefit of learning goals, Bouffard, Boisvert, Vezeau and Larouche (1995) examined self-regulation strategies with college students. This study found that students strongly oriented towards learning reported more frequent use of cognitive and metacognitive strategies, were more motivated and had better academic performances than those weakly oriented towards this goal.

Much of the research talks about students' beliefs about effort versus ability. Pintrich and Blumenfeld (1985) explained that it is not until the later primary school years that children begin to differentiate between ability and effort, and to recognise their differential contribution to performance. Nicholls and Miller (1984) presented a similar argument, arguing that the inference that one has high or low ability has different meanings at different levels of development. By the age of about twelve, at around the time of transition to secondary school, student perceptions of the differences between ability and effort become more differentiated. Carr, Borkowski and Maxwell (1991) for example, in a study of students who were underachieving readers, concluded that successful learning is due, in part, to children's beliefs that effort is important and that they have control over their learning.

Covington and Omelich (1979) have argued that effort is a double-edged sword, as failing with high effort implies low ability, but low effort often results in punishment and is not regarded highly by teachers or parents. Ego-involved students' self-concept could be threatened if trying did not lead to immediate success, as effort without results could be seen by these students as indicating a lack of ability. In mathematics in particular, if a student also believes that success is largely due to ability, these beliefs are doubly undermining.

Dweck (1990) proposed that some children consider their intelligence to be a fixed trait over which they have no control (entity theorists), whereas other children see it as a flexible quantity that they can develop through effort (incremental theorists). In a longitudinal study, Henderson and Dweck followed groups of children over the transition to secondary school (Henderson and Dweck, 1990). The groups were based on children's beliefs about ability (fixed or flexible) and confidence level (high or low), and achievement levels were compared for the four groups thus formed. Different patterns emerged over transition to secondary school. Incremental theorists did particularly well, with students who were high achievers at primary school continuing to achieve at a high level, while those in this group who were low in confidence and had not done particularly done well in primary school showed impressive gains in their achievement. Entity theorists however, did rather poorly. Low achieving entity theorists generally remained low achieving, while many sixth grade high achievers were now amongst the lowest in achievement, most particularly the high-confidence entity theorists, who showed the most pronounced decline. Dweck (1990) suggested that it may be that "the challenge and confusion of the transition are most threatening to those who believe that intelligence is fixed and are accustomed to themselves as having it" (p. 211).

It is clear that students have different views about the role that effort and ability in particular play in learning. These beliefs can influence the way students learn by affecting the way they approach learning itself.

3.3 Metacognition

To promote motivation, the development of metacognitive skills is vital. Metacognition was described by Flavell (1976) as referring

> to one's knowledge concerning one's own cognitive processes and products or anything related to them … for example, I am engaging in metacognition … if I notice that I am having more trouble learning A than B; if it strikes me that I should double-check C before accepting it as a fact … Metacognition refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects on which they bear, usually in the service of some concrete goal or objective. (p. 232)

It is argued that metacognition allows students to enhance their learning "by becoming aware of their own thinking as they read, write, and solve problems in school" (Paris and Winograd, 1990, p. 15). Stimulating students to think about the reasons for their successes and failures in mathematics could enable a re-evaluation of maladaptive beliefs and the positive reinforcement of adaptive beliefs. The selection of goals and tasks, the persistence with which a student attempts a task are all a reflection of the beliefs that students hold about how they learn.

The advantages to both students and teachers of a metacognitive approach to learning are enormous. Paris and Winograd (1990) explained that discussing cognitive and motivational aspects of thinking with students helps in two ways.

The first is that it transfers the responsibility for monitoring learning to students, and the second is that it promotes positive self-esteem and positive beliefs about learning and motivation in students. "Metacognition helps learners become active participants in their own performance rather than the passive recipients of instruction and imposed experiences. It is consistent with constructivist accounts of learning and development" (Paris and Winograd, 1990, p. 18). Kurtz and Borkowski (1984) argued that those students with an accurate and perceptive understanding of how they learn should be more persistent and achieve greater success because they are more likely to choose correct strategies. The authors also suggested that these students would be more likely to attribute good performance to controllable factors such as effort. In contrast, "a child who has immature metacognitive information and inaccurate beliefs about the causes of success and failure should be less strategic and persistent in the face of challenging academic tasks" (Kurtz and Borkowski, 1984, p. 337). However, metacognition should not be viewed as an end in itself, rather it should be seen as being embedded in the development of effective strategies for problem solving in all facets of learning.

Paris and Winograd (1990) discussed three situations that may be particularly influenced by metacognitive processes. The first is when children acquire new knowledge and skills. Students with an understanding of their own thinking may understand better which strategies they can use in order to learn. The second occasion is in trouble-shooting; when problems appear. Students with an awareness of the cognitive demands of the task and of the benefits of various strategies may be able to switch to strategies that are more advantageous when problems are encountered. The third occasion described by the authors is in the initial presentation of knowledge or a task. Paris and Winograd (1990) explained that whoever the presenter: expert, teacher or peer, "metacognitive understanding of the task at hand can facilitate instruction" (p. 22). At each of these critical junctures in learning, metacognitive knowledge influences students' beliefs about their own abilities and about learning, and from these beliefs about ability and learning flows motivation and engagement in learning.

In mathematics in particular, metacognition plays an important role. In an unpublished report, Silver (1982), cited in Garofalo and Lester (1985), argued that while cognitive actions had been the focus of research, there was a real need for this focus to be redirected to examine behaviour relevant to the selection of strategies, cognitive monitoring and evaluation of cognitive processes. Silver, it is stated, believed that metacognitive processes formed the "driving force" behind a great deal of success and failure in mathematics. In a study of third and fifth grade students' beliefs about learning mathematics, Lester and Garofalo (1982) found that children of this age do not routinely analyse information, monitor their progress or evaluate results; in other words they do not act metacognitively. In a later paper, the authors asserted that:

> it is particularly disturbing that [students] are so deficient in the regulatory skills of monitoring and assessing. These skills are important in all mathematical performance, but especially so in problem solving. Problem solving is a complex activity involving a variety of cognitive operations, each of which needs to be managed and all of which need to be co-ordinated. (Garofalo and Lester, 1985, p. 169)

Schoenfeld (1981) distinguished between tactical and managerial problem-solving behaviours. Tactical behaviours include algorithms and heuristics, managerial decisions include selecting frameworks for problems, deciding on a path of attack, monitoring progress and deciding what to do when problems are encountered. The managerial decisions described by Schoenfeld bear similarities to those situations described by Paris and Winograd (1990) as being particularly susceptible to influences from metacognitive processes.

If the goal for education is to motivate students to learn for learning's sake, research studies need to examine methods that enable teachers to assess which students need particular help. Understanding students' beliefs about the causes of success and failure, and their beliefs about how much control they have over these causes, is of primary importance in being able to formulate interventions appropriate for particular students. It seems that until about the age of twelve there may not be complete differentiation between ability and effort, and so examining beliefs at the age of transition to secondary school would provide new insights into student behaviour at this time.

How can we examine cognitive, motivational and personality constructs as a system that interacts to shape academic performance? Different frameworks have been constructed to examine this issue, however underlying many of these is the study of the self-system. According to Borkowski, Carr, Rellinger and Pressley (1990), the self-system includes constructs such as self-efficacy, locus of control, achievement motivation, and attributional beliefs, and is a "complex interdependent system that supports both metacognitive functions and academic performance" (p. 58). The authors also suggested that "the self-system constructs power metacognition by giving children reasons to learn" (p. 64).

Connell (1990) focussed on the self-system processes which he described as being of the most motivational significance; those of the individual's psychological needs for competence, autonomy and relatedness. It is this model that forms the theoretical framework for this study. Skinner (1995) argued strongly that competence research is important both because of its explanatory power and because it is proactive. "Postulating a need for competence gives ultimate power to individuals as sources and agents of their own motivation. It specifies that all people have the internal prerequisites for the development of well-functioning competence systems" (p. 15). Finding a way for teachers to help students to monitor their own motivation is one of the primary aims of this research study.

3.4 Competence

White (1959) postulated that an innate characteristic of humans is an intrinsic 'need' to feel competent, and that behaviours such as exploration and mastery attempts are best explained by this motivational force. Competence has two strands; understanding how to attain goals and being efficacious in performing the required actions to achieve these goals. Competence needs are fulfilled when a person feels able to achieve positive outcomes and avoid negative outcomes (Deci and Ryan, 1985). Competence therefore is an active component of the self-system, and can be thought of as having metacognitive components. The opposite of competence is described by Patrick, Skinner and Connell (1993) as helplessness, while Skinner (1995) suggested that the implication of a human need for competence is that "a price will always have to be paid for violating this need, in disaffection, depression, and apathy" (p. 16).

Competence beliefs are fostered in students when they are provided with *structure*. Structure encompasses "clearly communicated and optimally challenging expectations for and consequences of individual action, to constant administration of these consequences and to the provision of competence-relevant feedback" (Connell, 1990, p. 66). In simple terms, knowing what is expected of one and knowing the consequences of success and failure, consistency, and useful information about performance. Skinner and Belmont (1993) explained that teachers provide structure by "clearly communicating their expectations, by responding consistently, predictably, and contingently, by offering instrumental support and help, and by adjusting teaching strategies to the level of the child" (p. 572).

3.5 Autonomy

Autonomy has largely been studied by researchers interested in intrinsic motivation (Deci and Ryan, 1985; Deci and Ryan, 1991; Ryan, Connell, and Deci, 1985). Autonomy is described as experiencing choice in initiating, maintaining and regulating activity. It has also been described as:

> the connection between volition and action; it is the extent to which a person feels free to show the behaviours of his choice. Non-autonomous behaviours include both compliance and defiance, which have in common that they are reactions to others' agendas and not freely chosen. (Patrick *et al.*, 1993, p. 782)

Connell and Wellborn (1991) reported that for a primary school sample there were moderate to strong correlations between perceived autonomy, teacher reports of student engagement and a composite index of school performance. Significant differences in perceived autonomy were also found in a sample of students labelled as 'at-risk' of academic failure and other non-labelled students studied by Connell and Wellborn (1991). In this study, at-risk students showed significantly lower levels of perceived autonomy than other non-labelled students did. The authors concluded that "children and adolescents who experience themselves as regulating their own behaviour in school are more engaged in this domain and those engaged patterns of action are associated with higher levels of academic accomplishment" (p. 63). It has also been demonstrated (Midgley and Feldlaufer, 1987) that students with low levels of perceived autonomy also showed negative changes in their valuing of mathematics over transition.

Students' need for autonomy in learning is promoted when they experience autonomy support, that is "the amount of freedom a child is given to determine his or her own behaviour" (Skinner and Belmont, 1993, p. 573). Research has shown that when the classroom climate is seen as autonomy supportive rather than controlling, it has been associated with greater intrinsic motivation, trust, self-worth and satisfaction (Deci, Schwartz, Sheinman, and Ryan, 1981). However, it has also been shown that students in secondary schools are given fewer opportunities for autonomous learning than students in primary schools (Feldlaufer *et al.*, 1988).

3.6 Relatedness

Relatedness refers to the quality of involvement of the student with significant others, and in the context of the classroom, more specifically to teacher and peer involvement with the student. Relatedness is supported by *involvement*, where "teachers are involved with their students to the extent that they take time for, express affection toward, enjoy interactions with, are attuned to, and dedicate resources to their students" (Skinner and Belmont, 1993, p. 573).

The Midgley *et al.* (1989b) study showed that for students moving to a supportive secondary school environment, valuing of mathematics increased. However Feldlaufer *at al.* (1988), while agreeing that children need positive relationships with their teachers, found that secondary teachers were more often characterised by their students as less caring, warm and supportive than primary teachers.

The self-system is thus defined as an appraisal process in which students evaluate themselves with respect to these three basic psychological needs. Connell (1990) proposed that students' beliefs about themselves affect their learning and adjustment indirectly, through the construct of engagement.

3.7 Motivational engagement

Cambourne (1994) claimed that that while learners are exposed to thousands of demonstrations of techniques, methods and other learning practices during their lives, many of these are ignored by students, and therefore learning does not occur. He argued that teaching can only result in learning if the student is engaged with the learning process. Skinner, Wellborn and Connell (1990) carried out a study on 220 students in grades three to six, measuring, among other things, engagement, grades and achievement test scores. They found that students who were more engaged earned higher grades, scored better on standardised tests of achievement, and showed better personal adjustment to school.

Skinner and Belmont (1993) contended that children who are engaged are positive emotionally and show sustained behavioural involvement.

> They select tasks at the border of their competencies, initiate action when given the opportunity, and exert intense effort and concentration in the implementation of learning tasks; they show ... enthusiasm, optimism, curiosity and interest. (p. 572)

Disaffected students, however, can be bored, anxious, depressed or even angry about their presence in the classroom, they can withdraw from learning opportunities or be rebellious towards teachers and their peers.

Teachers respond in different ways to students' engagement or disaffection in their classes. Skinner and Belmont (1993) investigated aspects of teacher behaviour (involvement, provision of structure and autonomy support) and students' active engagement (behaviour and emotion) over a school year with grades 3 to 5 students. They found that students' engagement was influenced both by their perceptions of their teachers and by the effect of teachers' actual behaviours. Students whose teachers provided clear expectations, contingent responses and strategic help were found to be more likely to expend effort and to be persistent.

Another influence found in this study was between student engagement and subsequent teacher behaviour. "Teachers respond to children who have initially high behavioural engagement with more involvement, more autonomy support … more contingency and consistency, and they respond to children who are more passive with correspondingly more neglect, more coercion, and even inconsistency" (Skinner and Belmont, 1993, p. 578). Teachers' actions have an impact on subsequent student engagement, meaning that students with high behavioural engagement are treated in a way that is likely to increase their active participation in class, while teachers deal with children of low behavioural engagement in ways that serve to exacerbate their initial passivity and cause them to withdraw further from learning situations. These cycles, it is claimed by Skinner and Belmont, "underline the urgency of intervention into existing patterns of interactions between students and teachers" (Skinner and Belmont, 1993, p. 578).

Figure 3.1 summarises the facets of the model devised by Connell and Wellborn (1991) to illustrate the relationships between the basic needs of competence, autonomy and relatedness, engagement and academic outcomes. It was argued that student engagement is optimised when the social context, in the case of this study the mathematics classroom, fulfils student's basic psychological needs for competence, autonomy and relatedness.

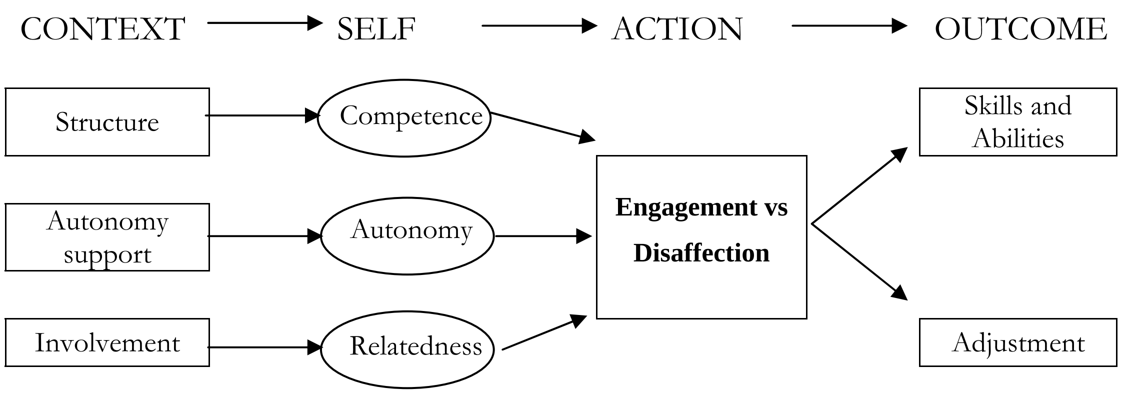

Figure 3.1 A motivational model of the effects of children's psychological needs on their engagement (Connell and Wellborn, 1991, p. 51)

Competence is the most complex of these three basic needs and perceived control is one attempt to map the competence system. Skinner described the perceived control model as originally being designed as a global model with contributing constructs from locus of control theory, attributional research, learned helplessness and self-efficacy (Skinner, 1995). A brief overview of each of these constructs will be given to provide a background for the perceived control model and to show how it incorporates aspects of each.

3.8 Locus of control

The notion of control; over one's life, learning environment, or of learning itself, had attracted a large amount of research over a number of years. Heider (1958) proposed that individuals were aware of the reasons they were rewarded or punished and that these reasons affected behaviour. Further to this, Rotter (1966) contended that these actions and outcomes could be regarded as *internal* or *external*. Internal referred to a person's belief that events or outcomes are contingent on their own behaviour, or on a relatively stable characteristic such as ability. External referred to beliefs that events are caused by factors that are beyond the individual's control, such as luck, task difficulty and powerful others.

Locus of control theories suggest that children's behaviour in achievement situations is influenced by their perceived locus of control. Rotter (1966) argued that students bring with them their own generalised belief systems that have developed from past experiences in school. Students who repeatedly experience failure, regardless of the amount of effort they may have exerted, may develop the belief that success is not contingent on effort. This belief may override information to the contrary in certain situations, with students clinging to their beliefs even when successful, preferring instead to interpret positive outcomes as reflecting good luck or an easy task.

3.9 Attribution theory

Attributional theories of motivation deal with the reasons that individuals use to explain events and how these attributions translate into actions. Weiner (1972, 1974, 1985; Weiner, Graham, Stern and Lawson, 1982), claimed that labelling causes simply as internal or external does not present a full picture, especially if the goal is the prediction of behaviour in achievement situations. Weiner added two more dimensions to the locus of control model: control and stability. He also claimed that the reasons that people give for their successes and failures fall into four categories; ability, effort, task difficulty and luck. Figure 3.2 illustrates the aspects of this attributional model.

	Locus of Control	
Stability of factor	**Internal**	**External**
Stable	Ability	Task difficulty
Unstable	Effort	Luck

Figure 3.2 Weiner's attributional theory model

Events that are both internally controlled and stable are perceived to be the result of a person's ability, while events that are internally controlled but unstable are seen to be the result of effort. This is because ability is seen as being a factor specific to the individual but over which the individual has no control, while the individual is perceived as being able to exert some control over the level of effort applied to a learning situation or test. External, stable outcomes are attributed to task difficulty, since the task difficulty is set, but by external agents. Luck is also outside the individual's control, and is seen as capricious. The dimensions added by Weiner allowed more specific behavioural predictions from beliefs about success and failure.

The consequences of attributions have a direct effect on motivation in the classroom. If success or failure is attributed to a stable factor then it will be expected that similar outcomes will occur in the future, however if the outcome is attributed to an unstable factor then the individual will have doubts as to their ability to repeat a success or failure (Pedro, Wolleat, Fennema, and Becker, 1981).

In short, students who attribute past failures to low effort may still be motivated to succeed provided that they are willing to increase their effort. However students who attribute their failures to lack of ability are not as likely to exert increased effort because of their beliefs that without prerequisite ability no amount of effort will lead to success. It is generally claimed that effort attributions are the most productive for learning, as effort, unlike ability or luck, is under the control of the individual. It has been found that 'mastery orientated' students felt that success was controllable, and hence were found to be "highly motivated because they feel that success is contingent upon their actions" (Kloosterman, 1988, p. 346).

A general finding in the literature is that attributions to effort for language subjects are significantly higher than those for mathematics, and that attributions to task difficulty and luck are higher in mathematics. Ryckman and Peckham (1987) suggested that findings such as this indicate a more adaptive attributional pattern in language subjects than in mathematics, with students feeling more in control in the former.

Attribution of success to ability may have negative effects on motivation, because if effort is not perceived as necessary for success students may not try very hard and may consequently not perform at their true capacity or develop good work habits. Kloosterman (1988) contended that "when uncontrollable causes [such as ability or task difficulty] are blamed for failure, motivation is generally poor" (p. 346). This type of attribution has been termed learned helplessness.

3.10 Learned helplessness

Learned helplessness occurs when failure is attributed to uncontrollable factors such as lack of ability and success either to the ease of the task or to being helped by others. Studies on learned helplessness have demonstrated that if individuals believe that there is no connection between their actions and the outcomes they wish to achieve they often become passive and depressed (Abramson, Seligman, and Teasdale, 1978). Kloosterman (1990) claimed that because "lack of ability is a stable cause of failure that cannot be overcome, learned-helpless students withhold effort rather than risk failure and 'confirmation' of their low ability" (p. 105).

The types of tasks that learned helpless students choose may be different from those chosen by other students. When the learned helpless student is presented with a choice of tasks, they often choose only those tasks that are either very easy or very difficult. Either their success will be assured or their failure can be blamed on the difficulty of the task, so their sense of self-worth can be preserved as failure has not been blamed on lack of ability.

Wolleat, Pedro, Becker and Fennema (1980) applied the principles of attribution theory and learned helplessness to the problem of mathematics avoidance, which they explained as a lack of persistence in mathematics related activities. They suggested that

> it appears reasonable to hypothesize that if a student attributes successful performance to ability, the likelihood of persisting in mathematics is higher than if that success were attributed to an unstable cause such as effort or luck. Conversely, when failure is attributed to ability, lowered persistence will result. (p. 357)

3.11 Self-efficacy

Bandura's self-efficacy theory posited that perceptions of efficacy "determine whether coping behaviour will be initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles or aversive experiences" (Bandura, 1977, p. 191). Thus, self-efficacy refers to the function of perceived control that acts to regulate behaviour. Individuals who do not believe that they are effective often become anxious and fearful, and do not perform well on challenging tasks (Bandura, 1986).

Bandura also argued that most perceived control theories examined beliefs about the effectiveness of responses in producing outcomes, but these beliefs could have no effect unless the individual also believed that they could "successfully execute the behaviour required to produce the outcome" (Bandura, 1977, p. 193). These beliefs were referred to as *efficacy expectations*.

Bandura argued that a successful performance would be more likely to boost self-efficacy beliefs if that performance were perceived to be the result of skill than from external causes. Skinner (1990b) contended that the effects of self-efficacy beliefs on the regulation of behaviour were analogous to what she termed as strategy and capacity beliefs.

3.12 The perceived control model

The model proposed by Skinner, Wellborn and Connell (1990) draws from locus of control theory, attribution theory and studies on learned helplessness and self-efficacy to present an integrated theory of perceived control. There are, however, important differences. Skinner, Chapman and Baltes (1988) proposed that statements frequently used to test attributions and locus of control could be "unpacked" into separate beliefs, which they labelled as *strategy* and *capacity* beliefs. For example an attribution of success to a cause, such as "*I did well because I tried hard"* implies both that the cause is effective; "*Effort is an important strategy for success"* and that the person is able to effect the cause; "*I can work hard".* In contrast, an attribution of failure such as "*I failed because of ability"* implies both that the cause is effective in producing the outcome; "*ability is important for succeeding"*, and that the person is unable to access the cause; "*I'm not very smart".* Disagreement with the statement "*I did well on a mathematics test because I am smart at mathematics*" could be interpreted as either "*I am not smart at mathematics"* or "*ability is not the most important strategy for succeeding at mathematics".* These different semantic structures have an impact on the interpretation of causal attributions, because for example when contrasting effort and ability attributions, they differ not only on the cause (*ability* versus *effort*) but also on students' beliefs about themselves (*I'm not very smart* versus *I didn't try hard*).

Skinner, Chapman and Baltes (1988) presented a multidimensional framework for perceived control in which three conceptually independent sets of beliefs were distinguished. These were *control beliefs*; expectations about the extent to which individuals can personally control academic outcomes; *strategy beliefs*; expectations about the extent to which individuals understand what it takes to do well in mathematics, and *capacity beliefs;* expectations about the extent to which individuals believe they possess the means of enacting these strategies. Perceived control is a combination of strategy, capacity and control beliefs that reflects the amount of control children feel they have over the learning process.

A study conducted in West Germany by Chapman, Skinner and Baltes (1990) provided evidence that this conceptualisation presented a more accurate picture of students' beliefs. A total of 180 children in Grades two, four and six completed the perceived control questionnaire and a standard intelligence test. The study showed a progressive increase in the correlation between capacity beliefs and cognitive performance in Grades two and six. At Grade six, capacity beliefs were found to be most strongly and consistently correlated with cognitive performance. Strategy beliefs did not show the same pattern of correlations, and this, it was claimed, underscored the empirical importance of distinguishing between the different types of beliefs.

947847 Yzxgzkm¡ hkrdkly

There are five strategies developed within the perceived control model. These strategies are labelled as unknown strategy ("*I don't know how to do well in school*"), powerful others ("*I have to have the teacher's help to do well in school*"), luck ("*I have to be lucky to do well at school*"), effort ("*working hard is the best way for me to succeed at school*") and ability ("*being smart is the best way to succeed at school*"). "Unknown" strategies were developed from the work done by Connell (1985), who interviewed children about strategies for success in school and found that some students said that they do not know the reasons for success and failure in the classroom. Connell suggested that not knowing these reasons might inhibit competence and motivation.

947848 Igvgicz¡ hkrdkly

Perceived capacity statements are statements derived directly from the strategy statements. Students are asked to endorse the degree to which they believe that they have or do not have the capacity for executing the powerful others, luck, ability and effort strategies. For example, "*I can work hard in school if I want to*" is a capacity statement tied to the effort strategy statement. There is no corresponding capacity statement for unknown strategies since it is not possible to enact an unknown strategy.

947849 Iutzxurhkrdkly

Control beliefs are simply expectations such as "*I can do well in school if I want to*", or the opposite, "*No matter what I do, I can't avoid failure*", without reference to specific means. Few other models include beliefs similar to control beliefs, which Skinner (1995) explained have turned out to be "key predictors of action" (p. 33). High control beliefs have been found to correlate positively with engagement (Skinner, Wellborn & Connell, 1990).

A summary model showing the relationship between the three types of beliefs is shown in Figure 3.3.

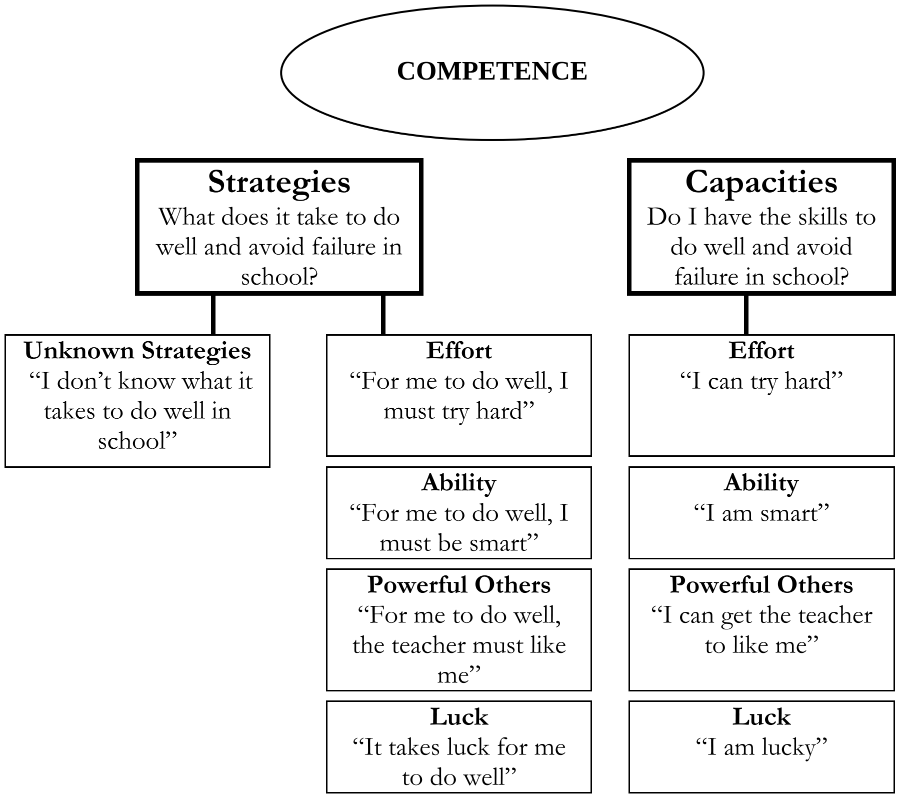

Figure 3.3 A measure of children's control, strategy and capacity beliefs in the academic domain (Connell, 1990)

What is most interesting about these strategy and capacity beliefs, and why they may be valuable in assisting with the assessment of student motivation, is that the strategy and capacity beliefs are independent. A student could be high on capacity ("*I can work hard*") but low on strategy beliefs ("b*ut effort isn't what it takes to do well in school*"). The opposite is also possible, high strategy beliefs ("*It takes ability to do well in school*") and low capacity beliefs ("*but I don't have ability*"). This formulation has clear differences from the attributional model, which does not distinguish between beliefs about the self and beliefs about the causes of events. Similarly with self-efficacy, believing oneself efficacious in producing an outcome implies both that one is capable of achieving it and that the strategy for doing so is correct.

This conceptualisation also differs from the models discussed previously in that the perceived control model describes both regulative and interpretive functions. The locus of control, attribution theory and learned helplessness models examine interpretive functions of perceived control, while the self-efficacy model deals with the regulative function of perceived control. The perceived control model deals with both regulative functions (*control beliefs*) and interpretive functions (*strategy* and *capacity beliefs*).

3.13 Findings from other studies

In the ten years since research on perceived control using this particular model began, a number of studies have used the associated instruments (Rochester Assessment Package for Schools, or RAPS) to investigate various aspects of learning. They are summarised in Table 3.1, and these and other relevant studies are discussed in more detail in subsequent sections.

Table 3.1
Studies Carried Out Using Aspects of the Perceived Competence Model

Author/s	Country, Participants	What was measured, major findings
Skinner, Chapman and Baltes (1988)	*West Germany* 155 students in Grades 2, 4 and 6.	**Perceived control: Strategy, capacity and control beliefs** Factor analyses established three-factor solutions for each of the known causes and two-factor solution for unknown.
Chapman, Skinner and Baltes (1990)	*West Germany* 180 students in Grades 2, 4 and 6.	**Perceived control and cognitive performance** Capacity beliefs strongly correlated with cognitive performance.
Skinner (1990a)	*West Germany and USA* 294 students from Grades 1-6 (USA), 215 from Grades 2, 4 and 6 (WG)	**Perceived control** Children's beliefs about internal and external causes became more differentiated with age. Beliefs about ability appear to have an impact on motivation and behaviour, emerging at age 11 – 12.

Table 3.1 (ctd.)

Author/s	Country, Participants	What was measured, major findings
Skinner, Wellborn and Connell (1990)	*USA* 200 students in Grades 3 – 6	**Perceived control, student engagement, achievement, teacher involvement and contingency** Engagement undermined by beliefs in nonaction strategies (ability, luck, powerful others) and by not knowing how to succeed. Path analysis found that teacher involvement and contingency indirectly affected student engagement and achievement.
Pierson and Connell (1992)	*USA* 74 students retained in grade, 69 students matched on ability but not retained	**Competence, autonomy and relatedness, structure, support and involvement, performance, engagement** Retained students reported less adaptive strategies for achieving success and avoiding failure.
Stiller and Ryan (1992)	*USA* 398 Grade 7 and 357 Grade 8 students	**Perceived autonomy, perceived involvement, control, coping, engagement self-regulation**. Teacher and parent involvement and autonomy support were predictors of student motivation, and correlated positively with student engagement, positive coping, control and self-regulation.
Patrick, Skinner and Connell (1993)	*USA* 264 students in Grades 3, 4 and 5	**Perceived control, autonomy, behaviour, emotion** Optimal motivation characterised by perceived control beliefs centred on the effectiveness of effort and autonomous reasons for engagement.
Schmitz and Skinner (1993)	*West Germany* 152 Grade 4 and 6 students	**Perceived control, achievement on particular tasks (mathematics and German homework and tests)** Success at tasks lead to attributions of correct answers to effort, ability and ease of task, failure lead to attributions of mistakes to effort and task difficulty and of correct answers to unknown causes.
Skinner and Belmont (1993)	*USA* 144 students in Grades 3,4 and 5. Surveys completed at the beginning and end of the school year.	**Teacher involvement, structure, autonomy support, student engagement**. Students' behavioural engagement predicted by teacher structure, emotional engagement by teacher involvement. Disaffected students received less contextual support from teachers, engaged students received more, exacerbating the problems of disaffected students.

Table 3.1 (ctd)

Author/s	Country, Participants	What was measured, major findings
Ryan, Stiller and Lynch (1994)	*USA* 606 middle school students in Grades 7 and 8	**Academic coping, self-regulation, students' engagement, perceived control** Emotional security with teachers associated with greater sense of control, autonomy and engagement in school, and coped more positively with academic failure.
Miserandino (1996)	*USA* 77 above-average Grade 3 and 4 students	**Perceived competence: Capacity ability, perceived autonomy, perceived engagement, achievement grades** Strong correlations found between perceived ability and autonomy with engagement and positive affect.

It can be seen from Table 3.1 that while many studies have been carried out, none have been in a specific subject context. Given that studies have recommended that learning contexts should be examined separately (for example Wigfield *et al.*, 1991), it seems appropriate that this study should examine the particular context of mathematics. No studies of beliefs have been conducted longitudinally, and no comparison can be made between grade levels from different studies. However, the interpretation of perceived control beliefs as shown by the variety of studies carried out using this construct clearly provides an insightful look into children's motivational behaviour.

3.14 The impact of perceived control

Perceived control influences outcomes through its effects on action and action regulation (Skinner, 1995). Skinner proposed that the construct the current model labels as action is the same as that more commonly labelled motivation, and the construct labelled as action regulation is usually referred to as coping.

It should be emphasised, however, that perceived control is not the only determinant of a child's level of performance. The effects of perceived control on performance are proposed to be mediated through its effects on engagement, however it cannot *increase* a child's actual competence, which must be a primary determinant of performance. Skinner (1995) argued that perceived control "simply gives people access to all the resources they already have, to all the responses in their repertoire" (p. 76). Perceived control can be used to help explain why, given two children with similar abilities, one is able to perform near the ceiling of their capacity while the other is not. Similarly, ability alone cannot be the sole predictor of achievement. Other factors such as perceived control may be prerequisites for engagement and learning.

The results of different levels of control can be seen in the behaviour and actions taken by students. Children with low perceived control are more likely to be unhappy, anxious and eventually depressed than children with high perceived control (Nolen-Hoeksema, Girgus, and Seligman, 1986). Students with high levels of control select challenging tasks and expect successful outcomes (Bandura, 1989) and they set high and concrete goals (Schunk, 1990). In contrast, students who do not expect control set low goals and are anxious about the outcomes of their endeavours, culminating frequently in failure (Bandura, 1989). Students with high levels of control beliefs have been shown to select tasks that are relatively difficult because these tasks seem to be the most challenging and fun, not because they can use these tasks to diagnose their competence (Dweck and Leggett, 1988; Nicholls, 1984a). Students with low control are more likely to choose tasks that are either extremely difficult or extremely easy, or even adopt an attitude of academic alienation, so that their subsequent performance cannot be used to assess their ability. When confronted by failure, or unexpected setbacks, students with low control worry about their efficacy and about the consequences of failure, while those students with high control are still concentrating on the task, considering other ways to approach the situation (Dweck & Leggett, 1988).

These relationships are recursive; students who are not doing well in school also perceive themselves as having no control over success and failure in this setting, and these beliefs help to generate patterns of action that cause performances that serve to reinforce their beliefs. It is important to intervene into these cyclical patterns in order to increase motivation for these students.

It was postulated (Skinner, 1990b; Skinner, Schindler and Tschechne, 1990) that the control beliefs that would undermine engagement could be distinguished from those that would promote engagement. Engagement was hypothesised to be undermined by beliefs that

> imply that there is no connection between one's action and desired outcomes. Sufficient for this would be *either* beliefs that outcomes are not contingent on actions (high strategy beliefs for non-action causes such as ability, powerful other, luck, or unknown factors) or beliefs that one is incapable of producing potentially effective actions (low capacity beliefs for … causes such as effort and ability. (Skinner,Schindler & Tschechne 1990, p. 177)

The combination of beliefs that were proposed to have the most devastating effects on engagement was high strategy beliefs and low capacity beliefs for the non-action causes. This might include statements such as "*Success in school is due to ability"* and *I'm not very smart*".

In contrast, it was proposed that high control beliefs would be sufficient in itself to promote engagement, but that contrary to predictions from locus of control theory about the positive effects of belief in effort, strategy effort would not be sufficient in itself to promote engagement. Instead, it is necessary for students to believe that they can produce the required effort themselves. These predicted combinations and interactions were supported by the study conducted by Skinner, Wellborn & Connell (1990).

In summary, Patrick *et al.* (1993) described profiles of children who were most likely to be engaged in the classroom. These were children who believed that

- effort is an important cause of school success and failure, and that they are able to exert the required effort (high effort strategy and capacity beliefs);
- ability not necessary for success, but that they themselves were smart (low strategy ability, high capacity ability beliefs);
- they are able to get powerful others (teachers) to help them or like them, and that they feel they are lucky (high capacity luck and powerful others beliefs).

In contrast, the students most likely to be disaffected are those who believe that

- they are not capable of exerting the required amount of effort and that they are nor smart (low capacity effort and ability beliefs);
- luck and the help of powerful others are needed to succeed, but they have no influence on others and they are unlucky (high strategy beliefs paired with low capacity beliefs for powerful others and luck);
- they don't understand the causes for success and failure (high unknown strategy beliefs).

A cross-sectional investigation of children's perceived control beliefs at different ages was reported by Skinner (1990a), who sampled students in primary schools in both the USA and West Germany. The participants completed only the *strategy* subscale of the Rochester Assessment Package for Schools (RAPS) in order that children's perceptions of the reasons for success and failure could be examined as a function of time. Factor structure of the scale changed from two to three to four factors as children got older, and changed from a simple internal, external and unknown causes structure to the more differentiated structure in the current model at about the age of 11 – 12 years. The investigation in the present study of children's beliefs as they move from primary to secondary school may find further differences.

3.15 Self-regulation

Self-regulation is defined as processes associated with the need for autonomy. In the school context, these processes examine the reasons why students engage in academic activities. Children were asked for the reasons that they participated in certain academic activities, such as doing homework, doing classwork, and answering questions (Connell and Ryan, 1984; Ryan and Connell, 1989). Reasons given were classified as emphasising external pressures or compulsion to behave, and internal mediators such as values or self-set goals. These reasons were then classified along a continuum of increasingly autonomous behaviour: external (*I do my work because otherwise the teacher will yell at me*), introjected (*I do my work because otherwise I'll feel guilty*), identified (*I do my work because I want to understand the subject*) and intrinsic (*I do my work because it's fun*).

External self-regulation is viewed as the least autonomous because the initiation of behaviour is controlled by the student's fears of external punishment (usually in the form of adult's approval or disapproval). Introjected self-regulation is the next least autonomous because the child engages in behaviour so as to protect against loss of self-esteem. Connell and Ryan (1984) explained that when children develop this form of self-regulation, "the approving and disapproving voice is inside the child's skin … rather than in the external, impersonal environment" (p. 69).

Identified and intrinsic self-regulation are an indication of more autonomous behaviour, identified self-regulation because the student participates in learning activities because the activity is seen as important, and intrinsic self-regulation because the activity is seen as interesting and enjoyable.

Lower levels of autonomous behaviour in children are manifested in reactions such as fear, tension, boredom, depression and attempts to evade the activity, while children with higher levels of autonomy react with exertion, persistence and optimism when faced with challenging tasks (Connell and Wellborn, 1991; Deci and Ryan, 1985; Deci *et al.*, 1981; Dweck, 1985; Nicholls, 1984a; Patrick *et al.*, 1993). An interesting significant correlation was found between introjected self-regulation and both anger and distress in the Patrick *et al.* (1993) study. The authors explain this relationship, pointing out

> the dual nature of pressured, introjected reasons. On the one hand, the regulation of behaviour is internalized, and so internal pressure to act in certain ways is maintained, resulting in distress. At the same time, however, because regulation of behaviour is not integrated, this style retains the evaluative character of being pressured by others, resulting in anger. (p. 789)

What is also evident from their analysis is that attribution of failure to luck was also a significant predictor of both anger and distress, attribution of failure to powerful others was a significant predictor of distress, and attribution to unknown causes was a significant predictor of both distress and boredom. The strongest predictors of motivated behaviour were found to be attributions of success to effort, and identified self-regulation strategies.

In a summary of other studies investigating aspects of this model (Connell and Wellborn, 1991), it was shown that high levels of perceived autonomy were significantly correlated with teacher ratings of student engagement and with performance. Students categorised as "at-risk" of academic failure were also found to have significantly lower levels of autonomy than other students who were not classified in this way. It is clear from these studies that to obtain a better picture of students' beliefs about learning, it is necessary to integrate questions about both perceived control and autonomy.

3.16 Relationships with teachers and peers

Investigations into the relationship between students and their teachers and peers, the partners in the academic context, indicate that emotional security is positively associated with Teacher-rated student engagement (Connell and Wellborn, 1991). In the Connell and Wellborn study, none of the relatedness variables were found to be correlated with school performance, indicating the importance of the engagement construct as a mediating variable. Without this variable, it might be assumed from the lack of correlation that student relationships had no effect on school performance, however if the path analysis model is examined it is clear the relationship is mediated through engagement.

Ryan and Grolnick (1986) found that students whose teachers were perceived as warm and supportive of student autonomy were more likely to be intrinsically motivated and to have greater feelings of perceived control than students who had a less supportive relationship with their teachers. In a study on transition described in the previous chapter, Midgley *et al.*(1989b) found that students experienced a decrease in their interest in learning when they move from a classroom where teacher support is high, to one where the perception of support is lower. Ryan, Stiller and Lynch (1994) found that adolescents who reported positive relationships with teachers showed more positive coping skills, greater engagement and more positive self-regulation, and higher levels of perceived control. Lynch and Cicchetti (1997) argued that after the transition to secondary school, students must become acclimatised to an "increasingly large and impersonal educational milieu", and that they are "exposed to a larger number of teachers with whom they have limited and circumscribed contact, and they encounter a large and unfamiliar set of new school peers" (p. 84).

Some methodological flaws are apparent in this latter study, with students being asked to respond how they felt "on average" about their teachers. This problem is acknowledged by the authors, who maintain that the results should be generalised with some caution. With this caveat in mind, however, they point out that there are a large number of students with insecure patterns of relatedness to their teachers after transition to secondary school, and give a "poignant example … that only 23% of elementary school children report having a *disengaged* pattern of relatedness with their teachers, whereas over 60% of middle-school children report being disengaged" (Lynch and Cicchetti, 1997, p. 94).

3.17 Summary

This chapter provided an overview of the psychological constructs related to motivation, and of the particular theories from which the perceived control model was developed.

It was argued that motivation to learn is an important goal in education, and that education shouldn't be seen simply as the means to an end. In a similar manner, it is more important for students to be focussed on learning goals than performance goals, the difference between these being described by Dweck (1985) as the difference between looking smart and being smart. Students oriented towards learning goals reported more frequent use of cognitive and metacognitive strategies, were more highly motivated and performed better academically.

It was also reported that perceptions about the roles of ability and effort became more differentiated at about the age of transition to secondary school, providing further rationale for a study of students' beliefs to be conducted at this time. Metacognition means that students become aware of the reasons for success and failure, and of how best to learn. For metacognitive learning styles to develop teachers must encourage students to think about and evaluate their own beliefs about learning. It is argued that the selection of goals and tasks and persistence are all a reflection of students' beliefs about how they learn. Researchers need to find ways that enable teachers to assess which students need particular help in order to develop appropriate interventions.

Connell (1990) proposed a global model of perceived control and its antecedents and consequences in the classroom. This model focuses on competence, autonomy and relatedness. It is argued that this focus empowers individuals as both agents and sources of their own motivation.

All of us need to feel competent and Connell argued that in the classroom students need structure as a precursor to competence. Structure refers to a clear communication of expectations, consistent, predictable and contingent responses, and teacher support. Autonomy refers to the amount of choice students have about the initiation, maintenance and regulation of activities in which they participate. More autonomy has been shown to lead to higher levels of engagement, and for autonomy teachers must feel confident enough to let students make their own choices. Relatedness refers to the quality of the relationships students have with their academic partners; peers and teachers. Teacher involvement with students promotes feelings of relatedness to others. It is argued that these three factors effect achievement through the mediating construct of engagement.

Students who were more engaged were found to earn higher grades, score better on standardised tests of achievement, and make more positive personal adjustment to school. They showed sustained behavioural involvement, enthusiasm, optimism, curiosity and interest. Teachers react to these students in a way that will reinforce students' beliefs and maintain their engagement, while they often respond to students with low engagement in ways that will act to perpetuate the problem. Engagement is thought to be optimised when the social context, in this case the classroom, fulfils students' basic psychological needs.

The perceived control model was developed from theories of locus of control, attributions, learned helplessness and self-efficacy. It was found that attributions to effort were generally higher for language subjects than for mathematics and attributions to task difficulty and luck were higher in mathematics. Motivation is generally found to be poor when uncontrollable causes are blamed for failure. These findings again underline the need for research studies to examine beliefs in separate subject areas.

Self-efficacy acts to regulate behaviour, and Bandura (1977) also argued that beliefs about how to succeed would not have any effect unless individuals also believed themselves able to execute the required behaviour.

The perceived control model "unpacks" attribution beliefs into strategy and capacity beliefs: "Is this a successful strategy?" and "Can I enact that strategy?" and asks students about control "Can I succeed if I want to?". Strategy and capacity beliefs have been shown to be independent, one can be high on strategy and low on capacity for a particular cause, or the opposite. The strength of control is that it gives students access to all the resources available to them, so that students with low actual ability are still able to develop to their full potential and feel confident about what they are doing.

An optimal profile for engagement is given as high effort strategy and capacity beliefs, low strategy ability, high capacity ability beliefs, and high capacity luck and powerful others beliefs. In contrast, the students most likely to be disaffected are those with low capacity effort and ability beliefs, high strategy beliefs paired with low capacity beliefs for powerful others and luck, and high unknown strategy beliefs.

Self-regulation was also discussed as it is linked to the need for autonomy. Students' reasons for working were classified along a continuum of increasing autonomy, from external to intrinsic. Introjected reasons, one step along that continuum from external, were found to be correlated to anger and distress, while children with higher levels of autonomy were found to react with exertion, persistence and optimism.

3.18 Conclusions

It is apparent from the last two chapters that despite commonly held perceptions that transition to secondary school is smoothed by special programs, there are still problems. A limited number of longitudinal and cross-sectional studies have implied that changes in perceived control are also evident over the transitional period, however despite recommendations, these studies have all been carried out within the broad school context, examining students' beliefs about generalised teaching and learning styles.

The present study draws its strength from its innovative approach to the investigation of the transition question. Perceived control is a powerful construct that has a great deal of practical appeal in education, and in mathematics education, it has the potential to provide teachers and researchers with a way to promote metacognitive learning and identify children with particular learning problems. Self-regulation and relationships with peers and teachers have also been shown to have a significant effect on engagement, and this study integrates these factors into its design. Essentially, where other studies have concentrated on ability and performance, this study focuses on motivation and engagement, factors that not only underscore performance, but also which promote real learning.

Chapter 4

Methods and Instruments

4.1 Introduction

This chapter describes the research study that was designed to examine perceived control beliefs in mathematics over the transition to secondary school. It provides details about the instruments and methods used to carry out the research, and describes the participants in the study. The investigation was longitudinal, with data collection carried out at three stages of the primary to secondary school transition, and the particular research design adopted is also discussed in this chapter.

4.2 Method of study

As the concern of this study was the changes in student beliefs about mathematics over the transition to secondary school, it was determined that a longitudinal panel design was most appropriate. The panel study design involves the collection of data on a random sample of individuals at different times. The advantage of a panel study over a trend or cohort study is that trends for groups or for individuals may be studied. Wiersma (1995) argued that only with a panel design could the possibility of a cause and effect relationship be explored, since the design provides "temporal ordering of variables" (p. 174).

One disadvantage of the panel design, and particularly of any longitudinal study attempting to track students in the transition from primary to secondary school, is that of attrition in the panel across the study. Students in Victoria are not allocated to particular primary or secondary schools, and student movement occurs throughout the school year due to external factors. The choice of secondary school is largely personal, and indications made by Grade 6 students as to the secondary school they would be attending were subject to change. For this reason, the duration of the study was necessarily brief, involving three data collection points for one group of students and two data collection points for another group of students. These data collections will be described more fully in later sections.

4.3 Procedures

Ethical approval was applied for and obtained for this project in April 1995 from the Monash University Standing Committee on Ethics in Research on Humans (Appendix 1). Permission was also obtained from the Department of School Education (DSE) to conduct research in Government schools (Appendix 2).

In 1995, the DSE grouped all schools in the southern and eastern suburbs of Melbourne into a single region, the South-East region. Three areas were chosen by the researcher as representative of the different school populations within this region, these were in the local government areas of Stonnington, Casey and Yarra Ranges.

After permission was obtained from the DSE administration for the region, five primary schools, selected at random from a list of those in each area, were approached by letter early in the second term to participate in the study. Three of these schools responded favourably and meetings with the principal and Grade 6 teacher / co-ordinator were conducted in weeks three and four of term two to explain the purpose of the study and the methodology with which it would be conducted. The entire cohort of Grade 6 students present at the time of data collection in terms two and four were to be surveyed, and explanatory statements and permission slips for both students and parents were given out and collected by the school on behalf of the researcher (Appendix 3).

The school in the Stonnington area is situated in a largely affluent inner-suburban area of Melbourne in close proximity to a large number of non-government schools. Most of the students attending the primary school will continue their secondary education at one of these non-government schools. Casey schools are situated in working class middle-suburban areas, and the students in grade six at this school are most likely to attend one of the local government schools. The Yarra Ranges schools are situated in an outer suburban, largely middle class area. Most of the students from these will attend the government secondary college either in the immediate township or in the adjacent town, while a small number will attend non-denominational independent schools.

All surveys were to be administered by the researcher, and all instruments were printed prior to visiting the schools. The researcher was at all times sensitive to the increased workload of classroom teachers, and so every endeavour was made not to add to this workload. It was emphasised to teachers that they would be free to carry on with other work while the survey administration was in progress, and that the researcher, being a qualified teacher then registered with the DSE, would be competent to manage their class. Principals and classroom teachers appeared to be quite happy with this arrangement.

The middle weeks of term two 1995 proved to be very busy for schools in the region. The initial administration of the Learning Assessment Project (LAP) was carried out with Grade three and five students at all participating schools, and as many of the classes involved in the study were composite Grade five and six classes, this created extra pressure on the teachers and students involved in the study. The week following the LAP testing was designated as Education Week in Victoria, and all schools were involved in community and school based activities for this week.

In the week following Education Week data collection occurred without any problems at two of the three primary schools. However on the day prior to data collection at the third primary school, the Grade 6 co-ordinator withdrew the school from the study, citing the reason for this withdrawal as the increased workload for the grade six teachers that the study would cause. During the following week the school was contacted repeatedly by the researcher to attempt to alleviate misconceptions about the amount of work involved for teachers, however the co-ordinator was adamant that the school would no longer participate in the study.

The term was rapidly drawing to a close and student reports and parent teacher interviews were being planned for the last week of term, so it was vital that a replacement school was found immediately. Personal contact was made with a principal at another primary school in a similar area to the one that had just dropped out of the study, and after discussion with the principal and the three grade six teachers this school agreed to participate in the study. Permission slips and explanatory statements were given out and collected in this week and the data collection occurred in the second last week of term two.

In fourth term of 1995, it was clear that due to attrition, a much larger sample would be required, and so a further fifteen primary schools were approached. After discussions with the Stonnington school about the difficulty of tracking their students after completion of grade six (the 21 students were expected to spread out to some 15 different secondary schools), it was decided that no other schools in this area would be targeted. As well, it was the aim of the researcher that the research design should be limited as much as possible to Government primary and secondary schools in order that cross-system variability could be controlled in some way. The fifteen primary schools thus approached were schools in areas close to those already sampled, with the intention being that the participating secondary schools would receive students from different primary schools participating in the grade six sample. Seven of these primary schools agreed to participate in the study and so over a four week period during late November and early December 1995, ten schools (including the initial three) were surveyed. There were 154 students who were involved in the first stage of the study; 76 females and 78 males, and 510 involved in the second stage; 231 females and 279 males. The number of male and female students from each school who participated in Stage 2 of the project are shown in Table 4.1

Table 4.1
Number of Male and Female Students at Each Primary School in Stage 2

	Primary Schools										
	YR				**S**	**C**					
School ID	3	4	5	7	2	1	6	8	9	10	Total
Females	48	7	17	10	8	32	16	24	46	23	231
Males	38	13	14	27	13	33	41	27	52	21	279
Total	86	20	31	37	21	65	57	51	98	44	510

Note: Schools 1, 2 and 3 also participated in Stage 1 of the study.
YR= Yarra Ranges, S = Stonnington, C = Casey

The secondary school sample was largely determined by the transition intentions of the primary school students. At the end of the survey administered in term four of their Grade six year, students were asked to indicate which secondary school they planned to attend. Twenty-seven secondary schools were listed by these students, not including the non-government schools from the Stonnington school sample, and so a subset of twelve secondary schools was chosen, representing 82.4% of the students surveyed in term four of Grade 6.

One of these schools was a government school situated in the Stonnington area, and although only four students were intending to attend this school, it was retained in the sample because it was felt that it might still provide a useful contrast to the other areas, although of course statistical analysis on the basis of only four students would be meaningless. Two non-government schools were included in the secondary school sample. One of these schools is a Catholic secondary college that caters for an ethnically diverse, largely working class population. It is a very different school from the Stonnington non-government schools. The school agreed that they would participate in the study, however an illness on the part of the co-ordinating teacher meant that the school was not able to participate in the study within the time frame set by the researcher. The other non-government school is a Christian independent school set in a rural area of the outer eastern suburbs. This school was included in the sample because students from a number of schools in both the Casey and Yarra Ranges areas attended the school, and it was felt that this might provide a different perspective to the other schools.

The remaining nine schools were all government schools, and eight of these agreed to participate in the study. Accordingly, the names of participating students were forwarded to either year seven or mathematics co-ordinators, permission and explanatory letters were forwarded to students and parents, and dates were set for data collection. Table 4.2 shows the movement of primary students to the particular secondary schools that participated in stage 3 of the study. A total of 418 students' names were submitted to these secondary schools, and eventually 302 students were surveyed in term two of their first year at secondary school, 148 females and 154 males. While all secondary schools in the study claimed to address transition by providing students with such things as peer group support, orientation camps and parent meetings, no school indicated that their transition programs addressed any specific cognitive or other psychological aims.

Data collection at the secondary schools was fraught with problems. As the number of students participating in this project was generally only a small proportion of all the Year 7 students at the school, these students had to be withdrawn from class to complete the questionnaire. Teachers were quite willing for this to occur for one class period, but it caused some problems for both school and students. Students, participating voluntarily in a research project for which they would receive no tangible reward, would have to return to class and catch up on any work missed out on in that class. Some students thought that this was quite unfair and withdrew from the study at this point. When large groups of students were withdrawn to complete the survey, the whole year level could be affected. For example at school E, where 77 students participated in the study, all other Year 7 classes were collapsed and given private study for the period. Because of this disruption, no return visits were conducted to follow up students absent on the day of the survey administration.

All of the schools are coeducational, and most cover Year levels 7 through to 12. The exceptions to this are schools EH, G, H and F in the Casey area which are junior campuses feeding into the same senior secondary college. School G was only opened in 1996, with an initial intake of Years 7 and 8 students only.

Table 4.2
Movement of Students from Primary to Participating Secondary Schools

			Secondary schools									
			YR				C					S
			E	M	U	B	D	F	G	EH	L	C
Primary Schools		enrolment	*1000*	*600*	*1200*	*800*	*1100*	*900*	*400*	*500*	*1040*	*850*
YR	3	*535*	63	6		5						
	4	*250*	2	12	2							
	5	*240*	23			5						
	7	*400*	6	3	12	1						
S	2	*230*										4
C	1	*440*				2	5	1	4	15	15	
	6	*525*				2	4		14	26	1	
	8	*430*					8		30	3	1	
	9	*375*				3		37	35			
	10	*710*				2	3		23	1	6	

YR = Yarra Ranges, C= Casey, S = Stonnington

4.4 Data collection

All surveys and achievement tests were administered at each stage of the study by the researcher. Students were told the basic purpose of the research; that is that their opinions were being sought about mathematics as a subject, ways to do well in mathematics, their mathematics classroom, and about their own ability in mathematics. They were advised of the complete confidentiality of the data, and assured that none of their answers would be reported directly to their teachers, parents, peers or the school.

Students were then asked to complete the questionnaire and a short mathematics test, the Progressive Achievement Test in Mathematics 2A (PAT Maths, Australian Council for Educational Research, 1984). None of the students refused to do either, however although they seemed quite happy to complete the questionnaire there were grumbles about the test, and some students became quite anxious. The questionnaire was read to the students to obviate any particular reading problems, and students were encouraged to ask questions regarding any lack of understanding of any part of the questionnaire. The PAT Maths test was administered under the guidelines given by the Australian Council for Educational Research (ACER).

The students first completed the composite questionnaire, and following this, they completed the PAT- Maths 2A test. After both the questionnaire and test were completed, students were invited to ask any questions they may have had about the nature or purpose of the study, and a number availed themselves of this opportunity. In general, while the students were finishing these tasks, the teachers completed the engagement questionnaires on each student.

Procedures in stage 2 were much the same as for stage 1, except that the PAT-Maths test was not carried out. There were a number of reasons for the non-inclusion of the achievement test. Foremost among these reasons was the amount of anxiety exhibited by many of the students at the mention of a "maths test". It was considered by the researcher to be counter - productive to include an experience that caused feelings like this in the students participating in the study. As well, given the arguments presented by Nicholls *et al.* (1989), discussed in Chapter 2), and that the aim of the research was to investigate motivational beliefs over transition, the non-inclusion of the achievement test was acceptable within the framework of this study. Practical reasons also had a bearing on this decision in that teachers only had limited time that they were prepared to give to the project, and the administration of the PAT-Maths test would have necessitated another time period out of the day taken up. Time constraints brought about by school commitments were also a factor, with many students participating in end of year school concerts and orientation days at their proposed secondary schools.

Data collection at Stage 3, midway through the second term of the Grade seven year, was of necessity conducted in a different manner. All the secondary schools are large, and the students participating in this study were usually only a small percentage of the total number of grade seven students present at the school. Therefore, it was necessary in general to withdraw the participating students as a group from class and administer the questionnaire to them. The questionnaire was not read to the students at this level, and only one student had obvious difficulties reading it. The researcher read the questionnaire to this student.

After completion of the questionnaire, the students were asked for any questions or comments, and generally the discussion centred on their new secondary school and how they felt about being in Year seven. The students were then thanked for their participation in the study.

A number of students were approached to be interviewed, however a very low response rate was obtained for this despite the letters being distributed by and with the blessing of the school. The interviews that resulted were conducted in rooms separate from other teaching rooms, so that complete privacy was assured. The interviews were audiotaped and transcripts made.

4.5 Instruments

Several different instruments were used at each stage of the study. The general student questionnaires will be discussed in this section, and then the short answer questions will be discussed.

The basic student questionnaire, the Student Perceptions of Control Questionnaire (*SPOCQ*), and the Teacher perceptions of student engagement questionnaire are both included in the Rochester Assessment Package for Schools (RAPS, Wellborn and Connell, 1987), and were reworded to refer specifically to mathematics. The questionnaire was piloted in the current form in first term of 1995 with all of the Grade five and six students and all of the teachers at one primary school. Any items that students or teachers flagged as difficult to understand were discussed and alternative wordings formulated. While care was taken to ensure that the original meaning of the question was retained, some questions were reworded to reflect Australian rather than American student vernacular. Attributions to luck were a common discussion point for a number of the students who trialled the questionnaire. Luck is not commonly thought to be associated with mathematics, and many students rejected any links between the two. For another group of students however, luck was vital for success in mathematics. Usually, luck was associated with being asked the "right" questions, the ones the student had particularly studied or learnt, or just those particular questions the student found easy. Bad luck was commonly associated with studying the wrong topic or being asked questions that had not been learnt.

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Included in Appendix 4 are student questionnaires for each stage of the study. The student instrument consisted of questions about students' general attitudes towards mathematics and beliefs about mathematics, questions about perceived teacher involvement, teacher autonomy support, teacher structure, relatedness, competence, engagement, coping and classroom environment, and questions about perceived ability and perceptions about other people's beliefs about the particular student's ability. These are described individually in the sections that follow.

4.5.1.1 Your views about mathematics

In the first part of the questionnaire, eleven items tapped students' liking of mathematics, persistence, perception of usefulness of mathematics, perceptions of mathematics as rule bound, open-mindedness and understanding of mathematics, on a four point Likert-type scale ranging from not at all true to very true.

The second part of the questionnaire consisted of a number of different subscales that are described in more detail.

4.5.1.2 Perceptions of teacher involvement, autonomy support and provision of structure

Perceptions of teacher involvement, provision of autonomy support and structure indices were taken from the Rochester Assessment Package for Schools (RAPS). Four self-report items assessed the degree to which students felt that their teachers cared personally for them and were involved in their learning (for example "*My teacher has plenty of time for me in mathematics"*). Four self-report items each assessed students' beliefs about autonomy support, such as "*My teacher lets me make decisions about my work in maths*", and teacher provision of structure such as "*The rules in my classroom are clear*". Each was rated by students on a four-point Likert-type scale, with responses ranging from not at all true to very true.

4.5.1.3 Perceived Control

This scale was also based on the RAPS questionnaire. It asked students to assess, on the same four-point Likert scale, statements about the degree to which they feel they are in control of their learning, the extent to which they believe that outcomes in mathematics are due to effort, ability, powerful others, luck, or unknown causes (*strategies*), and the extent to which they feel they are able to enact these causes (*capacities*). As shown in Chapter 3, strategy and capacity beliefs for all known causes are linked, so that the questionnaire not only examined whether students believed that particular strategies are successful, but whether they have the capacity to execute the particular strategy. Examples of such items are: "*Trying hard is the best way for me to do well in maths*" (effort strategy), and "*I can work really hard in maths*" (effort capacity).

Several interaction scores were calculated, using the method described by Pierson and Connell (1992) and Skinner, Wellborn & Connell (1990). Using these interaction scores, a summary score, CONMAX, was calculated which combined the interactions of the strategy and capacity beliefs that theoretically or empirically promote motivation and the interactions of the strategy and capacity beliefs that theoretically or empirically undermine motivation. The rationale for forming this combined score was given by Pierson and Connell, and although somewhat lengthy, it is included in its entirety as it provides empirical support for the use of this particular summary score.

> For effort, high strategy and high capacity beliefs are predicted to promote motivation, so the interaction score for effort is calculated by multiplying Effort Strategy by Effort Capacity. For ability, research has shown that an over-reliance on ability as a strategy can undermine motivation, so interaction scores are calculated by multiplying the additive inverse of Ability Strategy by Ability Capacity. For powerful others and luck, the detrimental effects of endorsing these strategies can be exacerbated by believing one lacks the capacity to influence them. Hence interaction scores are calculated by multiplying Powerful Others Strategy by the additive inverse of Powerful Others Capacity. The Promote and Undermine summary scores each include beliefs from all four causal categories as well as Control and Unknown Strategy beliefs. (Pierson and Connell, 1992, p. 304)

Higher values on the perceived control construct (CONMAX) reflect high levels of perceived control over positive and negative outcomes in mathematics ("*I can succeed in mathematics if I want to*"), high strategy and capacity beliefs for effort ("*Effort is an important way to succeed, and I can work hard*"), low strategy and high capacity beliefs for ability ("*Ability is not particularly important for succeeding in* *maths, but I am smart*"), low strategy and high capacity beliefs for powerful others and luck ("*Luck is not critical to success in maths, but I'm lucky, and getting the teachers to like me isn't vital for success, but I can get my teachers to like me*"), and low unknown strategy beliefs ("*I understand the causes of success and failure in mathematics*").

Skinner (1995) argued that while missing any of the elements of this "optimal profile" could be considered maladaptive, the most maladaptive profile would include: low control beliefs, high strategy and low capacity beliefs for effort, ability, powerful others and luck ("*All these causes are important, but I can't use them*"), and high strategy unknown beliefs.

4.5.1.4 Coping style

Items indicating student coping style were also derived from the RAPS, which was based on work originally carried out by Tero and Connell (1984). Items in the scale depict academic failure situations such as not doing well on a test or not understanding what the teacher was explaining, and ask the student to rate items on a four point Likert-type scale ranging from not at all true to very true.

The scale measures students' coping styles along four dimensions: projection ("*I say the teacher probably didn't explain the work properly*"), positive ("*I say that I'll try harder next time*"), denial ("*I say I didn't care about it anyway*") and anxiety ("*I worry that the other students will think I'm stupid*"), which form subscales.

4.5.1.5 Relatedness

A number of subscales measured perceived relatedness; all were taken from the RAPS. The subscales are relatedness to self, ("W*hen I think about myself I feel happy*"), teacher emotional security ("W*hen I'm with my teacher I feel relaxed*") and peer emotional security ("*When I'm with my classmates I feel tense*"). Students again rated the statements using a four point Likert-type scale ranging from very true to not at all true.

4.5.1.6 Autonomy

Autonomy is measured in the RAPS instrument by looking at self-regulation and the items in the current instrument are taken from this. Students' perceptions of their reasons for performing various behaviours such as "*Why do I work in maths classes?*" was assessed along four subscales: external ("*Because the teachers say we have to*"), introjected ("*Because I'll feel guilty if I don't*"), identified ("*Because doing well in school is important to me*") and intrinsic ("*Because it's interesting*"). Students rated these items on a four point Likert-type scale ranging from not at all true to very true.

4.5.1.7 Engagement

Items forming the engagement scale were also taken from the RAPS. These items assessed beliefs about positive affect ("*When I'm in maths class I feel happy*"), and degree of involvement ("*When I'm in maths classes I usually just act as though I'm working*"). Items were rated on a four point Likert-type scale ranging from not at all true to very true. The scale yielded a single factor solution, and so the scores were combined to form a total engagement score.

4.5.1.8 Classroom environment

The items forming this scale were taken from the Individualised Classroom Environment Questionnaire [*ICEQ*] (Fraser, 1990). The subscales used assess students' views on personalisation of the classroom ("*The teacher considers students' feelings*"), participation ("M*ost students take part in discussions*"), independence

("*Students choose their own partners for group work*"), and differentiation ("*Different students use different books, equipment and material*"). Students rated their responses on a five point Likert-type scale ranging with responses ranging from almost never to very often.

4.5.1.9 Ratings in mathematics

Students were asked to rate on a scale of 1 = weak to 5 = excellent, how good they thought they were in mathematics, how good they would like to be, where their teacher, parents and classmates would place them on the scale, and how good they and their parents would like them to be at mathematics.

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While students were completing their questionnaire, teachers completed the *Teacher rating of student engagement questionnaire* (Appendix 5) for each student present on the day. This questionnaire was based on that included in the RAPS, but expanded to allow for a number of other constructs.

Connell and Wellborn (1991) described engagement and disaffection as patterns of action. Three types of engagement are described in Figure 4.1. Extra questions were formulated and added to the existing questionnaire, so that each type of engagement was included. Several items felt by the teachers who trialled the questionnaire to also be indicators of engagement were included in the final instrument. These items were "*This student organises his/her work well*", and "*This student makes careless mistakes in his/her work*".

Cognitive engagement	**Behavioural engagement**	**Emotional engagement**
Flexible vs rigid problem solving Active vs passive coping with failure Attention vs boredom Preference for hard work vs easy work Independent vs dependent work styles Independent vs dependent judgements	Class participation vs uninvolvement On task vs off task behaviour Extra-curricular academically oriented vs extra-curricular non-academically oriented Drop outs Classes skipped Tardiness	Nervousness Curiosity Excitement Anger Discouragement Happiness Boredom Interest Sadness

Figure 4.1 Types of engagement used in construction of original engagement questionnaire (Connell and Wellborn, 1991, p. 54)

Teachers rated the behaviours listed on the questionnaire on a 5-point Likert - type scale ranging from almost never to very often. Scoring of the engagement questionnaire produced a combined score for engagement that could range from -4 to +4, with positive values indicating engagement and negative values reflecting disaffection.

4.6 Additional questions

At each stage of the study, a number of questions were asked to elicit more details about students' beliefs about mathematics, their hopes and fears about transition, what they expected of secondary school, and then whether these expectations or fears were realised. Students were provided with several lines in which to answer these questions, and were invited to write as much as they wanted. The additional short-answer questions for each stage of the study are shown in Table 4.3.

Table 4.3
Additional Short Answer Questions Asked at each Stage of the Study

Stage 1	
	Do you like maths? Explain why or why not. Do you think your teacher likes teaching maths? Explain why you think this. What do you think makes a person good at maths? Do you think you are good at maths? Explain why you think this.
Stage 2	
	Do you like maths? Explain why or why not. What secondary school do you plan to go to next year? What do you think will be the best things about going to secondary school? Is there anything about secondary school that you aren't looking forward to? What will you miss about primary school? Do you think that maths classes will be different in secondary school than they are in primary school? If so, how do you think things will be different?
Stage 3	
	Do you like maths? Explain why or why not. What have you liked **most** about going to secondary school? What have you liked **least** about going to secondary school? Do you miss anything about primary school? Have you found maths classes are different than they were in primary school? If you have, what would you say is the difference? How do you think you are doing in maths compared to primary school? Circle one of these. **Better** **About the Same** **Worse** If this is better or worse, why do you think this is?

4.7 Summary

This chapter has described the longitudinal study design for this research, and how the study was carried out. Problems were encountered with schools withdrawing from the study, attrition of students from Grade 6 to Year 7, and with obtaining interviews with students, and the method of addressing each of these problems was discussed. Initially three primary schools participated in the study; this was expanded to cover ten primary schools at the end of grade six and then a sample of ten secondary schools chosen so as to maximise catchment of the grade six students from the previous year.

A variety of scales and questions made up the student questionnaire; these measured beliefs about mathematics, perceptions of autonomy support, involvement and provision of structure, perceived control, coping style, autonomy, relatedness, engagement, classroom environment and self-ratings in mathematics. An interaction score (CONMAX) was calculated that combined the interactions of the strategy and capacity beliefs that are believed to promote motivation and the interactions that are believed to undermine motivation. Higher levels on the interaction score reflect more positive profiles of perceived control.

The instruments were next subject to validation using factor analysis and reliability analysis, and the description of this validation will form the contents of the next chapter.

Chapter 5

Validation of instruments

5.1 Introduction

In the previous chapter, the instruments used in this study were described. This chapter provides details about the validation of these instruments. The scales from the Student Perceptions of Control Questionnaire (*SPOCQ*) have been used in the United States and in Germany (see for example Connell and Wellborn, 1991; Patrick *et al.*, 1993; Pierson and Connell, 1992; Skinner and Belmont, 1993; Skinner, Wellborn & Connell, 1990), but there have been no studies published using these instruments with Australian students, and no studies examining belief systems within the specific area of mathematics. The Individualised Classroom Environment Questionnaire (ICEQ, Fraser, 1990) has been used widely in the specific context of mathematics with Australian students.

Principal components analysis was carried out on the engagement questionnaire and on each section of the student questionnaire to assess uni-dimensionality. This was deemed to be particularly important with the scales from the SPOCQ, because they had not been used with Australian students before. Gardner (1996) has argued that factor analysis is an essential step in the justification of a summated scale, as "the central assumption underpinning this method is that of uni-dimensionality, i.e. that that all the items in the scale inter-correlate with each other … and therefore measure a common construct"

(p. 913). Consistent with common practice factors loading less than .3 are not reported. Reliability analysis was also carried out with each of the scales used, and the results of all factor and reliability analyses are reported in this chapter.

5.2 Data screening

At each stage of data entry, checks were carried out on the accuracy of the computer coding. A random sample of 10% of students was selected and their data entries checked against the original manuscripts for keystroke errors. At each stage of the data entry, the percentage of keystroke errors was found to be extremely small (less than .001%). Frequency analysis was carried out for each variable and no variables were found with entries outside of the accepted range.

The data were then screened for outliers. Mahalanobis distance with $p < .001$ was used to screen for multivariate outliers on the perceived control constructs. One student was deleted from the study after the screening results found him to be both a univariate and multivariate outlier, and the classroom teacher revealed that this child was suffering particularly traumatic domestic problems.

5.3 Missing data

Examination of the data set during the data entry process revealed that there were few missing items of data, and that any such data were randomly distributed. Tabachnick and Fidell (1989) noted that while missing data can be a problem in data analysis, "the pattern of missing data is more important than the amount missing. Missing values scattered randomly through the data matrix rarely pose serious problems" (p. 61).

The frequency of missing data was highest for the teacher report items that assessed student engagement and teacher rating of student ability (4% and 3%, representing 40 out of 936 and 30 out of 936 cases respectively), however for student self rating items the amount of missing data did not exceed 2% (20 cases out of 936).

5.4 Perceived control beliefs

Consistent with the original analysis of data conducted by Skinner *et al.* (1988), principal components analysis was carried out separately on each category of known causes (Table 5.1). The aim of these analyses was to examine the data for each cause to see if the three-factor solution corresponding to strategy, capacity and control beliefs was present, as found in previous studies. For unknown causes, only two factors were expected, because there could be no capacity beliefs for unknown causes. The three-factor solution was able to be achieved with eigenvalues either greater than 1 or very close to 1.

Variables loaded as expected from previous research, with few exceptions. The report of the factor analysis in the original report on the development of the scale (Skinner *et al.*, 1988), showed similar factor patterns, with loadings ranging from .34 to .86. The results of the principal components analysis conducted for this study provide further evidence for the acceptability of the predicted three-factor solution for each category of known means in this perceived control model, corresponding to control, strategy and capacity beliefs.

Table 5.1
Eigenvalues and Factor Loadings (Varimax Rotation) for Perceived Control Scales, Stage 2

Scale	Factor	I	II	III
Ability				
	Eigenvalues	**2.67**	**1.27**	**.99**
Control		.59		
		.79		
Capacity beliefs			.75	
			.72	
Strategy beliefs				.75
				.60
Effort				
	Eigenvalues	**2.09**	**1.13**	**1.02**
Control		.40		
		.72		
Capacity beliefs			.64	
			.75	
Strategy beliefs				.55
				.80
Luck				
	Eigenvalues	**2.23**	**1.09**	**.96**
Control		.56		
		.76		
Capacity beliefs			.68	
			.77	
Strategy beliefs		(.36)		.59
				.77
Powerful Others				
	Eigenvalues	**1.87**	**1.32**	**1.07**
Control		.84		
		.78		
Capacity beliefs		(-.48)	.71	
			.66	
Strategy beliefs				.65
				.62
Unknown				
	Eigenvalues	**1.65**	**1.08**	
Control		.76		
		.49		
Strategy beliefs			.75	
			.57	

Note. Factor loadings less than .30 have been omitted. Factor loadings in brackets indicate items that cross-loaded on other factors.

The principal components analysis was followed by reliability analysis for each scale at each stage of data collection. These results are shown in Table 5.2.

Table 5.2
Reliability Analysis on Perceived Control Variables

Scale	Stage	No. of items	Scale Mean	Scale SD	Cronbach α
Control	1	2	3.44	0.70	.35
	2	2	3.40	0.70	.51
	3	2	3.43	0.95	.54
Capacity beliefs					
Ability	1	2	3.06	0.84	.79
	2	2	2.99	0.84	.81
	3	2	3.04	0.80	.81
Effort	1	2	3.58	0.64	.53
	2	2	3.53	0.59	.42
	3	2	3.39	0.62	.44
Luck	1	2	2.89	0.73	.30
	2	2	2.88	0.66	.41
	3	2	2.90	0.66	.43
Powerful Others	1	2	3.20	0.73	.44
	2	2	2.94	0.76	.45
	3	2	2.98	0.67	.46
Strategy beliefs					
Ability	1	2	2.06	0.84	.61
	2	2	2.14	0.81	.57
	3	2	2.07	0.75	.60
Effort	1	2	3.35	0.62	.38
	2	2	3.36	0.57	.39
	3	2	3.32	0.57	.38
Luck	1	2	2.18	0.82	.45
	2	2	2.31	0.76	.44
	3	2	2.14	0.68	.44
Powerful Others	1	2	1.47	0.67	.58
	2	2	1.61	0.78	.67
	3	2	1.61	0.70	.66
Unknown	1	2	1.82	0.86	.74
	2	2	1.87	0.78	.63
	3	2	1.79	0.75	.68

Means and standard deviations reported in Table 5.2 are the result of the scale mean and standard deviation divided by the number of items, in order that scores on different scales can be compared.

Reliability coefficients for some scales were not particularly high, as would be expected from a two-item scale. However as the factor analysis for these variables is robust, the conclusion from this particular analysis would be that the scale used in practice is acceptable as it agrees with that found in previous research. It can also be seen from Table 5.2 that reliability generally increased over the duration of the study.

5.5 Engagement

The questions that corresponded to the proposed student-rated engagement scale were entered into principal components analysis and one eigenvalue (3.71) was found to be significant. All questions loaded onto this single factor, and subsequent reliability analysis found that the Cronbach alpha coefficient was .82 at stage 1, .80 at stage 2 and .87 at stage 3. The questions were thus deemed to form an acceptable scale.

The principal components analysis on items comprising the proposed teacher-rated student engagement scale produced one eigenvalue of 16.33, and all items loaded onto this factor, with loadings ranging from .40 to .86. Reliabilities were found to be extremely high for this scale; .93 at stage 1, .97 at stage 2 and .95 at stage 3. These results indicated that the engagement questions are all measuring the same construct, and therefore it was appropriate that scores on these items be combined to form a total engagement score.

5.6 Self-regulation

Table 5.3 shows the eigenvalues and factor loadings for the self-regulation scale, and Table 5.4 shows the scale descriptive statistics and alpha values. The principal components analysis showed that the items loaded as expected from previous research, onto the scales previously labelled as intrinsic, introjected, external and identified self-regulation.

Table 5.3
Eigenvalues and Factor Loadings (Varimax Rotation) for Self-Regulation Scale, Stage 2

Scale	Factor	I	II	III	IV
Self-regulation					
	Eigenvalues	**3.09**	**1.87**	**1.64**	**.91**
Intrinsic		.71			
		.64			
Introjected			.85		
			.73		
External				.86	
				.65	
Identified		(- .38)			.79
					.54

The reliabilities of the self-regulation scales, as shown in Table 5.4, were found to be acceptable, with highest values for the identified and intrinsic subscales.

Table 5.4
Reliability Analysis of Self-Regulation Variables

Scale	Stage	No. items	Scale Mean	SD	Cronbach α
External	1	2	1.92	0.84	.59
	2	2	2.17	0.93	.69
	3	2	2.29	0.92	.74
Introjected	1	2	2.04	0.95	.67
	2	2	2.08	0.91	.60
	3	2	2.14	0.85	.60
Identified	1	2	3.61	0.63	.81
	2	2	3.45	0.87	.69
	3	2	3.31	0.80	.83
Intrinsic	1	2	2.91	1.02	.88
	2	2	2.61	0.92	.82
	3	2	2.51	0.99	.86

5.7 Coping

Table 5.5 shows the results of the principal components analysis and Table 5.6 the results of the reliability analysis for the coping scale. The principal components analysis produced four eigenvalues either greater than 1 or slightly less than 1, and variables loaded onto the predicted factors.

Table 5.5
Eigenvalues and Factor Loadings (Varimax Rotation) for Coping Scale, Stage 2

Scale	Factor	I	II	III	IV
Coping					
	Eigenvalues	**2.51**	**1.39**	**1.21**	**.97**
Projection		.71			
		.70			
Positive			.75		
			.64		
Denial				.66	
				.54	
Anxiety					.70
					.66

Reliabilities for the coping style scale (see Table 5.6) showed reasonably strong reliability for each subscale at each stage of the data collection.

Table 5.6
Reliability Analysis of Coping Scales

Scale	Stage	No. of items	Scale Mean	Scale SD	Cronbach α
Projection	1	2	1.54	0.75	.65
	2	2	1.63	0.76	.73
	3	2	1.68	0.67	.68
Positive	1	2	3.60	0.60	.65
	2	2	3.49	0.59	.56
	3	2	3.38	0.66	.59
Denial	1	2	1.92	0.74	.59
	2	2	2.00	0.73	.61
	3	2	2.08	0.77	.68
Anxiety	1	2	2.20	0.97	.70
	2	2	2.51	0.85	.69
	3	2	2.41	0.85	.69

5.8 Relatedness

The results of principal components analysis for the relatedness variables are shown in Table 5.7. Three eigenvalues greater than 1 were found, and items loaded cleanly onto three factors. The factors represent the previously described relatedness to teachers, self and peers.

Table 5.7
Eigenvalues and Factor Loadings (Varimax Rotation) for Relatedness Scale, Stage 2

Scale	Factor	I	II	III
Relatedness				
	Eigenvalues	3.45	1.89	1.44
Teachers		.77		
		.67		
		.76		
		.51		
Self			.81	
			.77	
			.74	
			.69	
Peers				.73
				.74
				.76
				.68

Cronbach alpha values for these subscales (shown in Table 5.8) were found to be consistently high, indicating that the instrument was reliable at each stage of the data collection.

Table 5.8
Reliability Analysis of Relatedness Scales

Scale	Stage	No. of items	Scale Mean	SD	Cronbach α
Self	1	4	3.06	0.67	.74
	2	4	2.96	0.69	.76
	3	4	3.03	0.69	.82
Teachers	1	4	3.02	0.74	.75
	2	4	2.95	0.67	.70
	3	4	2.98	0.68	.74
Peers	1	4	3.46	0.59	.71
	2	4	3.45	0.60	.74
	3	4	3.46	0.62	.80

Table 5.9 shows the results of principal components analysis on the ICEQ questionnaire (Fraser, 1990). Four of the ICEQ subscales, *Personalisation* (PE), *Participation* (PA), *Independence* (ID) and *Individualisation* (IV), were included in the current questionnaire. However, the principal components analysis on this data failed to replicate the factor structure that Fraser (1990) implied that it should have. A thorough search failed to find any published factor analysis on the *ICEQ*, and while cited reliabilities for these subscales were high, Gardner has argued most fervently that "*internal consistency does not provide sufficient evidence of uni-dimensionality*" (author's emphasis, 1996, p. 918).

It can be seen from this table that in this study all of the personalisation (PE) and participation (PA) items load onto a single factor. Factor 2 appears to reflect the amount of discipline and teacher directedness in the classroom, including items such as "*Students who break the rules get into trouble*" and "*The teacher decides how much movement and talk there should be in the classroom*". Factor 3 appears to reflect differentiation ("*Different students do different work*") and choosing partners for work ("*Students choose partners for group work*", "*The teacher decides which students should work together*"), while Factor 4 consists of all the work-oriented questions, for example "*Students who work faster than others move on to the next topic*", and "*Students are told exactly how to do their work*".

Table 5.9
Eigenvalues and Factor Loadings (Varimax Rotation) for Classroom Environment Scale, Stage 2

Factor	I	II	III	IV
Eigenvalues	**8.43**	**2.95**	**2.13**	**1.75**
Item				
PA 4	-.81			
PE 3	-.80			
PE 6	.78			
PE 1	.77			
PA 8	.73			
PA 3	-.69			
PE 4	-.68			
PA 1	.65			
PA 9	.65			
PE 2	.63			
PE 5	.60			
PE 8	.57			
PA 2	.50			
PE 9	.50			
PE 10	.48			
PA 10	.47			
PE 6	.44			
PE 7	.44			
PA 7	.39			
D 1	.38			
PA 5	.38			
ID 9		-.78		
ID 6		.74		
ID 4		-.60		
ID 8	(.35)	-.59		
ID 10		-.58		
ID 5		-.35		
D 4			.62	(.32)
ID 1			-.59	
ID 7			-.58	
D 5			-.55	
D 7			.49	
ID 2			-.32	
D 8		(.43)		-.48
D 6				-.48
D 10				-.46
ID 3				-.44
D 3				.43

Note: PE: Personalisation, PA: Participation, ID: Independence, D: Differentiation

As the ICEQ questions did not replicate the factor structure for which they were selected, the characteristics that they were supposed to measure could not be assumed to form a scale. Consequently, no further analysis was carried out on this particular part of the questionnaire for the present study.

5.9 Summary

This chapter described the analyses concerning the validity of the scales chosen to be used in this study. Data were screened for keystroke errors and for outliers and missing data were examined and found to be randomly distributed. Principal components analysis of the perceived control items on the questionnaire provided evidence that a three-factor solution was appropriate, corresponding to strategy, capacity and control beliefs. The scales pertaining to teacher and student-rated engagement, self-regulation, coping and relatedness were all found to be similar in factor structure to those described in previous research, and reliable within the limits of this study.

The items relating to the ICEQ questionnaire, however, were not found to conform to previously published subscales, and no principal components analysis on this questionnaire was able to be located. As such it was decided that this scale could not be used in the present study.

In the next chapter the initial data analysis is discussed, including an examination of the changes in each of the scales over the transition to secondary school.

Chapter 6

Cross-sectional comparisons

6.1 Introduction

This chapter presents the results of the analysis of data obtained from the student and teacher questionnaires at each stage of the study. As the study was longitudinal, the aim being to examine the changing attitudes to and beliefs about learning mathematics over the primary - secondary school transition, separate data analyses were carried out to examine both the effects within each sample and the effects between samples. This chapter will deal with the cross-sectional data analysis while chapter 7 will deal with the longitudinal analysis.

6.2 Research questions

In order to begin to examine the major research question, it was important to first look at the perceived control model to see whether the relationships described in the literature for general beliefs about school were valid in the particular context of mathematics. The following research questions were then explored in this section of the data analysis:

- What are the relationships between the perceived control variables and teacher-rated student engagement?
- Are these the same before and after the transition to secondary school?

6.3 Statistical methods

A number of different statistical methods were employed in the analysis of the data, in order to examine both the longitudinal effects of all of the variables and the cross-sectional contribution of the perceived control variables to Teacher-rated student engagement.

Initial data analysis, comprising descriptive statistics, correlations and regression procedures was carried out on the whole data set collected at each stage of the study.

6.4 Analysis of cross-sectional data: Aims

Skinner, Wellborn and Connell (1990) proposed that beliefs that indicated that students felt that their school performances were out of their control were those most likely to undermine engagement in learning. These beliefs include high strategy beliefs for powerful others, luck or unknown factors, and a low belief in one's own ability or capacity to exert effort. If the perceived control model applies within the specific context of mathematics, these beliefs would correlate negatively with teacher-rated student engagement. As well, high control beliefs would correlate positively with engagement, and engagement would correlate positively with achievement and teacher rating of student achievement.

The data analysis in this initial stage was also to a large extent exploratory, investigating whether beliefs were different before and after the transition to secondary school.

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6.4.1.1 Descriptive Statistics

The descriptive statistics for the perceived control beliefs for the 154 students who participated in stage 1 of the study are shown in Table 6.1. Paired sample t-tests were carried out, revealing that effort was perceived as the most effective strategy for influencing performance in mathematics (effort *vs* luck, $t_{153} = -15.32$, $p < .001$) followed by luck and ability (ability *vs* unknown, $t_{153} = -2.10$, $p < .01$) then unknown, while powerful others was seen as having little importance ($t_{153} = 4.92$, $p < .001$). For capacity beliefs, students rated effort as the easiest cause to enact, with powerful others, ability and luck decreasingly less accessible to them (effort *vs* powerful others, $t_{153} = -5.15$, $p < .001$, ability *vs* luck, $t_{153} = -2.67$, $p < .01$).

Table 6.1
Descriptive Statistics for Stage 1 Students: Perceived Control Variables (N = 154)

Variable	Mean	SD
Control beliefs	3.44	.71
Strategy beliefs		
Effort	3.35	.62
Luck	2.18	.82
Ability	2.06	.84
Unknown	1.82	.85
Powerful Others	1.47	.67
Capacity beliefs		
Effort	3.58	.64
Powerful Others	3.20	.73
Ability	3.06	.84
Luck	2.89	.73

6.4.1.2 Correlations between variables

The correlations among strategy and capacity beliefs are shown in Table 6.2. On the diagonal, in red, are the correlations between the strategy and capacity beliefs for each cause. Above the diagonal are the intercorrelations for capacity beliefs, and under the diagonal are the intercorrelations for strategy beliefs. These data are consistent with the findings of Skinner, Wellborn & Connell (1990) and Skinner *et al.* (1988). Both these studies and the present study found similar patterns of correlation between strategy and capacity beliefs for each cause, including little overlap between strategy and capacity beliefs for each cause, strongly suggesting that "the two aspects of perceived control are empirically distinguishable" (Skinner *et al.*, 1988, p. 26). In terms of the relationship between strategy beliefs, it is noteworthy that strategy effort, rated as most important by this group of students, was uncorrelated with any other strategy beliefs. A high correlation was found between unknown and luck strategies, suggesting that students who don't really know how to succeed in mathematics are just as likely to pin their hopes on luck as anything else.

Intercorrelations between capacity beliefs were highest between capacity ability and capacity effort, and capacity ability and capacity luck. Students who believe that they are smart at mathematics also believe that they can work hard and that they're lucky.

Table 6.2
Correlations Among Strategy and Capacity Beliefs: Stage 1

	Capacity beliefs			
Strategy beliefs	Effort	Ability	Luck	Others
Effort	.15	.52 **	.38 **	.09
Ability	.10	-.22 **	.53 **	.03
Luck	.14	.39 **	-.23 **	.06
Others	-.02	.32 **	.35 **	-.08
Unknown	.00	.34	.56 **	.35 **

** $p < .01$

The relationship between perceived control and its proposed antecedents and consequences was examined by correlating the set of control related beliefs with perceived teacher behaviour, Teacher-rated student engagement, achievement, and teacher rating of student ability (see Table 6.3). It should be noted that achievement data in the form of results from the PAT-Maths test were only available for the initial sample of students obtained in stage 1 of the study.

Teacher-rated engagement was found to be strongly correlated with control beliefs ($r = .36$), strategy luck ($r = -.41$), strategy unknown ($r = -.41$), capacity effort ($r = .34$) capacity ability ($r = .38$) and capacity luck ($r = .32$). Students who were perceived to be the most highly engaged with their work in mathematics had high control beliefs, felt that they know how to succeed, that they are smart, and they can work hard. Although they believe that luck does not play a significant role in success, they believe nevertheless that they are lucky in maths.

With the exception of capacity luck, these same beliefs also correlate most strongly with achievement scores and teachers' rating of student ability. In addition, strategy ability appears as a strong correlate with both achievement and teacher rating of ability, suggesting again that weaker students are more likely to rely on ability as a strategy. This is a maladaptive belief, as these students are those most likely to say that to succeed in maths one has to be smart, but that they are not smart. By not succeeding in tests and classwork they are perhaps reinforcing this belief.

Teacher provision of autonomy support appears to be most strongly related (negatively) to strategy unknown ($r = -.29$). This provides evidence that students whose teachers let them make choices about their work are least likely to be unsure about how to succeed in mathematics.

Teacher involvement was positively correlated with control beliefs and, as one might expect, with capacity powerful others, and negatively with strategies for luck, unknown and powerful others.

Teacher provision of structure was found to be negatively correlated with strategy luck and strategy unknown, but positively with capacity effort, capacity ability and capacity luck. Students who felt their teachers provided them with a structured environment were more likely to believe in themselves as able to work hard and achieve success. They were less likely to believe in luck as a way of achieving success, or to be unsure about how to succeed.

Table 6.3
Correlations between Perceived Control and its Proposed Antecedents and Consequences: Stage1

	Engagement	PAT maths	Ability rating	Autonomy support	Involvement	Structure
Control beliefs	.36 **	.26 **	.32 **	.15	.21 *	.34 **
Strategy beliefs						
Effort	.01	-.10	.03	.08	.12	.10
Luck	-.41 **	-.41 **	-.45 **	-.19 *	-.18 *	-.38 **
Ability	-.18 *	-.29 **	-.30 **	-.01	-.11	-.13
Unknown	-.41 **	-.48 **	-.43 **	-.28 **	-.29 **	-.42 **
Powerful others	-.19 *	-.21 *	-.20 *	-.11	-.21 **	-.42 **
Capacity beliefs						
Effort	.34 **	.26 **	.31 **	.10	.19 *	.26 **
Ability	.38 **	.28 **	.46 **	.16	.14	.33 **
Powerful others	.08	-.04	-.05	.01	.25 **	.15
Luck	.32 **	.18 *	.32 **	-.01	.08	.24 **

* $p < .05$, ** $p < .01$

Correlations between teacher rating of student engagement, teacher rating of student ability and the results from the PAT-Mathematics test were examined. Strong correlations were found between all three, with the highest correlations, as might be expected, between teacher ratings of student ability and engagement ($r = .71$). The correlation between teacher rating of ability and the PAT-Mathematics score was .63, and between teacher rating of engagement and PAT-Mathematics was .58 (all $p < .001$).

6.4.1.3 Regression Analysis

The initial examination of the data was followed by multiple regression in order to identify the unique contribution of each of the perceived control beliefs. Engagement was regressed firstly onto the four capacity beliefs. The equation was found to be significant ($R^2 = .19$, $p < .001$), and capacity ability and effort were both found to be significant predictors of engagement ($\beta = .22$, $p < .05$ and $\beta = .18$, $p < .05$ respectively). Engagement was then regressed onto the five strategy beliefs. The equation was significant ($R^2 = .19$, $p < .001$), and both strategy luck and strategy unknown were found to be significant negative predictors of engagement ($\beta = -.27$, $p < .01$; $\beta = -.26$, $p < .01$ respectively).

A third set of regression analyses was carried out to examine the unique effects of the paired strategy and capacity beliefs for each cause on engagement. For effort and ability, only capacity beliefs predicted engagement (both βs = .35, $p < .001$). For luck, both strategy and capacity beliefs predicted engagement, however a high reliance on luck as a strategy for success predicted low engagement (strategy $\beta = -.36$, $p < .001$, capacity $\beta = .24$, $p < .01$). For powerful others, strategy beliefs were a significant negative predictor of engagement ($\beta = -.18$, $p < .05$). Taken together, these analyses provide support for the claim by Skinner,Wellborn & Connell.(1990) that "children's beliefs about strategies and capacities are conceptually and empirically distinct from each other" (p. 27).

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6.4.2.1 Descriptive Statistics

At the end of the Grade 6 year, the study was expanded and 510 students were surveyed. The descriptive statistics for the perceived control variables are shown in Table 6.4. Strategy beliefs remain in the same order of importance as in early Grade 6, however the differences between each of them were significant at this stage of the study (effort *vs* luck $t_{509} = 25.54$, $p < .001$; luck *vs* ability $t_{509} = 4.45$, $p < .001$; ability *vs* unknown $t_{509} = 6.51$, $p < .001$; unknown *vs* powerful others $t_{509} = 6.44$, $p < .001$). Effort was still seen by students as the easiest cause to enact, however ability was seen as the next most accessible (effort *vs* ability $t_{509} = 16.44$, $p < .001$) at this stage of the study.

Table 6.4
Descriptive Statistics for Stage 2 Students: Perceived Control Variables (N = 510)

Variable	**Mean**	**SD**
Control beliefs	3.40	.70
Strategy beliefs		
Effort	3.35	.58
Luck	2.31	.76
Ability	2.14	.80
Unknown	1.86	.77
Powerful Others	1.61	.77
Capacity beliefs		
Effort	3.53	.59
Powerful Others	2.93	.75
Ability	2.99	.83
Luck	2.88	.66

6.4.2.2 Correlations

The correlations between strategy and capacity beliefs for the participants in stage 2 of the study are shown in Table 6.5. Again, there is little overlap between strategy and capacity beliefs for each cause, however it is notable that inverse relationships exist between all strategy and capacity pairs with the exception of effort. Students who believe that effort is an important strategy also believe that they can work hard, while ability, luck and powerful others are seen as more important strategies by those students who feel least able enact them. In other words, the student who believes that they have ability in maths is not likely to see ability as a way of succeeding at mathematics. Conversely, and far more damaging in terms of motivation, students who believe that they are unlucky are most likely to believe that they *have* to be lucky to do well in mathematics. Strategy effort was again uncorrelated with any other strategies, and the highest correlations were seen between capacity ability and effort, and ability and luck.

Table 6.5
Correlations among Strategy and Capacity Beliefs: Stage 2

	Capacity beliefs			
Strategy beliefs	Effort	Ability	Luck	Others
Effort	.14**	.49 **	.38 **	.12 **
Ability	.02	-.20 **	.52 **	.12 **
Luck	.05	.39 **	-.23 **	.15 **
Others	-.03	.32 **	.28 **	-.17 **
Unknown	-.09	.28 **	.35 **	.32 **

** $p < .01$

Correlations between perceived control and its proposed antecedents and consequences for stage 2 of the study show a few differences to those already described for the stage 1 students (see Table 6.6). The relationship between teacher autonomy support and strategy powerful others increased, (r = -.26) as did the relationship between teacher provision of structure and capacity powerful others (r = .31).

Although the correlation between teacher rating of student ability and teacher rating of student ability was again high (r = .75, $p < .001$), this indicates that there are still a number of students that teachers rate as having high ability but low engagement.

Table 6.6
Correlations between Perceived Control and its Proposed Antecedents and Consequences: Stage 2

	Engagement	Ability rating	Autonomy support	Involvement	Structure
Control beliefs	.38 **	.38 **	.18 **	.28 **	.34 **
Strategy beliefs					
Effort	.08	.13 **	.05	.05	.15 **
Luck	-.36 **	-.30 **	-.18 **	-.24 **	-.35 **
Ability	-.21 **	-.20 **	-.15 **	-.21 **	-.27 **
Unknown	-.39 **	-.36 **	-.26 **	-.37 **	-.45 **
Powerful others	-.21 **	-.15 **	-.26 **	-.38 **	-.43 **
Capacity beliefs					
Effort	.31 **	.28 **	.16 **	.19 **	.31 **
Ability	.48 **	.49 **	.20 **	.20 **	.36 **
Powerful others	.06	.08	.10*	.31 **	.31 **
Luck	.34 **	.31 **	.16 **	.28	.30 **

** $p < .01$

6.4.2.3 Regression Analysis

Multiple regression was carried out as before, and findings were similar to those for stage 1 students. The regression equation for strategy beliefs was found to be significant (R^2 = .29, $p < .001$), with significant predictors again strategy luck ($\beta = -.23$, $p < .01$), and strategy unknown ($\beta = -.33$, $p < .001$). The regression equation for capacity beliefs was also found to be significant ($R^2 = .33$, $p < .001$). On this occasion, significant predictors were found to be capacity ability ($\beta = .37$, $p < .001$) and capacity luck ($\beta = .21$, $p < .01$).

The regression of pairs of causes onto Teacher-rated engagement produced similar results to that obtained in the stage 1 analysis. Strategy ability and capacity ability were both found to be significant predictors of engagement (strategy ability $\beta = -.21$, $p < .01$; capacity ability $\beta = .49$, $p < .001$). For effort, capacity was the only significant predictor ($\beta = .38$, $p < .001$), while for powerful others strategy was the sole predictor ($\beta = -.21$, $p < .01$). Again, for luck, both strategy and capacity beliefs were strongly significant predictors of engagement (strategy $\beta = -.33$, $p < .001$, capacity $\beta = .35$, $p < .001$).

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6.4.3.1 Descriptive Statistics

The descriptive statistics shown in Table 6.7 reflect those for the previous two stages of the data collection. Capacity beliefs for powerful others decreased, however students in general still feel confident that they are able to get their teachers to like and help them in mathematics.

Table 6.7
Descriptive Statistics for Stage 3 Students: Perceived Control Variables (N = 302)

Variable	Mean	SD
Control beliefs	3.43	.69
Strategy beliefs		
Effort	3.32	.57
Luck	2.14	.68
Ability	2.07	.74
Unknown	1.79	.74
Powerful Others	1.60	.70
Capacity beliefs		
Effort	3.38	.62
Powerful Others	2.74	.63
Ability	3.03	.80
Luck	2.89	.66

6.4.3.2 Correlations

The correlations between strategy and capacity beliefs (Table 6.8) again show little intercorrelation between strategy and capacity beliefs for a particular cause, and overall reflect patterns similar to that described in previous sections. The increasing correlation between strategy effort and strategy unknown (*r* = -.19) is of interest, suggesting that students who are unsure of strategies for success may increasingly reject effort as an effective strategy, perhaps believing that it couldn't be that simple.

Table 6.8
Correlations Among Strategy and Capacity Beliefs: Stage 3

	Capacity beliefs			
Strategy beliefs	**Effort**	**Ability**	**Luck**	**Others**
Effort	.10	.47 **	.22 **	.29 **
Ability	-.01	-.17 **	.30 **	.17 **
Luck	-.10	.32 **	-.16 **	.09
Others	-.11	.25 **	.27 **	-.05
Unknown	-.19 **	.23 **	.40 **	.28 **

** $p < .01$

Again, although correlations are lower overall, similar patterns can be seen in the correlations between perceived control, engagement and beliefs about ability (Table 6.9). Correlations between strategy effort and ratings of teacher involvement, autonomy support and structure have gone against this trend however, and increased.

Table 6.9
Correlations Between Perceived Control and its Proposed Antecedents and Consequences: Stage 3

	Engage-ment	Ability rating	Autonomy support	Involvement	Structure
Control beliefs	.26 **	.32 **	.13 *	.29 **	.31 **
Strategy beliefs					
Effort	.08	.13 *	.10	.15 **	.25 **
Luck	-.20 **	-.24 **	-.05	-.24 **	-.28 **
Ability	-.18 **	-.16 **	-.11 *	-.12 *	-.13 *
Unknown	-.30 **	-.36 **	-.24 **	-.37 **	-.44 **
Powerful others	-.16 **	-.06	-.11	-.28 **	-.33 **
Capacity beliefs					
Effort	.30 **	.27 **	.14 *	.31 **	.36 **
Ability	.36 **	.47 **	.18 **	.29 **	.30 **
Powerful others	.21 **	.15 *	.08	.28 **	.20 **
Luck	.17 **	.20 **	.03	.24 **	.20 **

* $p < .05$, ** $p < .01$

Correlation between teacher rating of student engagement and ability was higher again ($r = .78$, $p < .001$), which is interesting given that different teachers were assessing both this time.

Mathematics teachers at secondary school may be more explicit to their students about the role of effort in success than their primary school counterparts. As many primary teachers are not themselves particularly confident in mathematics, there may be a greater perception in the primary classroom that factors other than effort are at play in successful mathematics learning.

6.4.3.3 Regression Analysis

Regression produced similar results to those described for stages 1 and 2 of the study. The equation obtained when all strategy beliefs were regressed onto teacher-rated engagement was found to be significant ($R^2 = .11$, $p < .001$) however in this instance only strategy unknown was found to be a significant predictor ($\beta = -.23$, $p < .001$). When the set of four capacity beliefs were regressed onto engagement ($R^2 = .16$, $p < .001$), significant predictors were found to be ability ($\beta = .26$, $p < .001$), effort ($\beta = .13$, $p < .05$) and powerful others ($\beta = .12$, $p < .05$).

Regression examining the effects of pairs of strategy and capacity beliefs for each cause found that effort was the only cause for which strategy and capacity beliefs did not both predict engagement. For ability, the regression equation was significant, with significant predictors strategy beliefs ($\beta = -.12$, $p < .05$), and capacity beliefs ($\beta = .34$, $p < .001$). Luck was also significant, with both strategy beliefs ($\beta = -.18$, $p < .01$) and capacity beliefs ($\beta = .15$, $p < .01$) significant predictors, and similarly powerful others was significant, with strategy beliefs ($\beta = -.15$, $p < .01$) and capacity beliefs ($\beta = .20$, $p < .001$) significant. For effort the significant predictor was capacity beliefs alone ($\beta = .29$, $p < .001$).

6.4.3.4 Analysis of variance on extreme groups

In order to explore the possibility of interactions between strategy and capacity beliefs and teacher-rated engagement, all four known beliefs were divided into high and low groups, based on the top and bottom quarters of the distribution of each variable. A 2 (strategy high *vs* low) × 2 (capacity high *vs* low) ANOVA was performed using these groups, with teacher-rated student engagement as the dependent variable. Skinner *et al.* (1990) conducted the same analysis and found each of the four interaction terms to be significant. While no interaction effects were significant in the present study, the effects of low capacity beliefs are similar to that of the Skinner study, and these effects can be seen from the following graphs of the means (Figure 6.1).

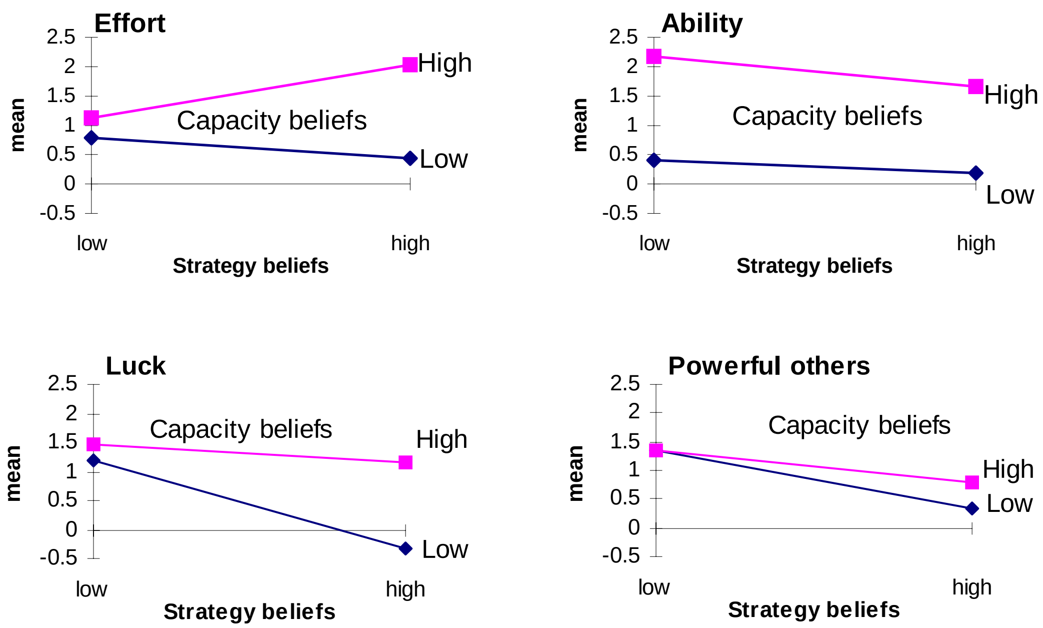

Figure 6.1 Teacher-rated student engagement as a function of the interaction between strategy and capacity beliefs, stage 2 sample (N=510)

High strategy beliefs appear to exacerbate low capacity beliefs for effort, while in effect boosting engagement for those students with high capacity beliefs for effort. A different pattern of interactions between strategy and capacity beliefs was apparent for ability, luck and powerful others, where high strategy beliefs linked to low capacity beliefs resulted in the lowest levels of engagement.

6.5 Summary and Discussion of results

These data show that little change occurs from early Grade 6 through late Grade 6 and after the transition to secondary school. Students believe throughout this time that effort is the most important strategy for succeeding in mathematics, and generally believe that they have the capacity to put in the required amount of effort. Students in general also felt, although the means for these were not as high as for effort, that they were smart enough to succeed, that they were lucky, and that they could get their teacher's help and attention when they needed it.

Control beliefs correlated strongly with teacher-rated engagement, achievement and teacher-rated ability, indicating that students who feel in control of their learning are those students who are most engaged and who achieve at the highest level. Strategy effort was uncorrelated with engagement, suggesting that effort as a strategy is not sufficient in itself to promote engagement, but requires students to believe that they also have the capacity to work hard. Student engagement was found to be undermined by beliefs in the nonaction strategies of powerful others, luck and ability, and most strongly by students' reports that they did not know what strategies were effective.

At each stage of the study teacher-rated student engagement was found to be strongly correlated with its proposed consequence; ability or achievement. Although achievement was only assessed at one point of this study, strong correlations were found between teacher ratings of ability and actual achievement.

These data confirm the findings of Skinner, Wellborn & Connell (1990), and indicate that in mathematics, as at school in general, particular combinations of beliefs about how to succeed can have positive or negative effects on student engagement. The highest levels of engagement were reported in those students with strong beliefs in effort as a means of succeeding in mathematics and who perceived that they are capable of exerting the required effort. The lowest levels of engagement were seen among those students who believed that success and failure were, in essence, out of their control; for whom luck was the way to succeed, but that they were unlucky in mathematics.

The cross-sectional data served to confirm that the perceived control model is useful when adapted to mathematics. Strategy and capacity beliefs, together with beliefs about control, appear to be relatively independent of each other, and various combinations predict high or low engagement amongst students. As suggested in the literature, students can be high on strategy beliefs ("*Being smart is what matters the most for success in maths*") but low on capacity beliefs ("*But I'm not smart*"), or high on capacity beliefs ("*I can try hard*") but low on strategy beliefs ("*Effort is not at all important*").

One of the strengths of the perceived control model is this ability to "split apart" attributions; for example an attribution of success to a cause ("*I succeeded because I worked hard*") implies both that the strategy is effective and that the student is able to access it ("*effort is important for success*", and "*I can work hard*"). In contrast, an attribution of failure to a particular cause ("*I failed because I didn't work* *hard enough*") implies that the strategy is effective but the self has no access to it ("*effort is important for success*", but "*I just can't seem to work hard enough*"). Skinner (1995) argued that these distinctions are essential when interpreting beliefs about the self, particularly when contrasting beliefs about causes such as effort and ability, for example "*I didn't try very hard*" versus "*I'm dumb at maths*".

Although the patterns of beliefs appear to be quite stable from early Grade 6 through to mid year 7, comparison needs to be made longitudinally among cohorts, that is between students common to stages 1 and 2, and between students common to stages 2 and 3. The next chapter deals with the analysis of these data.

Chapter 7

Longitudinal comparisons

7.1 Introduction

While the previous chapter dealt with the analysis of the cross-sectional data, it was also important to look at longitudinal changes in each cohort of students. The research questions to be addressed in this chapter are:

- Do the relationships between the perceived control variables and engagement remain the same after transition to secondary school?
- Are these changes the same for male and female students?
- Are there changes in views about mathematics, the antecedents or consequences of perceived control, self-concept, autonomy or coping over the primary secondary transition?

7.2 Comparing stages: Looking longitudinally

The data sets gathered at each of the three stages of the study were subsequently adjusted to create three longitudinal sets, which were analysed using more powerful statistical techniques to attempt a more fine-grained examination. The most powerful data are the larger sets of 154 students who participated in both stage one and two of the data collection, and the 302 students who participated in both stage two and three of the data collection. These data sets were analysed separately, while the data from the 74 students who participated in all three stages of the data collection will be shown graphically where appropriate to illustrate the longitudinal aspects of the study.

7.3 Statistical methods

In the analysis of longitudinal effects, the repeated measures design of the study acts to eliminate some systematic bias attributable to subjects in one group being different from subjects in other groups, and yet brings with it other problems, particularly higher correlations between measures than would be obtained with a randomised design. The statistical considerations necessary to minimise Type I error, and yet retain power, are discussed in the next section.

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Repeated measures analysis of variance (ANOVA) was used to examine the longitudinal data. The use of repeated measures in statistical analysis presents particular problems, notably heterogeneity of the variances of differences among pairs of levels of the repeated measure. Levine (1991) recommended that the Mauchly test of sphericity be employed to determine whether the heterogeneity assumptions are violated, however he warned that "unfortunately, problems, primarily regarding the test's oversensitivity, reduce its practical value" (p. 27). In a case where Mauchly's test is significant, the multivariate tests should be used in preference to the univariate, however Levine argued that it is possible the multivariate test could have a negative bias, leading to reduced power. If the univariate test was found to be significant and the assumptions of heterogeneity violated, but the multivariate test non-significant, Levine's recommendation was "the use of a correction in the degrees of freedom, permitting a choice of a larger critical F-value, which, if properly selected, avoids the bias problem" (p. 28).

This procedure involves the use of a correction factor, *epsilon*, which when multiplied by both the numerator and denominator degrees of freedom of the F-ratio, identifies the bias free F distribution. These corrected degrees of freedom can then be used to obtain a correct critical F-value against which the empirical F-value can be tested. The value of epsilon serves both as a correction factor and a measure of the extent to which the heterogeneity assumptions were violated. Its value can vary between 1, indicating no violation of assumptions, to $1/(k\text{-}1)$, where k is the number of levels of the repeated measures factor, indicating maximum violation of assumptions. In the case of this study, with a maximum of three levels of repeated measure factors, the lower bound for epsilon was 0.5. The two correction factors produced by SPSS_{WIN} in the repeated measures print out are the *Greenhouse-Geisser epsilon* and the *Huynh-Feldt epsilon*.

In the analysis discussed here, if the univariate test was found to be significant but the heterogeneity assumptions were violated, then the multivariate tests were examined. Low power and a non-significant result in the multivariate test would imply that the multivariate test might be negatively biased, and so the procedure in this case would be to use the *Huynh-Feldt epsilon* to calculate new degrees of freedom and thus re-examine the calculated F-value against a revised critical F-value.

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Two types of contrasts were examined for variables where significant differences were found, using the smaller data set of 74 students for whom three data points were available. The first contrast compared each level of the factor except the first, to the previous level. This contrast is analogous to post-hoc testing in simple ANOVA. The second type of contrast (trend analysis) employed used the *polynomial* subcommand in $SPSS_{WIN}$ in order to examine the data for linear and quadratic effects across levels of the factor.

7.4 Perceived control measures

Tables 7.1 and 7.2 show the descriptive statistics for all perceived control beliefs for the students involved in both stages 1 and 2 and in both stages 2 and 3 respectively. It can be seen that there are few significant differences from early to late Grade 6, or from late Grade 6 to mid Year 7. Effort was seen as the most important strategy for achieving success and avoiding failure in mathematics, and capacity beliefs for this variable were the highest. However there was a significant decrease in capacity effort between late Grade 6 and Year 7, and post-hoc analysis of the data revealed that this was a linear decreasing trend ($F_{1,73} = .54$, $p < .05$). This suggests a perception by some students that no matter how hard they work, it may not be enough to do well in mathematics at secondary school.

Table 7.1
Descriptive Statistics for Perceived Control Variables for Students Common to Stages 1 and 2 (n = 143)

	Stage 1		Stage 2		$F_{1,142}$	Sig
	Mean	SD	Mean	SD		
Control	3.26	.70	3.44	.67		
Strategy Beliefs						
Ability	2.03	.83	2.00	.79		
Effort	3.35	.62	3.31	.57		
Luck	2.17	.82	2.08	.65		
Powerful Others	1.46	.65	1.57	.80		
Unknown	1.78	.82	1.73	.81		
Capacity Beliefs						
Ability	3.09	.80	3.00	.89		
Effort	3.59	.65	3.55	.62		
Luck	2.93	.72	2.92	.64		
Powerful Others	3.19	.74	3.00	.71	8.57	**
CONMAX	30.84	19.08	30.00	19.18		

** $p < .01$

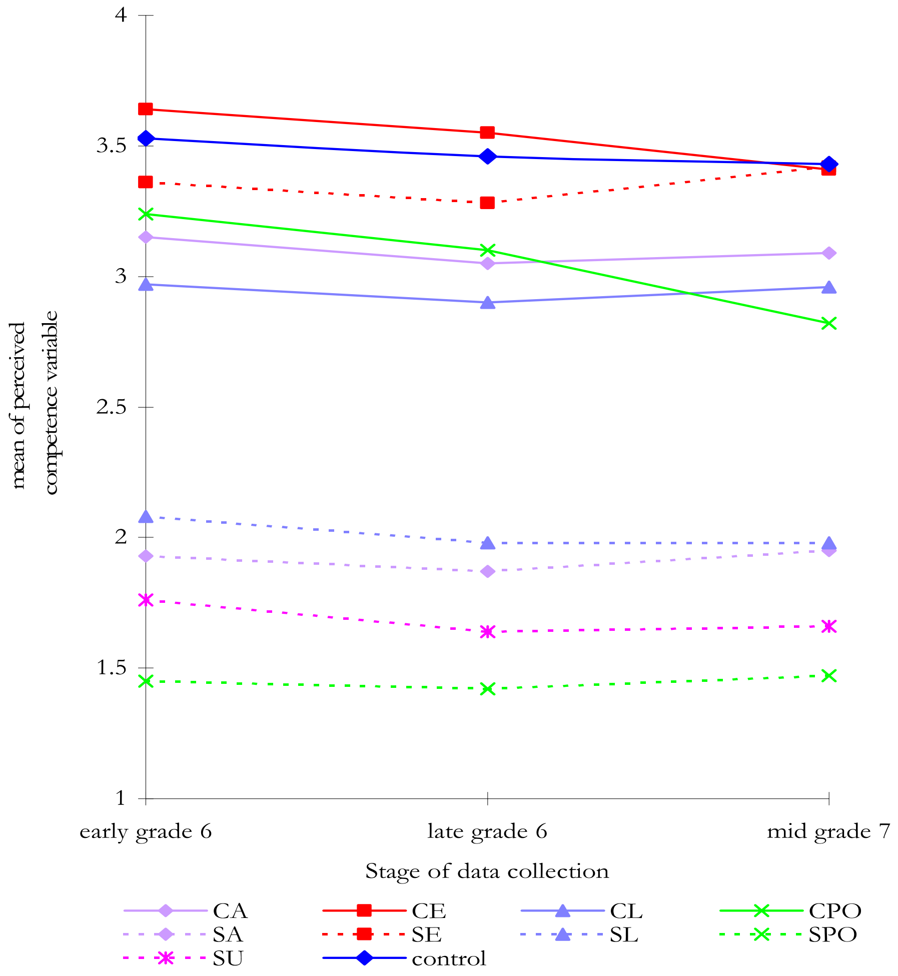
Capacity powerful others also decreased significantly, both from early to late Grade 6, and from late Grade 6 to year 7, however as this was tied to a low value for strategy powerful others it probably doesn't represent a significant maladaptive belief. Low capacity beliefs are particularly detrimental when they are tied to high strategy beliefs, such as where students are saying "*This is an important way to succeed in maths, but I can't do it*".

Table 7.2
Descriptive Statistics for Perceived Control Variables for Students Common to Stages 2 and 3 (n = 302)

	Stage 1		**Stage2**		$\mathbf{F_{1,142}}$	**Sig**
	Mean	SD	Mean	SD		
Control	3.41	.68	3.43	.69		
Strategy Beliefs						
Ability	2.08	.78	2.07	.74		
Effort	3.35	.59	3.32	.57		
Luck	2.28	.74	2.14	.68		
Powerful Others	1.55	.73	1.60	.70		
Unknown	1.86	.76	1.79	.74		
Capacity Beliefs						
Ability	3.01	.81	3.03	.80		
Effort	3.51	.60	3.38	.62	8.12	**
Luck	2.86	.66	2.89			
Powerful Others	2.91	.75	2.74	.63	13.20	***
CONMAX	28.16	19.24	25.30	17.09	6.89	**

** $p < .01$, *** $p < .001$

Data from the two larger groups revealed that the combined perceived control variable, CONMAX, showed no change between early and late Grade 6, but then decreased significantly between Grade 6 and Year 7. These trends are reflected in the data for the smaller sample of students who were surveyed three times, where ANOVA showed that there was no significant difference between stage 1 and stage 2, while the difference between stage 2 and stage 3 was marginally significant ($F_{2, 140} = 2.99$, $p = .05$). Mauchly's test of sphericity proved to be significant, and thus the multivariate results were examined. Wilk's lambda was not significant, and so the Huynh-Feldt epsilon value of .88 was used to correct the number of degrees of freedom for the distribution. This correction produced a critical value of $F_{2, 124} = 3.07$, and so the empirical value of F= 2.99 was concluded to be non-significant for this small sample of students. The graph presented in Figure 7.1, which shows the perceived control beliefs of the smaller group of 74 students, reflects the changes described in Tables 7.1 and 7.2. The magnitudes of the changes vary from that for the larger data sets, however the trends are similar.



C: Capacity, S: Strategy, A: Ability, E: Effort, L: Luck, PO: Powerful Others, U: Unknown

Figure 7.1 Means for perceived control variables for 74 students common to stages 1, 2 and 3

Between stage 1 and 2 there was only one gender difference apparent, male students perceived strategy powerful others as more important than female students did ($F_{1,141} = 5.92$, $p < .05$) although neither saw it as particularly important (stage 1 means – Female: 1.35, Male 1.58, stage 2 means – Female 1.43, Male 1.70). Between stage 2 and 3 however, several more gender differences became apparent, and these are shown in Table 7.3.

Ability was seen as a more important strategy by males than by females ($F_{1,300} = 4.64$, $p < .05$), and this was tied to higher capacity beliefs for males than for females ($F_{1,300} = 14.26$, $p < .001$).

Table 7.3
Gender Differences on Perceived Control Beliefs: Stage 2-3 Data

Strategy ability ($F_{1,300} = 4.64$, $p < .05$)				
	Stage 2		**Stage 3**	
	Mean	**SD**	**Mean**	**SD**
Females	1.99	.72	2.00	.68
Males	2.16	.83	2.14	.80
Capacity ability ($F_{1,300} = 14.26$, $p < .001$)				
	Stage 2		**Stage 3**	
	Mean	**SD**	**Mean**	**SD**
Females	2.83	.82	2.91	.79
Males	3.19	.76	3.14	.78
Strategy effort ($F_{1,300} = 5.04$, $p < .05$)				
	Stage 2		**Stage 3**	
	Mean	**SD**	**Mean**	**SD**
Females	3.33	.58	3.39	.54
Males	3.37	.59	3.24	.59
Strategy powerful others ($F_{1,300} = 7.64$, $p < .01$)				
	Stage 2		**Stage 3**	
	Mean	**SD**	**Mean**	**SD**
Females	1.46	.66	1.50	.67
Males	1.64	.79	1.70	.72

Gender × stage of study differences were apparent for strategy effort; where females assigned it much the same importance from time 2 to time 3 and males assigned it with less importance at stage 3, after transition. Similar gender differences were seen with strategy powerful others as from time 1 to time 2.

7.5 Engagement, ability and antecedents of perceived control

Tables 7.4 and 7.5 show the descriptive statistics for engagement, perceived ability and the antecedents to perceived control; teacher-provision of structure, autonomy support and involvement. A significant decline in student perceptions of provision of structure occurred during the Grade 6 year, and more significant differences can be seen over the transition period. Teacher-rated engagement declined significantly, as did students' own ratings of engagement, indicating that students' perceptions were echoed by their teachers, and suggested that students are less engaged in the learning process in mathematics at this stage of secondary school.

Table 7.4
Descriptive Statistics for Measures of Engagement, Ability and Beliefs About Teachers: Early to Late Grade 6 (n= 154)

	Stage 1		**Stage2**		$F_{1,142}$
	Mean	SD	Mean	SD	
Student-rated engagement	3.42	.50	3.38	.49	
Teacher-rated engagement	1.45	1.29	1.47	1.33	
Perceived teacher structure	3.37	.48	3.26	.55	5.54 *
Perceived teacher autonomy support	2.83	.44	2.80	.45	
Perceived teacher involvement	3.41	.53	3.34	.57	

* $p < .05$

Students' perceptions of teacher autonomy support and teacher involvement also show a significant decline over the transition to secondary school. Teachers at secondary school are perceived to be less likely to let students make decisions about their learning and students feel less involved with their teachers. Students have just moved from a primary school where they have had one teacher for the entire year, a teacher who has probably known them for a number of years, to a whole new school, so this latter statistic is not surprising.

ANOVA showed that female students felt that their teachers were more involved with them than did male students at both stages 1 and 2 of the study (means: females stage 1: 3.47, males stage 1: 3.34, females stage 2: 3.46, males stage 2: 3.23), but no significant gender differences were apparent during transition to secondary school.

Table 7.5
Descriptive Statistics for Measures of Engagement, Ability and Beliefs About Teachers: Late Grade 6 to Year 7 (n = 302)

	Stage 2		**Stage 3**		$F_{1,301}$
	Mean	**SD**	**Mean**	SD	
Student-rated engagement	3.33	.46	3.25	.56	6.79 **
Teacher-rated engagement	1.39	1.43	1.21	1.17	5.71 *
Perceived teacher structure	3.23	.50	3.19	.55	
Perceived teacher autonomy support	2.76	.45	2.55	.45	45.43 ***
Perceived teacher involvement	3.31	.55	2.98	.64	76.56 ***

* $p < .05$, ** $p < .01$, *** $p < .001$

Although gender differences were not significant, it was found that female students felt more engaged in learning mathematics than male students at all stages of the study (see Figure 7.2), and their teachers also believed them to be more engaged (female means: 1.70, 1.46, 1.37; male means: 1.22, 1.5, 1.07 for stages 1, 2 and 3 respectively).

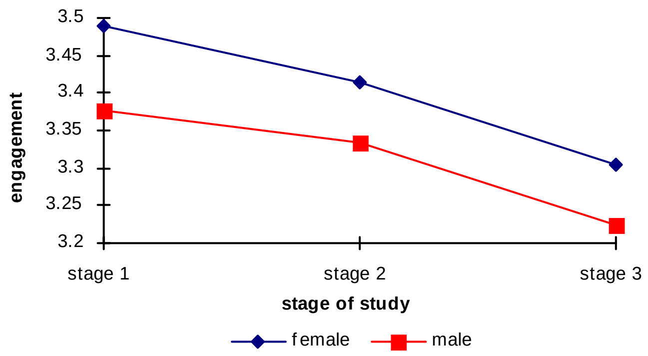


Figure 7.2 Student-rated engagement levels for stages 1, 2 and 3

7.6 Relatedness

Descriptive statistics for relatedness to self, peers and teacher are presented in Tables 7.6 and 7.7. Relationships with teachers and peers appear quite stable over both time periods, however relatedness to self showed a significant decline, both from stage 1 to 2 and again from stage 2 to 3. Relatedness to self was assessed using the stem "*When I think about myself I feel*" with the individual items "*happy, important, unhappy and bad*", and the data indicate that students showed a declining self-esteem during late primary and early secondary school.

Table 7.6
Descriptive Statistics and Results of ANOVA for Relatedness Variables: Stage 1-2 (n = 154)

	Stage 1		**Stage 2**		**$F_{1,142}$**
	Mean	SD	Mean	SD	
Relatedness to Self	3.07	.67	2.95	.73	4.73 *
Relatedness to Peers	3.47	.60	3.47	.58	
Relatedness to Teachers	3.04	.73	3.03	.72	

* $p < .05$

Table 7.7
Descriptive Statistics and Results of ANOVA for Relatedness Variables: Stage 2-3 (n = 143)

	Stage 2		Stage 3		$F_{1,142}$
	Mean	SD	Mean	SD	
Relatedness to Self	2.93	.67	3.03	.69	4.99 *
Relatedness to Peers	3.49	.53	3.45	.62	
Relatedness to Teachers	2.95	.66	2.96	.70	

* $p < .05$

Significant gender differences and gender × time interactions were apparent when ANOVA was conducted on the relatedness-to-self variable. Self-esteem among male students was higher than for female students in Grade 6, and the gap widened on transition to secondary school, where males' self-esteem rose at a greater rate than females'. The means for this variable, and the results of two way (stage of study[SS] × gender[G]) ANOVA, are shown in Table 7.8.

Table 7.8
Gender Differences in "Relatedness To Self" Variable

	Stage 2	Stage 3	F (gender)	F(gender x stage)
Females	2.88	2.88	8.98 **	4.20 *
Males	2.99	3.17		

* $p < .05$, ** $p < .01$

7.7 "How Good?" measures

Students were asked about their perceptions of how good they were in maths, how good their teachers, parents and peers thought they were, and about their own and parents' expectations of how good they would like to be in maths. Two-way ANOVAs were conducted on both the stage 1-2 and stage 2-3 data sets (gender [G] x stage of study [SS]), revealing few differences in primary school, but more over the transition to secondary school represented by the stage 2-3 data (Table 7.9)

Table 7.9
Descriptive Statistics for Students' Beliefs About Mathematics Ability; Stage 1 and 2 (n = 154)

		Stage 1		Stage 2		Gender (G)	Stage of Study (SS)	G x SS
		M	**SD**	**M**	**SD**	**df = 1**	**df = 1**	**df = 1**
HGS	All	3.66	.90	3.61	.83			
	F	3.68	.93	3.64	.84			
	M	3.65	.86	3.58	.82			
HGSW	All	4.78	.45	4.74	.57			
	F	4.69	.52	4.68	.60	F= 4.04 *		
	M	4.86	.35	4.80	.52			
HGT	All	3.62	.90	3.64	.96			
	F	3.67	.79	3.58	.99			
	M	3.56	1.00	3.70	.93			
HGP	All	3.79	.96	3.79	.91			
	F	3.83	.95	3.86	.91			
	M	3.79	.96	3.72	.91			
HGPW	All	4.72	.51	4.62	.64			
	F	4.65	.53	4.67	.56		F=3.86 *	F=5.03 *
	M	4.79	.48	4.58	.71			
HGC	All	3.51	1.02	3.67	.96			
	F	3.63	.96	3.61	.96		F=3.88 *	F=4.56 *
	M	3.39	1.08	3.73	.96			

* $p < .05$
(Key: HGS: How good are you at maths; HGSW: How good would you like to be; HGT: How good does your teacher think you are; HGP; How good do your parents think you are; HGPW; How good would your parents like you to be; HGC: How good do your classmates think you are)

During the Grade 6 year, students generally rated themselves as slightly above average in ability, and although both males and females had high aims for success in maths, male students wanted to be better at maths than female students did. Marginally significant results for the effect of stage of study showed that male students also felt that their parents did not expect as high a level of success from them, and that their classmates would rate them more highly in the latter part of the year. Female students' beliefs remained fairly constant throughout the year.

Gender differences, however, were more apparent over the transition to secondary school. The results of the multiple univariate two-way ANOVAs (gender [G] x stage of study [SS]) carried out on the stage 2-3 data set for the six "how good" variables are shown in Table 7.10.

Table 7.10
Descriptive Statistics for Students' Beliefs About Mathematics Ability; Stage 2 and 3 (n = 302)

		Stage 2		Stage 3		Gender (G)	Stage of Study (SS)	G x SS
		M	**SD**	**M**	**SD**	**df = 1**	**df = 1**	**Df = 1**
HGS	All	3.61	.78	3.63	.85			
	F	3.48	.77	3.49	.79	F=11.59		
	M	3.74	.77	3.77	.88	***		
HGSW	All	4.71	.52	4.60	.66			
	F	4.64	.55	4.49	.67	F=9.13	F=10.61	
	M	4.78	.48	4.70	.64	**	***	
HGT	All	3.51	.86	3.60	.90			
	F	3.45	.80	3.41	.82	F=9.58		F=4.36
	M	3.57	.92	3.79	.93	**		*
HGP	All	3.73	.92	3.79	.90			
	F	3.70	.88	3.64	.94	F=4.32		F=4.62
	M	3.75	.96	3.93	.84	*		*
HGPW	All	4.65	.56	4.60	.69			
	F	4.55	.60	4.53	.60	F=8.10		
	M	4.75	.56	4.67	.76	**		
HGC	All	3.53	.98	3.58	.93			
	F	3.47	.81	3.56	.81			
	M	3.58	1.11	3.60	1.04			

* $p < .05$, ** $p < .01$, *** $p < .001$

(Key: HGS: How good are you at maths; HGSW: How good would you like to be; HGT: How good does your teacher think you are; HGP; How good do your parents think you are; HGPW; How good would your parents like you to be; HGC: How good do your classmates think you are)

Again, most students rated themselves as slightly above average, and would like to be somewhere between "*above average*" and "*excellent*". Male students were more confident of their ability in mathematics than female students, shown in the higher male mean scores for "*How good are you at maths?*". Both males and females moderated their expectation of themselves over the transition to secondary school, perhaps reflecting a more realistic idea about what they could achieve. Males, however, remained more ambitious than females. Male students also exhibited more confidence in others' belief in their ability, rating teacher and parent assessments of ability higher than did the female students in the study. Figure 7.3 shows the means for female and male students on all six of these measures for the smaller sample of 74 students.

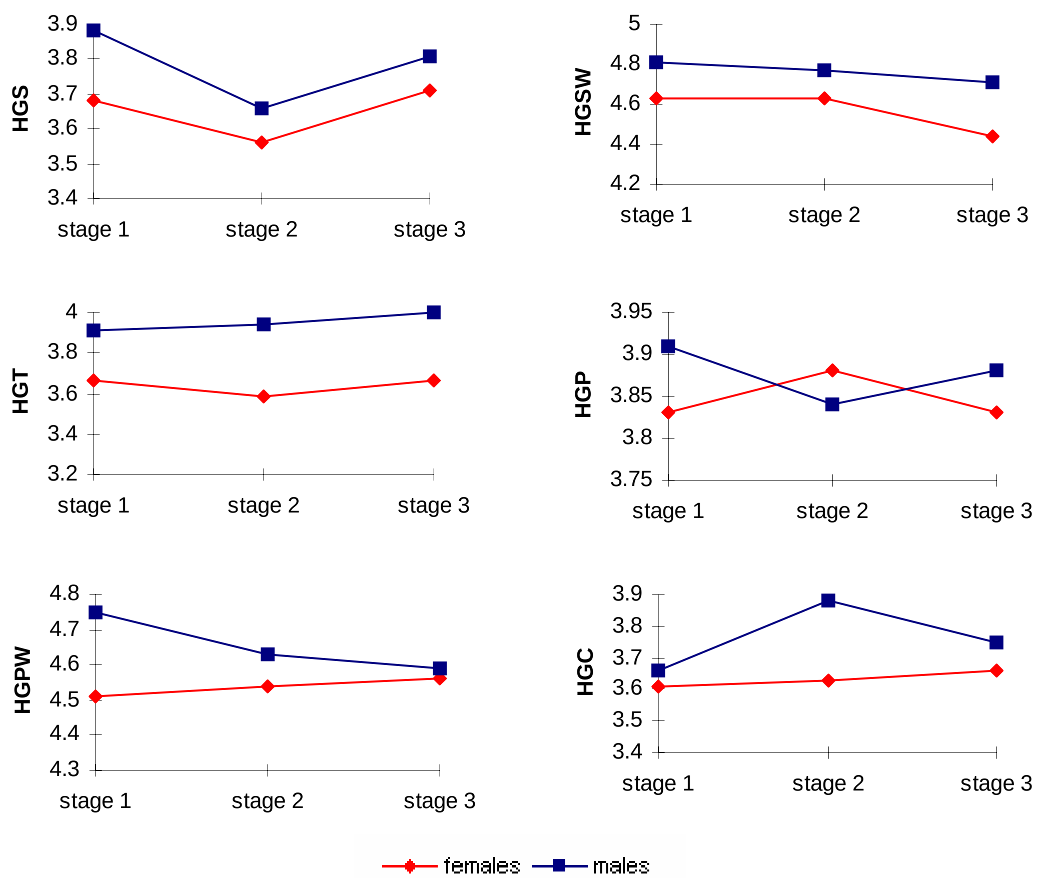


Figure 7.3 Graphs representing three stage data for "How Good" variables for female and male students

7.8 Autonomy

Autonomy beliefs reflect the extent to which students feel that they are involved in behaviours or activities that they want to be involved in. For students to maintain high motivation in mathematics, it is essential that they feel that this motivation comes from within themselves. Students in this study were asked to rate nine alternative answers to the question "*Why do I work in maths?*". Reasons given for working range from *external*, "Because the teacher says we have to"; *introjected*, "Because I'll feel guilty if I don't"; *identified* "Because I think it's important"; and *intrinsic* "Because its fun".

Tables 7.11 and 7.12 show the descriptive statistics for autonomy beliefs for the stage 1-2 cohort and the stage 2-3 cohort respectively. At both stages in Grade 6, students are most likely to work for identified reasons, however a number are involved in their studies enough to say that they work because it's fun. External reasons are not seen as particularly significant reasons: students do not appear to feel pressured to work in mathematics. After the transition to secondary school however, students in this sample were significantly more likely to work in mathematics because of external pressures, and significantly less likely to be intrinsically motivated. External motivation appears to be an increasingly important factor in student motivation, precisely the opposite to what teachers would hope to be happening with students of this age.

Table 7.11
Descriptive Statistics for Autonomy Beliefs: Stage 1-2 Data (n = 154)

	Stage 1		**Stage2**	
	Mean	SD	Mean	SD
External	1.88	.84	1.99	.88
Introjected	2.01	.95	2.13	.93
Identified	3.62	.62	3.62	.61
Intrinsic	2.90	1.02	2.94	.81

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 7.12
Descriptive Statistics for Autonomy Beliefs: Stage 2-3 Data (n = 302)

	Stage 2		**Stage 3**		$\mathbf{F_{1,300}}$
	Mean	SD	Mean	SD	
External	2.11	.92	2.29	.92	7.67 **
Introjected	2.06	.90	2.13	.85	
Identified	3.59	.61	3.52	.66	
Intrinsic	2.82	.79	2.72	.90	3.64 *

* $p < .05$, ** $p < .01$

The cohort for whom three data points are available exhibit similar patterns of behaviour, particularly with the fall in intrinsic beliefs and a rise in external beliefs. Figure 7.4 shows the changes in forms of autonomy beliefs for the sample of 74 students.

Significant gender differences were apparent at stage three of the data collection, after the transition to secondary school, when female students' intrinsic motivation was found to be significantly lower than that for males (female mean 2.57, male mean 2.87, $F_{1,299} = 7.95$, $p < .01$). Differences between stage 2 and stage 3 were assessed using t-tests for paired sample, and it was found that both identified and intrinsic motivation decreased for girls ($t_{147} = 2.35$, *p* $< .05$ for identified, $t_{147} = 3.05$, *p* $< .01$ for intrinsic), while for boys, external self-regulation increased significantly ($t_{152} = 2.41$, *p* $< .05$).

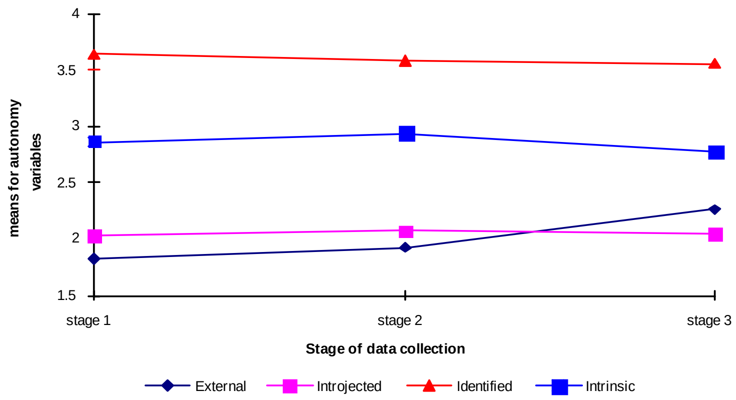


Figure 7.4 Student reasons for working in mathematics: three stage data

7.9 Coping styles

Coping styles reflect the ways that students cope with difficulties in mathematics; for example failing a test or not understanding a teacher's explanation. It was generally found that students coped in a positive way with these situations, although significantly less positively at the end of primary school and significantly less positively again in year 7 (Tables 7.13 and 7.14). Further investigation using repeated measures ANOVA within each gender found that this significant overall decline was caused primarily by girls' beliefs. From stage 2 to stage 3, the means for positive coping for female students fell from 3.48 to 3.30, while for males the means were 3.49 and 3.44 for stages 2 and 3 respectively. Anxiety about difficulties was not as apparent in the stage 3 sample, and a significant decline was seen for both female and male students.

Table 7.13
Descriptive Statistics for Coping Styles: Stage 1-2 Data (n = 144)

	Stage 1		Stage		$F_{1,142}$
	Mean	SD	Mean	SD	
Anxiety	2.19	.95	2.28	.95	
Denial	1.92	.76	1.92	.74	
Projection	1.54	.74	1.43	.65	
Positive	3.60	.58	3.46	.62	9.53 **

** $p < .01$

Table 7.14
Descriptive Statistics for Coping Styles: Stage 2-3 Data (n = 302)

	Stage 2		Stage 3		$F_{1,300}$
	Mean	SD	Mean	SD	
Anxiety	2.53	.92	2.41	.84	4.95 *
Denial	2.00	.72	2.08	.77	
Projection	1.61	.74	1.69	.67	
Positive	3.48	.58	3.37	.66	8.05 **

* $p < .05$, ** $p < .01$

7.10 Views about mathematics

Of interest also were students' beliefs about mathematics and about learning mathematics. Tables 7.15 and 7.16 show the means for the stage 1-2 and stage 2 - 3 data respectively for the eleven questions exploring students' beliefs about mathematics and its perceived usefulness.

Liking of and preference for mathematics (statements 1 and 7) declined significantly between early and late Grade 6. Responses to short answer questions included at the end of the questionnaire provided some details about students' feelings. The 510 students who participated in the wave 2 data collection were asked "Do you like maths? Explain why or why not". Eleven percent of the students answered "no", either because the work was boring or repetitive or they had already covered it, while 8% said "no", because they weren't very good at it, for example the students who made comments such as "Pu Kjut'z hkig{yk oz'y ngxj gtj K's j{sh'. A number of strongly negative affective comments were made by students about why they didn't like maths, and it should be noted with some concern that many of these involved fear, embarrassment and ridicule. Typical comments made by the students in this study include:

- Kju tuz iotk s gzny hkig{yk ynkt Kyuxm yus kznotm u{z gtj znkt mkz oz iuxxkizkj *yoi+ oz oy tkrr; *yoi+ gry g;y xutm *yoi+,

- Kjut)z iotk s gzny s {in hkig{yk Kmkz g hoz lxokktj *yoi+ ynkt s uyz vkuvrk gxk lotoynkj znkxk *yoi+ s gzn gtj Kgs yzok *yoi+ muotm,

- Kjut'z iotk s gzny zngz s {in hkig{yk Kmkz grr zktyk gtj oz s gnky oz {tlu;ghrk *yoi+,

- Pu Kjut'z xkgrr; iotk s gzny hkig{yk Kngzk oz ynkt ;u{ jut'z mtuy gtj gtyykx gtj kxkx;utk rg{mny gz ;u{, and

- Kju tuz iotk s gzny hkig{yk Kgs glxgoj ul s {motm *yoi+ {v,4

In all, 37% of students who responded to the open ended questions answered that, for one reason or another, that they didn't like maths. In contrast, eleven percent of students answered "yes" they liked mathematics, for external reasons such as needing it later on for university, a job or shopping, while about 26% answered "yes" because the work was fun, or interesting, or because they were good at it. A number of students who appeared to be good at maths liked it for rather self-serving reasons, for example a number of students made comments in a similar vein to "_ky K ju iotk s gzny hkig{yk oz'y otzkxkyzotm gtj l{t4 Y nkt vkuvrk ngxk zxu{hrk znk;'rr z{xt zu ;u{ gtj ;u{ ynuy znks nuy zu ju oz'.

Table 7.15
Descriptive Statistics for "Views About Maths" Questions: Stage 1-2 Data (n = 144)

	Stage 1		**Stage2**		$F_{1,142}$
	Mean	SD	Mean	SD	
1. Maths is one of my favourite subjects	2.95	.86	2.83	.91	4.89 *
2. When a maths problem comes up that I can't solve immediately, I keep trying until I work it out	3.30	.64	3.28	.67	
3. Maths is a subject that will be useful to me when I leave school	3.71	.66	3.70	.68	
4. Maths problems can always be solved by following rules	3.40	.77	3.28	.70	
5. In maths it is possible to have more than one right answer	3.47	.76	3.34	.91	
6. I usually understand the work we do in maths	3.39	.68	3.35	.74	
7. I like maths more than I like most other subjects	2.68	1.01	2.50	1.03	6.90 **
8. Maths is only important at school	1.48	.82	1.47	.85	
9. Some people are good at maths and some just aren't	3.39	.84	3.17	.93	5.81 *
10. I give up working on maths problems when I can't understand them	1.89	.96	1.91	.90	
11. In maths something is either right or it's wrong	3.19	.90	2.97	1.03	6.52 *

* $p < .05$, ** $p < .01$

An adaptive and significant decrease in the belief in innate ability in mathematics was apparent between primary and secondary school (statement 9), however the means (stage 1: 3.40, stage 2: 3.32, stage 3: 3.10) indicate that for most students this was still a firmly held belief. Students were also quite sure in their beliefs that mathematics is about following rules, and it can be seen that the means for statement 4 were quite stable over the primary - secondary transition. Several students made comments similar to •]dt sgzny_ kxkx;zndtm ngy g rumdgr gtyykx.gtj d ;u{ lumy znk x{ky czyuxmyu{ž.

Table 7.16
Descriptive Statistics for "Views About Maths" Questions: Stage 2-3 Data (n = 302)

	Stage 2		Stage 3		$F_{1,301}$
	Mean	SD	Mean	SD	
1. Maths is one of my favourite subjects	2.74	.92	2.65	.97	
2. When a maths problem comes up that I can't solve immediately, I keep trying until I work it out	3.25	.68	3.17	.69	
3. Maths is a subject that will be useful to me when I leave school	3.74	.58	3.70	.54	
4. Maths problems can always be solved by following rules	3.39	.72	3.39	.65	
5. In maths it is possible to have more than one right answer	3.30	.91	3.27	.89	
6. I usually understand the work we do in maths	3.34	.70	3.43	.66	4.26 *
7. I like maths more than I like most other subjects	2.40	1.07	2.43	1.05	
8. Maths is only important at school	1.50	.80	1.50	.78	
9. Some people are good at maths and some just aren't	3.28	.89	3.10	.91	9.49 **
10. I give up working on maths problems when I can't understand them	2.04	.92	1.93	.85	
11. In maths something is either right or it's wrong	3.18	.94	3.00	.89	9.13 **

* $p < .05$, ** $p < .01$

Other beliefs were quite adaptive, with students showing stable persistence with solving problems (statements 2 and 10), belief in the usefulness of mathematics (statements 3 and 8), understanding of mathematics (statement 6) and recognition that it is possible to have more than one right answer (statement 5). The latter may reflect an increasing use of problem-solving strategies in the mathematics classroom that encourages students to explore their methods and look for other solutions to problems.

Gender differences were examined using t-tests for independent samples. Table 7.17 shows the means for female and male students at each stage of the study. Significant differences are shaded to highlight them and the results of the t-test included in the cell underneath the mean values. Female students were significantly less likely to agree that maths is one of their favourite subjects, or that they liked maths more than most other subjects, however it is encouraging to note that there were very few gender differences overall.

Table 7.17
Descriptive Statistics and Results of t-tests for Gender Differences for "Your Views About Mathematics"

	Stage 1		**Stage 2**		**Stage 3**	
	F *n=76*	M *n=78*	F *n=231*	M *n=279*	F *n=148*	M *n=154*
1. Maths is one of my favourite Subjects	2.87	2.96	2.65	2.90	2.51	2.77
			t(508)=-3.11 **		t(300)= - 2.34 *	
2. When a mathematics problem comes up that I can't solve immediately, I keep trying until I work it out	3.30	3.27	3.27	3.23	3.22	3.12
3. Maths is a subject that will be useful to me when I leave school	3.76	3.63	3.68	3.72	3.65	3.76
4. Maths problems can always be solved by following rules	3.46	3.22	3.36	3.42	3.37	3.42
5. In maths it is possible to have more than one right answer	3.47	3.46	3.29	3.35	3.24	3.30
6. I usually understand the work we do in mathematics	3.37	3.36	3.29	3.33	3.39	3.47
7. I like maths more than I like most other subjects	2.57	2.74	2.31	2.47	2.30	2.56
					t(300)=-2.11 *	
8. Maths is only important at school	1.54	1.46	1.61	1.48	1.53	1.47
9. Some people are good at maths and some just aren't	3.42	3.38	3.41	3.25	3.12	3.09
			t(508)= 2.05 *			
10. I give up working on maths problems when I can't understand them	1.97	1.88	1.97	2.05	2.01	1.85
11. In maths something is either right or it's wrong	3.26	3.09	3.10	3.24	3.01	3.00

* $p < .05$, ** $p < .01$

Most of the responses to the views about mathematics statements reveal similar trends for female and male students. The responses to question 4: *Maths is a subject that will be useful to me when I leave school* however, showed that while males gradually perceived mathematics as more useful in their post-school life, female students perceived it as less useful. This pattern of beliefs would provide a stronger incentive for male students to continue their mathematics studies past the compulsory level.

Students were also asked whether maths classes would be different in secondary school. Almost 58% of students said that they thought it would be harder, some with specific reasons such as "yk yorr ju gmkhxg. znk xkgrr¡. xkgrr¡. xkgrr¡. xkgrr¡ ngxj sgzny". A number of comments reflected a fairly low opinion of secondary mathematics teachers, such as:

"_ky oz yorr hk xkx¡ ngxj gtj znk¡ l{yz mokk ¡u{ ynkkzy gtj ¡u{ ngxk zu ju oz yoznu{z znk zkginkx zkrrotm ¡u{ nuy zu ju oz,.

- _ky K ju znotm znk igyyky yorr hk jdlkxktz hkig{yk yk yorr ngxk zu rkgxt oz u{xykrxky,.
- _ky znk¡]sgzny igyyky_ yorr hk ngxjkx4 Znk zkginkx yorr tuz nkrv sk,.and
- Y k yorr mkzg sgzny huum gtj mkz zurj zu ju oz gtj zngz"y oz,4

Some students had already determined in Grade 6 that they would have difficulties in secondary school; "O gzny yorr hk s{in ngxjkx4 K znotm K yorr lgor", however some looked forward to it eagerly "Kxkimut oz yorr hk kxkt sukk l{t", and "… oz yu{rj hk ngxjkx gtj sg¡hk kxkt suxk kziozotm". Unfortunately these positive comments were vastly outnumbered by the negative. These students had all participated in orientation days at their secondary schools when they answered these questions, so they had ideas about secondary school already fixed firmly in their minds.

7.11 Summary

It has been demonstrated in this chapter that the perceived control model is useful in describing changing beliefs about mathematics over the primary-secondary school transition. As particular combinations of perceived control variables were seen to affect student engagement, a summary variable (CONMAX) was used which takes account of the strategies and capacities found to maximise perceived control. Higher scores on this variable imply that the student has more well-developed views about learning mathematics.

CONMAX was seen to remain stable over the Grade 6 year, but then declined significantly after transition to secondary school. Students generally felt less in control of their learning; less able to control their successes and failures. Perceptions of teacher provision of autonomy support and teacher involvement also declined significantly over the transition to secondary school. Female students felt more engaged with their work than males at each stage of the study, a view echoed by their teachers, and they were also more likely to maintain beliefs about teacher involvement. Girls were also more likely to suffer from a decline in self-esteem over the transition to secondary school, and this decline occurred at a greater rate than for male students.

Students generally rated themselves as slightly above average in ability, and when asked about how good they would like to be in mathematics, male students held higher expectations than female students did. Although both female and male students moderated their expectations somewhat over the transition to secondary school, male students' expectations remained higher than female students', and males were more confident of their higher rating with teachers, parents and peers than females.

Self-regulation was found to be mainly due to identified reasons, and it was shown that after transition to secondary school, external regulation increased while intrinsic motivation tended to decrease. Intrinsic and identified self-regulation significantly decreased for females after transition, and intrinsic self-regulation was seen to be significantly lower than for males, while external self-regulation increased significantly for males.

Coping styles were generally found to be positive, but declined through Grade 6 and over the transition to secondary school, particularly for female students.

It would appear that there were some significant changes over the transition to secondary school. Many of these changes focus on students' beliefs about secondary school requiring more individual work than primary school, and feelings of less control over their learning than they had in primary school. However the changes described are averages over all students, and it was hypothesised that more extreme changes could occur in particular students but be "cancelled out" by the nature of the data analysis. Another method of data analysis may be more fruitful in discovering particular profiles of students "at risk" of diminished engagement in learning mathematics after the transition to secondary school, and so the investigation moved to the more exploratory area of cluster and discriminant analysis, which is the topic of the next chapter.

Chapter 8

Trajectories of perceived control

8.1 Longitudinal data analysis: A different view

The initial method of analysing the longitudinal data, as seen in the previous chapter, was to look at differences in sample means over time, with the focus thus being on the average change across all subjects. Univariate ANOVAs were performed individually on each cohort and on the data sets comprising students common to stages 1, 2 and 3, students common to stages 1 and 2, and on the data set comprising students common to stages 2 and 3. While some significant changes were found in perceived control beliefs, coping strategies, self-regulation beliefs and engagement, these changes could be seen only as trends among a large cohort of students, and were not sufficient to identify profiles of students "at risk" in mathematics.

Hirsch, DuBois and Brownell (1993) argued that the nature of analysis of variance is that it "identifies the modal trajectory" (p. 84), and that using ANOVA may mask subgroup differences. For example there may have been a balancing out of students who gained slightly with those who declined slightly, or even a balancing of students who gained considerably with those who declined considerably. Even the significant decline in the summary variable CONMAX found over the primary - secondary school transition needs a more fine-grained investigation if it is to prove a useful construct. Interventions planned might be significantly different if the differences were found to be a slight decline over the whole group rather than a substantial decline in one group coupled with slight increase in the rest of the cohort. Interventions might also be more precise if it could be determined that particular subscales of the perceived control construct showed differential effects on different groups of students. The significantly lower self-esteem shown by girls in early secondary school also needs further investigation to see whether there are subgroups whose self-esteem declines substantially, and to see whether particular factors characterise such a decline.

To investigate the major research question, it was important to analyse the data in such a way that subgroups of children who react differently to secondary school may be identified. These different reactions, or *trajectories*, were investigated with the use of cluster analysis. Cluster analysis is a method that attempts to define homogeneous groups within a data set. The variable used as a criterion for defining the clusters was CONMAX, which has already been described in previous chapters as a composite variable representing the student's level of perceived control in mathematics, and represents a combination of strategy and capacity beliefs. Cluster analysis was followed by discriminant analysis, for the purpose of determining whether particular components of the CONMAX construct were better predictors of cluster membership than others.

8.2 Cluster analysis

Cluster analysis is a method of multivariate data analysis in which a heterogeneous group is divided into more homogeneous sub-groups or clusters based on the strength of the relationship between particular response variables for individual cases. Eklund (1996, p. 1) described cluster analysis as "a classification procedure which may be used in an exploratory or confirmatory way. Its goal is to determine natural groups which reflect underlying structure by relating similar measures of an observed variable". Anderberg (1973) explained the nature of cluster analysis, and emphasised that interpretability of a solution should be paramount in the acceptance of a cluster solution:

> Cluster analysis is a device for suggesting hypotheses. The classification of data units on variables obtained from a cluster analysis procedure has no inherent validity ... The worth of a particular classification and its underlying explanatory structure is to be justified by its consistency with known facts and without regard to the manner of its original generation. Ideally, the set of clusters generated by a cluster analysis procedure will produce combinations of entities which otherwise might never be considered for examination but reveal aspects of the data which are self-evident in retrospect (p. 22).

Cluster analysis therefore is a useful tool for grouping participants on the basis of their similarity on a particular profile, and so was used in this study to examine the data for differing trajectories in perceived control over the transition to secondary school. The aim of this analysis was that the set of clusters produced should reflect different trajectories that might otherwise be lost in the data. Two types of cluster analysis were utilised in this data analysis; hierarchical and non-hierarchical, and their application is discussed in the following sections.

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There is a number of different methods of hierarchical cluster analysis, however the agglomerative method has been dominant in terms of frequency of use (Aldenderfer and Blashfield, 1984). Agglomerative hierarchical clustering starts with all cases as individuals. At the first step, two cases are merged to form a single cluster, based on their similarity coefficient. Small values for this coefficient indicate that clusters that are quite similar are being blended, while large values indicate that the clusters are quite diverse. At the second and subsequent steps, either individual cases are added to existing clusters or two existing clusters are combined. Eventually only one cluster, containing the whole data set, remains. Agglomerative clustering has the disadvantage that once individuals are assigned to a cluster they will not be removed from it, even though they may subsequently fit better with another cluster. However the agglomerative technique is most widely supported (for example it is the only option provided by $SPSS_{WIN}$) and so this method was used in this study.

Agglomerative hierarchical clustering was used as a first step in the exploration of the data set, using the combined perceived control measure CONMAX as the clustering variable. The algorithm chosen for the hierarchical clustering was Ward's method (Ward, 1963) in which all of the possible combinations of clusters are examined at each step of the clustering process to find the two clusters for which minimal information loss will occur when they are combined. The objective function formed by this method uses the error sum of squares (ESS), and joins groups or cases that result in the minimum possible increase in the ESS. A review of hierarchical clustering methods in Deppeler (1994) concluded that "of the hierarchical methods, Ward's minimum variance method appears to perform better than all other methods tested" (p. 93).

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After the method was chosen for the hierarchical cluster analysis, the problem of how many groups to define became apparent. Hierarchical cluster analysis performs a series of data mergers until there is only a single cluster, representing the entire data set. At the most basic level, a dendogram can be produced and visually inspected for interpretable clusters. The tree structure of the dendogram presents many different groups that may be present in the data, however the question becomes where to "cut" the tree so as to extract the optimal number of groups. As this method is reliant purely on the judgement of the researcher, other methods were examined that were felt to be more objective.

In the merging process some measure of distance between two clusters is used, referred to as similarity or agglomeration coefficients, which are produced in the agglomeration schedule by $SPSS_{WIN}$. These agglomeration coefficients can be graphed in relation to the number of clusters, a process similar to the scree test in factor analysis. The resulting graph can then be examined for a "marked flattening … [which would suggest] that no new information is portrayed by the following mergers of clusters" (Aldenderfer and Blashfield, 1984, p. 54). This method is still somewhat subjective, and the graph frequently does not produce a clear solution, so another more formal method of determining the number of clusters was sought.

Mojena (1977) devised a procedure based on the relative sizes of the similarity coefficient to determine where to stop the merging process. This procedure determines whether a "jump" in the relative size of coefficients is large enough to be deemed significant. The "stopping rule" is to select the number of groups corresponding to the first stage in the agglomeration process that satisfies the rule: $\alpha_{j+1} > \overline{\alpha} + ks_{\alpha}$, where α represents the agglomeration coefficient, and $\alpha_0, \alpha_1, \ldots, \alpha_{n-1}$ are the fusion levels corresponding to stages with n, n -1, … , 1 clusters. The terms $\overline{\alpha}$ and s_{α} represent the mean and standard deviation of the α

values and *k* is a constant. While Mojena (1977) suggested a value of *k* in the range 2.75 to 3.5, Milligan and Cooper (1985) argued that 1.25 is a more appropriate value for *k*. As this research was largely exploratory, the smaller value was used as it was deemed more likely to produce interpretable groups. Following this, non-hierarchical cluster analysis was employed to further investigate the groups suggested by the hierarchical cluster analysis. This will be discussed in the next section.

8.2.3 Non-hierarchical cluster analysis

There is a variety of non-hierarchical procedures, and in this analysis the convergent *k*-means method was used. This is an iterative partitioning procedure that works in the following manner. The algorithm begins by dividing the data set randomly into a predetermined number of clusters, and the centroids of these clusters are calculated. Each data point is then allocated to the cluster with the nearest centroid, and when all data points have been assigned the centroids are re-calculated and data points are moved to closer centroids if necessary. This iterative procedure continues until no data points change clusters. Deppeler (1994) concluded that "of the non-hierarchical procedures, convergent *k*-means method appears to consistently outperform other non-hierarchical methods" (p. 94). Hirsch *et al.* (1993) used *k*-means cluster analysis, arguing that "for prevention purposes, *k*-means has the advantage … of being sensitive to extreme profiles and thus does not mask atypical patterns in order to achieve similarly sized groups" (p. 87).

8.3 Cluster analysis of the smaller data set

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Initially, data analysis focussed on the data set comprising students who participated in each of the three stages of data collection. Although this group was relatively small, it is deemed large enough for exploratory analysis of this type. The mean of the agglomeration coefficients, $\overline{\alpha}$, was found to be 4377.61, and the standard deviation 9100.39. Using $k = 1.25$, the value for α_{j+1} was therefore 15 753.10, and it was apparent from the agglomeration schedule that the gap between the second last and final cluster merges was found to be greater than this. This then suggested a two cluster solution, which would next be further explored using non-hierarchical clustering techniques.

Choosing the number of clusters to examine with the *k*-means cluster analysis was guided by the results of the hierarchical cluster analysis. However as the nature of the cluster analysis was exploratory, it was vital both that the number of clusters chosen should be the most economical possible, and that these clusters should define an *interpretable* number of separate groups. Eklund (1996) argued that the researcher should have some knowledge of the significance of the cluster groupings, and so to allow for interpretability he recommended an examination of the cluster solutions at least one greater and one less than that obtained from the hierarchical method. For the initial sample, 71 out of 74 cases were available for analysis, due to missing data on three cases. It was decided that cluster solutions for two, three and four clusters would be examined using *k*-means cluster analysis.

8.3.2 *k*-means cluster analysis

Following the exploration of the data using the hierarchical clustering technique, three *k*-means cluster analyses were performed on the combined stage 1-2-3 data set, specifying that two, three and four clusters be defined. Graphs of the means for perceived control for the two-cluster, three-cluster and four-cluster solutions defined by the *k*-means clustering algorithm are shown in Figure 8.1, where time 1 represents early Grade 6, time 2 late Grade 6 and time 3 early in Year 7. Table 8.1 presents the mean scores for the perceived control variable over the three time periods for the alternate cluster solutions examined. It is apparent from both Table 8.1 and Figure 8.1 that the four cluster solution showed interesting differences between the groups who start out with high levels of perceived control early in Grade 6 and also between those that start out with relatively low levels of perceived control. Of the groups that started out with high levels of perceived control, one group remained high while the other suffered a rather large decline.

Table 8.1
Mean Perceived Control Scores for Alternate Clustering Solutions

	Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
4 cluster Solution	(n=3)	(n=22)	(n=25)	(n=21)
CONMAX A	1.83	17.23	38.82	46.81
CONMAX B	-7.83	14.57	39.42	45.43
CONMAX C	-10.17	23.86	22.32	45.69
3 cluster solution	(n=3)	(n=24)	(n=44)	
CONMAX A	1.83	18.46	42.94	
CONMAX B	-7.83	16.17	42.55	
CONMAX C	-10.17	22.56	34.11	
2 cluster solution	(n=25)	(n=46)		
CONMAX A	15.94	42.16		
CONMAX B	11.58	42.33		
CONMAX C	19.16	33.33		

The opposite occurred with the group whose perceived control was low to start with; one group stayed very low, while the other group rose significantly. In moving to a three-cluster solution, the two groups that began with high perceived control were combined and an average group formed, while the two-cluster solution merged the lower two clusters.

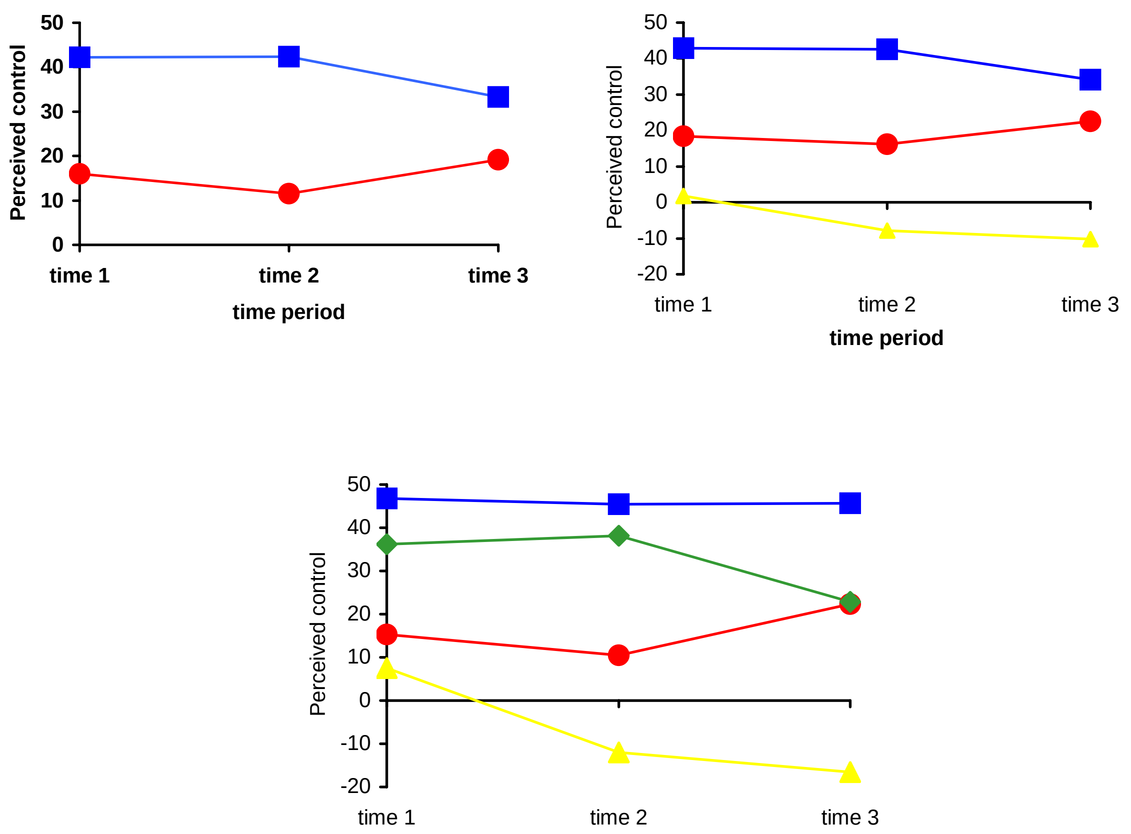

Figure 8.1 Means for perceived control over the primary-secondary transition for two, three and four cluster solutions

It would appear that interesting differences between clusters in the four-cluster solution are masked when the number of clusters is decreased. It was apparent that the selection of the higher level cluster solution was the most likely to maximise cluster differences, and so the data analysis proceeded with the four-cluster solution.

Whichever solution was chosen, there appeared to be a large group of students who exhibited high levels of perceived control in primary school which declined sharply on transition to secondary school. These students are particularly at risk because it is difficult to identify them. At both instances in primary school, most of these students held high perceived control beliefs, so there are no obvious behavioural or motivational problems in Grade 6 that would alert teachers to possible problems in secondary school.

8.4 Cluster solutions for the larger sample

8.4.1 Validity and replicability of cluster solutions

The next stage in the development of a cluster solution was to examine the clustering for the larger stage 2 and 3 data set to see whether similar clusters existed for this group. This set comprised matched data from the larger sample of 302 students who were surveyed both late in term 4 of Grade 6 and late in term 2 of Year 7. Aldenderfer and Blashfield (1984) argued that the degree of replicability of a cluster solution is best examined by clustering different samples from the same population, similar to the method of split half reliability. The method utilised in this analysis of examining two data sets from the same population would clearly provide some evidence of replicability for the solution. It should be noted that while this technique may be seen as a check for the internal consistency of a solution, Aldenderfer and Blashfield (1984) warned that it does not guarantee the *validity* of a solution. They argue that a more powerful validation of a clustering solution is to "perform significance tests that compare the clusters on variables *not* used to generate the cluster solution" (p. 66).

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Hierarchical cluster analysis, conducted as previously described, produced a mean for the agglomeration coefficient of 3 802.23 and a standard deviation of 15 094.99. The figure for α_{j+1} was therefore 22 670.96, and on examination of the agglomeration schedule this suggested a three-cluster solution.

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As before, on the basis of the hierarchical cluster analysis, two, three and four cluster solutions were investigated using *k*-means cluster analysis. The mean scores for perceived control over the two stages of data collection, the end of primary school and the beginning of secondary school, are shown in Table 8.2, while the graphs illustrating these means are shown in Figure 8.2.

The results of cluster analysis for the larger stage 2-3 data set supported the findings of the cluster analysis for the smaller group. Again the four-cluster solution showed a group of students whose perceived control declined sharply after the transition to secondary school. The three-cluster solution merged cluster 3 into clusters 2 and 4, and the two-cluster solution merged mainly the two higher groups.

Table 8.2
Mean Perceived Control Scores for Alternate Clustering Solutions: Stage 2-3 Data

	Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
4 Cluster Solution	(*n*=38)	(*n*=68)	(*n*=107)	(*n*=77)
CONMAX B	-2.26	13.38	36.79	43.85
CONMAX C	-2.88	27.11	20.83	43.81
3 cluster solution	(*n*=40)	(*n*=133)	(*n*=117)	
CONMAX B	-4.72	24.09	43.78	
CONMAX C	.20	21.75	37.91	
2 Cluster solution	(*n*=71)	(*n*=219)		
CONMAX B	2.81	36.24		
CONMAX C	7.84	30.96		

It can be seen from the graphs of perceived control in Figure 8.2 that detail is lost with each merger in the clustering process. The four-cluster solution defines clearly the students who are potentially "at risk" in mathematics at secondary school, those whose perceived control is high and drops off after transition. This is the group for whom intervention at the primary school or early secondary school level would be most appropriate, and so the four-cluster solution would appear to be far more useful in practical terms than the three-cluster solution. A five-cluster solution was examined, however this solution was rejected because of two factors. The extra trajectory defined was not substantially different from others defined, and the five-cluster solution included a cluster with only 5 students, which presented practical concerns with regard to further analysis.

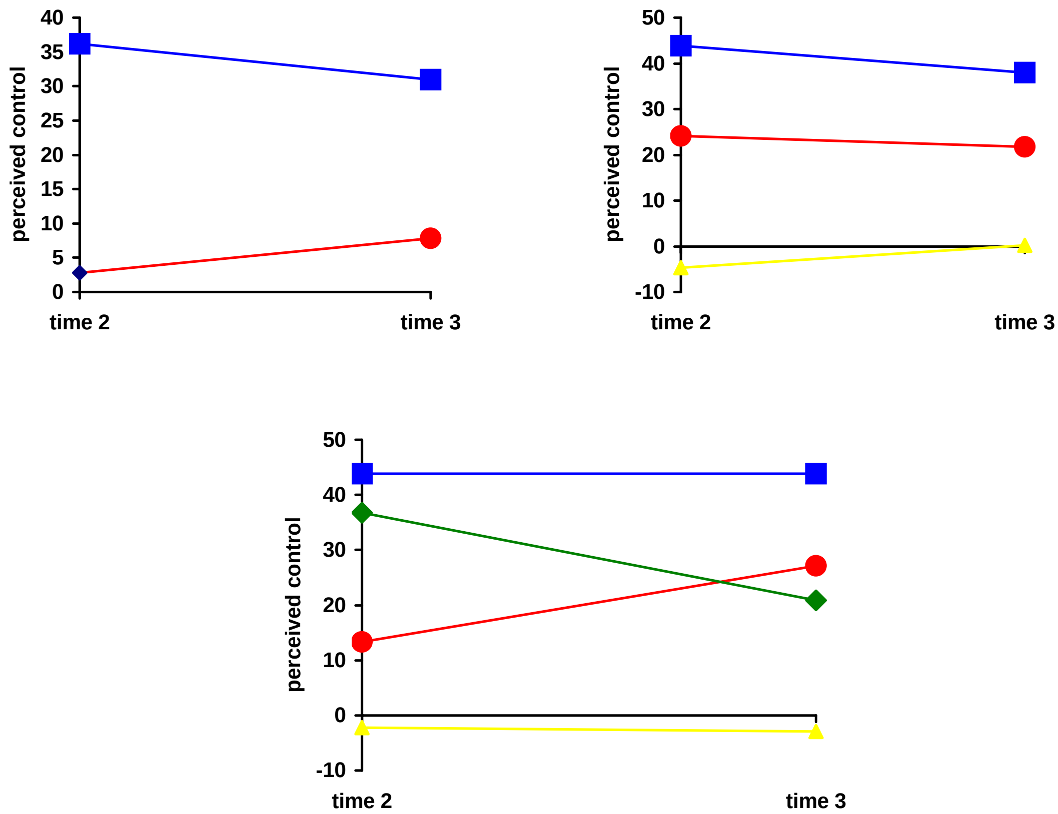

Figure 8.2 Means for two, three and four-cluster solutions; wave 2 and 3 data set

For convenience, it was decided to attach descriptive labels to each of the groups formed by the cluster analysis. The group whose perceived control remained high throughout the study were named the *consistently high* group, while the group whose perceived control started high in Grade 6 but dropped after the transition to secondary school became the *decliners* group. The group whose perceived control remained low was labelled the *chronically low* group, while those whose perceived control was low in Grade 6 but improved markedly over the transition to secondary school became the *risers* group.

As the predictor variable (CONMAX) was a combination of strategy and capacity beliefs, a discriminant analysis was carried out using cluster membership as the grouping variable and the strategy, capacity and control beliefs from time 2 (fourth term primary school) as independent variables. It was considered that for intervention measures it was more important to know the predictors before entering primary school and this is why these were the independent variables used in the discriminant analysis.

8.5 Discriminant analysis

Discriminant analysis is a technique that examines the extent to which multiple predictor variables are related to a categorical criterion, in this case group membership. It is particularly useful for determining which of the predictor variables best characterises the group differences. Discriminant analysis forms linear combinations of the independent variables that serve as the basis for classifying particular cases into one of the defined groups. The optimal discriminant function will minimise the probability of misclassification (Norušis, 1993).

Direct discriminant analysis was performed using all perceived competence variables as predictor variables for group membership in the clusters. Of the original 302 cases, 12 were deleted from the analysis because of missing data. Prior probabilities were assumed to be equal, following the conservative recommendation by Stevens (1996, p. 281).

One significant discriminant function was calculated, accounting for 97.8% of the between groups variability and 74% of the total variance among groups, with χ^2 (30) = 393.56, $p < .001$. This discriminant function maximally separated the *consistently high* and *decliners* from the *chronically low* and the *risers*, as can be seen in the plot of group centroids shown in Figure 8.3.

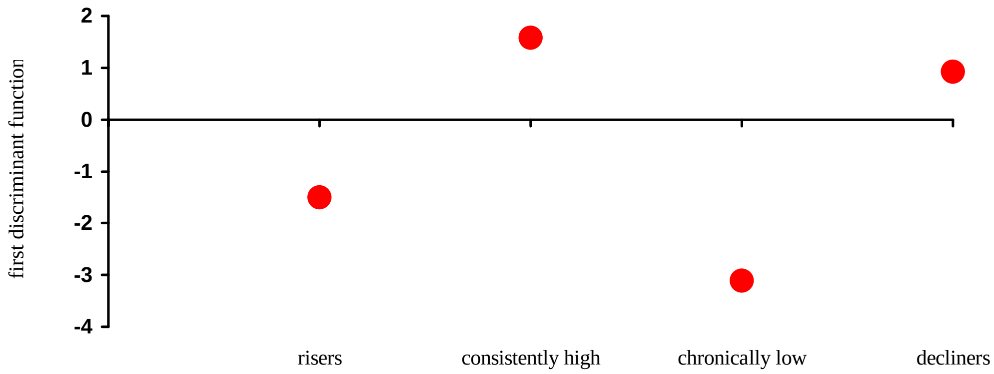

Figure 8.3 *Group centroids for the four cluster solution*

The loading matrix of correlations between predictors and discriminant functions, shown in Table 8.3, suggests that the best predictors for distinguishing between these groups are beliefs about control and capacity beliefs for ability, effort and luck, and unknown strategy beliefs; knowing or not knowing how to succeed in mathematics. For interpretation of this analysis, loadings (column 2) less than .30 were not considered (Tabachnick and Fidell, 1989, p. 539). The canonical correlation of .86 represents a large correlation between group membership and the significant discriminant function.

Table 8.3
Results of Discriminant Function Analysis of Individual Perceived Control Beliefs

Predictor variable	Correlations of predictor variables with discriminant functions	Univariate $F_{3, 286}$	*p*
Control	.56	81.93	***
Strategy ability	- .21	11.86	***
Strategy effort	.11	3.48	*
Strategy luck	- .29	23.24	***
Strategy powerful others	- .25	17.09	***
Strategy unknown	- .41	45.90	***
Capacity ability	.55	84.85	***
Capacity effort	.51	71.04	***
Capacity luck	.41	44.93	***
Capacity powerful others	.21	12.90	***
Canonical *R*	.86		
Eigenvalue	2.79		

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 8.3 also shows the univariate F-tests between each of the predictor variables and the discriminant function. All of these are significant, indicating that each of the predictors acts to discriminate between the groups, although as was seen in the previous chapter, Strategy effort contributes less to the prediction than any of the other variables. The means for the significant predictor variables are shown in Table 8.4. The *consistently high* group present the most positive profile of the four groups, with the highest scores on Capacity ability, Capacity effort, Capacity luck and Control (*I am smart, I can work hard, I'm lucky* and *I can do well in maths if I want to*), and the lowest on Strategy unknown (*I don't know how to do well in maths*). The groups progressively show more detrimental belief structures, with the *chronically low* group exhibiting low belief in their own ability, in Capacity effort, and Capacity luck, and being more likely to agree with statements such as "*I don't know what it takes to do well in maths*".

Table 8.4
Means of Significant Predictors for All Groups

	Control	Capacity ability	Capacity effort	Capacity luck	Strategy unknown
chronically low	2.50	2.12	2.74	2.18	2.68
risers	3.04	2.44	3.19	2.55	2.21
decliners	3.69	3.34	3.77	3.07	1.60
consistently high	3.84	3.56	3.83	3.22	1.48

A total of 68.28% of grouped cases were correctly classified by this discriminant function, as shown in Table 8.5. Chance allocation of the 290 cases into cells retaining the marginal totals would yield 79/290 cases, or 27% correct. Clearly the discriminant function procedure classification rate is substantially better than this rate.

Table 8.5
Classification Results for Discriminant Analysis

		Predicted Group Membership			
Actual Group	*n* cases	**consistently high**	**decliners**	**chronically low**	**risers**
consistently high	77	52 (67.5%)	23 (29.9%)	0 (0%)	2 (2.6%)
decliners	107	36 (33.6%)	66 (61.7%)	0 (0%)	5 (4.7%)
chronically low	38	0 (0%)	1 (2.6%)	23 (60.5%)	14 (36.8%)
risers	68	0 (0%)	2 (2.9%)	9 (13.2%)	57 (83.8%)
marginal totals		88	92	32	78

It can be seen that while the discriminant function is best at predicting the *risers* group, it also performs quite respectably at predicting the *decliners*, who are the critical group to try and identify.

In summary, the combination of cluster and discriminant analysis identified four reasonably distinct sub-groups of students. A substantial number (35%) of the students in the sample showed a decline in their perceived control over the primary-secondary school transition. These students appear to have strategies for or beliefs about learning that may be effective in primary school but are not effective in secondary school.

It would appear that it is more difficult to separate the groups that are closest together, in this instance the *consistently high* and *decliners* groups and the *chronically low* and *risers* groups. For the purposes of intervention, it is particularly necessary to be able to identify students in the *decliners* group, and the identification of particular changes in beliefs by the *risers* group may provide clues to help other groups. In order to facilitate this identification, further discriminant analyses were carried out to examine the differences between these groups.

8.6 Differences between consistently high and decliners

One hundred and eighty-four cases were used in a direct discriminant analysis using all perceived competence variables as predictor variables for group membership in the *consistently high* and *decliners* clusters. A single discriminant function was calculated, with $\chi^2(10) = 28.10$, $p < .01$. The loading matrix of correlations between predictors and the discriminant function, shown in Table 8.6, suggests that the best predictors are Capacity ability, Capacity powerful others and Control beliefs, and these are also the only predictors that serve to discriminate between the two groups.

Table 8.6
Results of Discriminant Function Analysis of Individual Perceived Control Beliefs in Primary School for Consistently High and Decliners Groups

Predictor variable	Correlations of predictor variables with discriminant functions	Univariate F (1, 182)	*p*
Control	.46	6.55	*
Capacity ability	.49	7.58	**
Capacity effort	.18	1.06	
Capacity luck	.34	3.70	
Capacity powerful others	.49	7.42	**
Strategy ability	- .34	3.65	
Strategy effort	.32	3.08	
Strategy luck	- .10	.32	
Strategy powerful others	- .19	1.15	
Strategy unknown	- .23	1.73	
Canonical *R*	.38		
Eigenvalue	.17		

* $p < .05$, ** $p < .01$ *** $p < .001$

It can be seen from Table 8.7 that students in the *consistently high* group believed more strongly in their own ability and in their capacity for obtaining the assistance of their teachers, and had a higher level of belief that "*I can do well in maths if I want to*" than those students whose perceived control dropped in Year 7.

Table 8.7
Means of Significant Predictors for Consistently High and Decliners Groups: Primary School

	Capacity ability	Control	Capacity powerful others
Decliners	3.34	3.69	2.97
Consistently high	3.56	3.84	3.25

8.7 Differences between chronically low and risers groups

One hundred and six cases were used in a direct discriminant analysis using all perceived competence variables as predictor variables for group membership in the *chronically low* and *risers* clusters. A single discriminant function was calculated, with $\chi^2(10) = 38.17$, $p < .001$. The loading matrix of correlations between predictors and the discriminant function, shown in Table 8.8, demonstrates that there are quite different predictors that discriminate between these two groups and the previous two groups discussed. The correlations suggest that the best predictors to separate these two groups were Control, Capacity effort, Capacity luck, Strategy luck and Strategy unknown.

Table 8.8
Results of Discriminant Function Analysis of Individual Perceived Control Beliefs in Primary School for Chronically Low and Risers Groups

Predictor variable	Correlations of predictor variables with discriminant functions	Univariate $F_{1,104}$	*p*
Control	.57	16.01	***
Capacity ability	.34	5.62	*
Capacity effort	.57	15.68	***
Capacity luck	.47	10.76	**
Capacity powerful others	.11	.58	
Strategy ability	- .29	4.16	*
Strategy effort	.13	.79	
Strategy luck	- .48	11.06	**
Strategy powerful others	- .21	2.21	
Strategy unknown	- .55	14.66	**
Canonical *R*	.57		
Eigenvalue	.47		

* $p < .05$, ** $p < .01$ *** $p < .001$

The means for the significant predictors are shown in Table 8.9. This table shows that the *risers* are more likely to think that they know how to succeed in maths than the *chronically low* group. They are also less likely to attribute success in mathematics to luck, feel more in control of their learning, be more confident of their ability and the extent to which they can put in the required amount of effort to succeed.

Table 8.9
Means of Significant Predictors for Chronically Low and Risers Groups; Primary School

	Control	**Capacity effort**	**Strategy unknown**	**Strategy luck**
Chronically low	2.50	2.73	2.68	2.99
Risers	3.04	3.19	2.21	2.49

8.8 Gender differences

In order to investigate gender differences within groups, separate discriminant analyses were conducted within each cluster using gender as the predictor variable. No significant discriminant functions were obtained for the *risers* group ($\chi^2(10) = 15.60$, $p > .05$), the *consistently high* group ($\chi^2(10) = 15.13$, $p > .05$), or the *chronically low* group ($\chi^2(10) = 16.64$, $p > .01$). However for the *decliners* group, a significant discriminant function was obtained, $\chi^2(10) = 28.54$, $p < .001$.

Differences within the *decliners* group were found to be on the variables Capacity ability and Capacity luck. Males were found to be likely to have stronger beliefs in their own ability (female mean 3.16, male mean 3.47), while females believed that they were luckier (female mean 3.20, male mean 2.96). The univariate F-tests for each were significant (Capacity ability $F_{1,105} = 9.81$, $p < .01$, Capacity luck $F_{1,105} = 5.76$, $p < .05$), and the correlations between the discriminating variables and the discriminant function were .53 and -.41 for Capacity ability and Capacity luck respectively.

8.9 Summary

In this chapter, it was hypothesised that sub-groups of students experienced differences in perceived control over the transition to secondary school. Cluster analysis using the combined perceived control variable was used as a means of exploring the general school population sampled in this study to see if homogeneous sub-groups were apparent. A four-cluster solution was developed that produced groups which were thought to reflect the hypothesised sub-groups.

The labels for these groups: *consistently high*, *decliners*, *risers* and *chronically low*, reflect the changes in perceived control beliefs of each of the groups over the transition from primary to secondary school.

Discriminant analysis was then carried out using the separate perceived control variables as predictor variables for cluster membership. A single discriminant function was defined that separated the four groups, and the best predictors were found to be Control, Capacity ability, Capacity effort, Capacity luck and Strategy unknown. Students in the *consistently high* group were more confident of their ability, the amount of effort they could put into their work and the amount of control they had over their learning, while the *chronically low* group were the least confident on these variables. In conjunction with this, these students had the highest mean for Strategy unknown, indicating that perhaps many of them don't have strategies for success because they really don't have any idea about *how* to be successful.

Further discriminant analysis was then carried out in an attempt to find out whether any of the perceived control variables would discriminate between i) the *consistently high* and *decliners* groups and ii) the *chronically low* and the *risers* groups. The best predictors between the *chronically low* and *decliners* groups were Capacity ability, Capacity powerful others and Control, with the *decliners* group losing confidence in all three over the transition to secondary school. The best predictors between the *chronically low* and *risers* groups were found to be Capacity effort, Capacity luck, Control, Strategy luck and Strategy unknown. The *risers* group were more confident of their ability to work hard and be lucky by being asked the right questions, while the *chronically low* group are less sure about the strategies for success, but feel perhaps it may be due to luck, which they in turn don't feel they have.

Gender differences were only found in the *decliners* group, with males having stronger beliefs in their own ability and females being more likely to believe that their success was due to luck. In essence, the boys are saying "I am smart at maths", while the girls are saying "I am lucky in maths". This could have consequences further along the academic track; as boys are challenged academically the belief in their own inherent ability may be enough to get them over any hurdles, while girls challenged may feel threatened as they are only relying on luck.

The next chapter examines the validity of the cluster solution by examining the effects on the different variables and subscales over the transition to secondary school. The cluster solution should be reflected in these other subscales if the solution is to be deemed valid.

Chapter 9

Other trends within and between clusters

9.1 Introduction

The major aim of this research was to identify changes in perceived control beliefs among students over the period of transition to secondary school. It was hypothesised that groups of students would exhibit differing trajectories of perceived control over transition and the analysis of the previous chapter has confirmed that these groups are clearly definable. This chapter provides an examination of the validity of the cluster solution determined in the previous chapter. It also looks at the trends within the defined groups and the trends between the groups on a range of other variables for which data were collected in this study.

9.2 Transition trends on other variables: Research questions

In order to assess the effect of transition on each group of students, and to provide some evidence for the validity of the clustering solution, as advocated by Aldenderfer and Blashfield (1984), means for variables other than perceived control, both inter-group and intra-group, were examined. A number of comparisons were also of interest at this stage of the data analysis. These generated several subsidiary research questions, which guided the data analysis for this chapter.

1. *Are there significant differences between the four cluster groups on variables other than perceived control?*
2. *If so, are the differences apparent at Grade 6, Year 7, or both?*
3. *Are there significant differences on these other variables between the "consistently high" and "decliners" groups?*
4. *Are there significant differences on these other variables between the "chronically low" and "risers" groups?*
5. *Are there the same changes over transition between the "consistently high" and "decliners" groups?*
6. *Are there the same changes over transition between the "chronically low" and "risers" groups?*

9.3 Statistical tests conducted

In order to facilitate the discussion of the results for this part of the data analysis, the statistical techniques used will be described in this section.

Multiple univariate ANOVAs were used to examine the differences between groups, in order to answer research questions 1 and 2. Paired samples t-tests were then used to determine whether significant changes had occurred on each of the variables between time 2 and time 3; over the primary secondary transition, which would answer questions 5 and 6. Finally, independent groups t-tests were used to examine the differences between the *consistently high* and *decliners* groups and between the *chronically low* and *risers* groups, to answer questions 3 and 4. For all tests, a negative prefix means that the value of the mean for the second element in the pair is higher than the mean for the first element. For example for the *chronically low* versus *risers* comparisons, a negative value for the t-test indicates that the value for the mean for the *risers* was higher than the mean for the *chronically low*. Similarly, for the Grade 6 - Year 7 comparison for the *consistently high* group, a negative value means that the Year 7 mean was higher than the Grade 6 mean.

9.4 Engagement, ability and antecedents of perceived control

Table 9.1 shows the means for both student and teacher-rated engagement and for students' beliefs about teachers for Grade 6 and Year 7. Multiple univariate ANOVAs found that there were significant differences between groups for all variables. At both the Grade 6 and Year 7 level, the *consistently high* group had the highest levels of perceived engagement, both on their own rating and teachers' ratings, and the *chronically low* group consistently had the lowest levels.

Table 9.1
Cluster Means for Measures of Engagement, Ability and Beliefs About Teachers: Grade 6 and Year 7

	Grade 6				$F_{3,286}$	*p*
	Consistently high	*Decliners*	*Risers*	*Chronically low*		
Student-rated engagement	3.56	3.45	3.13	2.93	30.93	***
Teacher-rated engagement	2.00	1.64	.98	.03	21.59	***
Perceived teacher structure	3.53	3.29	3.05	2.81	27.18	***
Autonomy support	2.82	2.86	2.63	2.63	5.63	***
Teacher involvement	3.54	3.38	3.17	2.93	14.60	***
	Year 7					
Student-rated engagement	3.69	3.10	3.25	2.87	32.78	***
Teacher-rated engagement	1.81	1.21	1.20	.37	15.45	***
Perceived teacher structure	3.48	3.09	3.18	2.84	15.72	***
Autonomy support	2.70	2.59	2.45	2.35	7.33	***
Teacher involvement	3.40	2.84	2.94	2.62	20.74	***

*** $p < .001$

These two groups were also the highest and lowest groups on the other variables; the *consistently high* group believing that their teachers are more involved with them, provide more autonomy support and more structure, and the *chronically low* groups feeling more estranged from their teacher, less supported and less structured. This finding is consistent with the findings of Skinner and Belmont (1993), who found that teachers actually did respond more positively to students who were perceived to be more engaged and motivated in ways that would serve to increase this engagement. Conversely, students who are initially passive and do not participate in class will be treated by their teachers in such a way as to reinforce their problems; with less structure, less involvement and less autonomy support.

It is the two groups who change during the transition that are of particular interest here. On most of the variables the *decliners*' beliefs have become more negative while the *risers*' beliefs have become more positive, indicating that the groupings defined on perceived control are also reflected by these variables.

9.4.1 Differences between consistently high and decliners groups

Table 9.2 summarises the separate t-tests on these two groups. Independent groups t-tests, testing for differences between the groups, found significant differences between student-rated engagement at both Grade 6 and Year 7, and for teacher-rated engagement at Year 7. The non-significance of difference of the teacher's rating of engagement between these two groups is important since it demonstrates that it may not be until Year 7 that these differences become readily apparent.

Students in the *consistently high* group felt that they had significantly more structure provided by their teachers both in Grade 6 and 7, and that their teacher was more involved with them. There were no significant differences between these two groups on the autonomy support variable.

Examining the paired samples t-tests for the *consistently high* group, it was found that student-rated engagement increased significantly from Grade 6 to Year 7, while both perceived autonomy support and teacher involvement declined significantly, although by a smaller amount. For the *decliners* group, all differences were found to be highly significant between Grade 6 and Year 7, and all means declined over the transition to secondary school, especially those for perceived teacher involvement and student-rated engagement.

Table 9.2
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Consistently High and Decliners Groups

	consistently high vs decliners				*consistently high*		*decliners*	
	Grade 6		Year 7		Grade 6 - Year 7		Grade 6 - Year 7	
	t_{182}	p	t_{182}	p	t_{76}	p	t_{106}	p
Student-rated engagement	2.16	*	8.27	***	-3.04	**	7.20	***
Teacher-rated engagement	1.74		3.79	***	1.56		3.99	***
Perceived teacher structure	3.58	***	5.02	***	0.74		3.29	***
Autonomy support	-0.52		1.61		2.09	*	5.42	***
Teacher involvement	2.22	*	6.23	***	2.04	*	8.32	***

* $p < .05$, ** $p < .01$ *** $p < .001$

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The differences between the *chronically low* and *risers* groups (shown in Table 9.3) were found to be similar to those between the *consistently high* and *decliners* groups. Again there were no significant differences found between groups either in Grade 6 or Year 7 for autonomy support, however all other differences were significant. Students in the *chronically low* group had the lowest levels of engagement, and perceived that they had the lowest levels of teacher structure and involvement, particularly after the transition to secondary school. Teachers at both primary and secondary school rated students in the *risers* group as more highly engaged than those in the *chronically low* group. While this was a significant difference at both grade levels, it was noteworthy that although different teachers were rating these students, for the *chronically low* students their primary and secondary teachers rated them at a similar level, perhaps implying that these students are clearly recognisable at either grade level.

Table 9.3
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Chronically Low and Risers Groups

	chronically low vs risers				*chronically low*		*risers*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{104}	p	t_{104}	p	t_{37}	p	t_{67}	p
Student-rated engagement	-2.18	*	-3.88	***	0.69		-2.11	*
Teacher-rated engagement	-3.71	***	-3.64	***	-2.28	*	-1.07	
Perceived teacher structure	-2.80	**	-3.49	***	-0.26		-1.90	
Autonomy support	0.00		-1.14		2.99	**	2.63	**
Teacher involvement	-2.15	*	-2.96	**	2.80	**	3.16	**

* $p < .05$, ** $p < .01$ *** $p < .001$

9.5 Relatedness variables

It is important to examine the quality of students' relationships with their "academic partners"; their peers and teachers, and their own emotional security, as "secure relationships … should enhance students' engagement in the pursuit of learning" (Connell, 1990, p. 80). The relatedness variables, seen in Table 9.4, showed similar patterns to the engagement variables previously discussed. The *consistently high* group exhibited the highest levels of emotional security and felt closer to both their peers and teachers at both Grade 6 and Year 7, while the *chronically low* group had the lowest levels of each of these. These findings for different groups extend those from previous research studies that have examined relatedness to teachers and peers on a global level, and present formidable problems for those students in the *chronically low* group. Midgley *et al.* (1989b) found that valuing of mathematics increased for students moving to a supportive school environment, which means that some of the students in the current study will do well. Significant differences between groups were again found for all variables at both grade levels.

Relatedness to peers remained strong through primary school and into secondary school, however there were indications that the *decliners* group experienced some difficulties in this area as they were the only group who suffered a significant decline on this variable over transition.

Table 9.4
Cluster Means for Relatedness Variables: Grade 6 and Year 7

	Grade 6				$F_{3,286}$	*p*
	Consistently high	*Decliners*	*Risers*	*Chronically low*		
Relatedness to Self	3.20	3.00	2.79	2.57	10.06	***
Relatedness to Peers	3.65	3.56	3.38	3.22	7.46	***
Relatedness to Teachers	3.33	3.01	2.74	2.47	21.33	***
	Year 7					
Relatedness to Self	3.34	2.96	3.03	2.61	11.06	***
Relatedness to Peers	3.61	3.42	3.51	3.21	4.01	**
Relatedness to Teachers	3.49	2.79	2.98	2.39	34.26	***

** $p < .01$, *** $p < .001$

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The results of the t-tests examining differences between these two groups are shown in Table 9.5. Emotional security, measured by the relatedness to self variable, is significantly different between these two groups in Grade 6, and these differences also increase after transition to secondary school. Transition also has a different effect on relatedness to teachers; increasing significantly for the *consistently high* group and decreasing significantly for the *decliners* group. In Year 7, students in the *consistently high* group have significantly more secure relationships with their academic partners than those in the *decliners* group, facilitating engagement and probably adjustment to secondary school. The students in the *decliners* group however, may have found that existing relationship problems with teachers and peers were exacerbated by transition to secondary school, and the decline in emotional security may be a consequence of this.

Table 9.5
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Consistently High and Decliners Groups

	consistently high vs decliners				*consistently high*		*decliners*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{182}	*p*	t	*p*	t_{76}	*p*	t_{106}	*p*
Relatedness to Self	2.18	*	3.96	***	-1.73		0.54	
Relatedness to Peers	1.30		2.08	*	0.53		2.20	*
Relatedness to Teachers	3.79	***	7.66	***	-2.52	**	2.72	**

* $p < .05$, ** $p < .01$ *** $p < .001$

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The differences between these two groups are shown in Table 9.6. A similar pattern to that described for the two other groups is also evident here. Mean values for all relatedness variables rose after transition, however this increase was greater for the *risers* group. Consequently, this group showed significantly higher levels of relatedness to self, peers and teachers than the *chronically low* group after transition.

Table 9.6
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Chronically Low and Risers Groups

	chronically low vs risers				*chronically low*		*risers*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{104}	*p*	t_{104}	*p*	t_{37}	*p*	t_{67}	*p*
Relatedness to Self	-1.65		-2.99	**	-0.23		-0.54	
Relatedness to Peers	-1.25		-2.43	*	0.09		-1.65	
Relatedness to Teachers	-1.99	*	-5.02	***	0.53		-2.72	**

* $p < .05$, ** $p < .01$ *** $p < .001$

9.6 "How Good?" measures

These measures, which asked students how good they think they are at maths and how they think that others perceive them, again show consistent patterns (Table 9.7). At both Grade 6 and Year 7 levels the *consistently high* group have a high level of confidence in their ability and perceive that others also believe this, while again the *chronically low* group show the lowest levels of confidence in their own ability. Interestingly, these variables do not show the same "crossover" between the *decliners* and *risers* groups seen with the perceived control variables (see Figure 8.2). The ranking of the groups on each measure after transition was consistent with the ranking before transition, although changes in means did occur.

Students' beliefs about their own ability were also compared with their perceptions of others' beliefs. The *consistently high* group presented a general air of superiority. They felt that both their primary and secondary school teachers underrated their ability, and that at secondary school their peers also underrated their ability. In Grade 6, the *decliners* group similarly felt that their teachers underrated their ability, however in Year 7 these ratings became more congruent.

Significant differences were apparent though in perceptions about parents' beliefs. This group felt that their parents would rate them more highly either than they would rate themselves, or that their teachers or classmates would rate them. This conflict could possibly be damaging to students' self esteem or level of anxiety, as they attempt to reconcile their parents' expectations and their beliefs about their own ability. It may also give rise to feelings of being an "impostor", that is not being as good as others think that you are.

The *risers* group also felt that their parents would rate them more highly than their teachers or classmates, however this perception is congruent with the students' perceptions of themselves, and so the conflict described for the *decliners* group is unlikely to affect this group. This group may instead feel that their parents have confidence in them, and so feel supported. Sadly perhaps for the *chronically low* group, their perceptions are all congruent; they not only rate themselves at a fairly low level, but they believe that their parents, teachers and peers would all rate them at a similar level. These students feel that "I'm not very good at maths, and everyone agrees with me", and if they also believe that success in maths is mainly due to ability, is there any incentive for them to try any harder, or to continue in mathematics past the compulsory level?

Table 9.7
Means for All Groups for "How Good" Variables: Grade 6

	Grade 6				$F_{3,286}$	*p*
	Consistently high	*Decliners*	*Risers*	*Chronically low*		
HGS	4.10	3.89	3.22	2.68	60.64	***
HGSW	4.84	4.78	4.59	4.47	6.53	***
HGT	3.94	3.77	3.16	2.68	33.35	***
HGP	4.17	3.98	3.40	2.79	32.26	***
HGPW	4.71	4.70	4.49	4.74	2.92	*
HGC	4.05	3.78	3.12	2.61	33.97	***
	Year 7					
HGS	4.26	3.63	3.59	2.62	46.33	***
HGSW	4.84	4.60	4.54	4.19	8.88	***
HGT	4.13	3.59	3.50	2.89	19.89	***
HGP	4.24	3.93	3.72	2.76	30.92	***
HGPW	4.72	4.72	4.59	4.19	7.02	***
HGC	4.08	3.61	3.51	2.78	19.35	***

* $p < .05$, *** $p < .001$
Note: HGS: How good are you at maths; HGSW: How good would you like to be; HGT: How good does your teacher think you are; HGP; How good do your parents think you are; HGPW; How good would your parents like you to be; HGC: How good do your classmates think you are. Scores could range from 1 (weak) to 5 (excellent).

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Few significant differences were evident between these two groups at the Grade 6 level (Table 9.8). Students in the *consistently high* group rated their own ability more highly than students in the *decliners* group, and they believed that their classmates would also rate them more highly.

After the transition to secondary school, significant differences were evident between these groups on five out of the six "How Good" variables. The only variable for which there were no significant differences was "How good would your parents like you to be at maths?" and it seems that students in both groups felt that their parents held high expectations. In isolation this could be thought of as quite constructive, however teamed with the *decliners* group's lowered belief in their own ability it could prove to be a point of concern.

Table 9.8
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Consistently High and Decliners Groups

	consistently high vs decliners				*consistently high*		*decliners*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{182}	*p*	t_{182}	*p*	t_{76}	*p*	t_{106}	*p*
HGS	2.37	*	6.40	***	-2.41	*	3.47	***
HGSW	1.08		3.10	**	0.00		3.00	**
HGT	1.57		4.43	***	-2.03	*	1.90	
HGP	1.67		2.79	**	-1.10		0.55	
HGPW	0.17		0.05		-0.21		- 0.33	
HGC	2.31	*	3.72	***	-0.32		1.88	

* $p < .05$, ** $p < .01$ *** $p < .001$
Note: HGS: How good are you at maths; HGSW: How good would you like to be; HGT: How good does your teacher think you are; HGP; How good do your parents think you are; HGPW; How good would your parents like you to be; HGC: How good do your classmates think you are. Scores could range from 1 (weak) to 5 (excellent).

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In contrast to the other two groups, where differences appear more consistently after transition, the differences between these two groups are already quite evident in Grade 6 (Table 9.9). The *risers* group rate themselves more highly, and believes that teachers, parents and peers would rate them at a similar level. The *risers* group see their parents as having higher expectations of them in Year 7, but as this is coupled with a greater belief in their own ability, this is a combination of beliefs that should foster motivation and confidence.

The differences that are evident in Grade 6 are more pronounced at Year 7 level, with the *risers* group showing significant increases in their personal rating of ability, and of their perceived ratings by parents, teachers and classmates. This seems to be a significant increase in confidence, with these students saying "I am doing better in maths, and my teachers, parents and classmates think so too". In contrast, the only significant change for the *decliners* group was a decrease in their perception of their parents' ambition for them.

Table 9.9
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Chronically Low and Risers Groups

	chronically low vs risers				*chronically low*		*risers*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{104}	p	t_{104}	p	t_{37}	p	t_{67}	p
HGS	-4.17	***	-6.24	***	0.18		-3.75	***
HGSW	-0.91		-2.16	*	1.62		0.62	
HGT	-3.02	**	-3.55	***	-0.88		-2.87	**
HGP	-3.37	***	-5.34	***	0.12		-2.80	**
HGPW	-1.99	*	-2.40	*	2.87	**	-1.22	
HGC	-2.81	**	-4.08	***	-1.19		-3.45	***

*$p < .05$, ** $p < .01$ *** $p < .001$
Note: HGS: How good are you at maths; HGSW: How good would you like to be; HGT: How good does your teacher think you are; HGP; How good do your parents think you are; HGPW; How good would your parents like you to be; HGC: How good do your classmates think you are. Scores could range from 1 (weak) to 5 (excellent).

9.7 Autonomy beliefs

Why do students work in mathematics classes? Most said they worked for identified reasons "*Because doing well in school is important to me*", and for the *consistently high*, *decliners* and *risers* groups the next favoured was intrinsic "*because it is interesting*". For the *chronically low* group however the next most important reason was external "*because the teachers say we have to*", and by Year 7, intrinsic reasons are the least likely for this group. The means for the autonomy variables are shown in Table 9.10.

Table 9.10
Means for All Groups for Autonomy Variables: Grade 6 and Year 7

	Grade 6				$F_{3,286}$	p
	Consistently high	*Decliners*	*Risers*	*Chronically low*		
External	1.81	1.91	2.43	2.71	10.70	***
Identified	3.83	3.71	3.36	3.20	16.68	***
Intrinsic	3.26	2.90	2.45	2.40	20.19	***
Introjected	1.98	1.97	2.15	2.24	1.32	
	Year 7					
External	1.94	2.41	2.21	2.72	7.78	***
Identified	3.89	3.45	3.46	3.09	16.63	***
Intrinsic	3.40	2.53	2.57	2.26	24.75	***
Introjected	2.09	2.15	2.00	2.41	1.98	

* $p < .05$, ** $p < .01$ *** $p < .001$

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At Grade 6 level, the *consistently high* students were significantly more likely to work for intrinsic reasons, and the beliefs of this group of students did not alter on transition to secondary school (Table 9.11). The *decliners* however suffered a significant decrease in intrinsic and identified motivation and a significant increase in external motivation, so that in Year 7 the two groups were separable on all but introjected reasons.

Table 9.11
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Consistently High and Decliners Groups on Autonomy Measures

	consistently high vs decliners				*consistently high*		*decliners*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{182}	*p*	t_{182}	*p*	t_{76}	*p*	t_{106}	*p*
External	-0.79		-3.57	***	-1.06		-4.87	***
Identified	1.76		5.34	***	-1.40		4.22	***
Intrinsic	3.42	***	7.64	***	-1.70		4.35	***
Introjected	0.06		-0.46		-0.92		-1.92	

*** $p < .001$

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In contrast, there were no significant changes found for either of these groups from Grade 6 to Year 7, but some significant differences were found between the two groups at the Year 7 level (Table 9.12). The *risers* group was more inclined than the *chronically low* to work for identified reasons, and the *chronically low* were more inclined than the *risers* to work for external and introjected reasons. These last two are the lowest on the autonomy continuum, and add further to the predicament of this group of students.

Table 9.12
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Chronically Low and Risers Groups on Autonomy Measures

	chronically low vs risers				*chronically low*		*risers*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{104}	*p*	t_{104}	*p*	t_{37}	*p*	t_{67}	*p*
External	1.63		2.76	**	-0.07		1.83	
Identified	-1.13		-2.61	**	0.67		-1.34	
Intrinsic	-0.31		-1.70		0.93		-1.25	
Introjected	0.47		2.55	**	-1.11		1.35	

** $p < .01$

9.8 Coping styles

The means for coping styles for Grade 6 and Year 7 are shown in Table 9.13. Students were found to be most likely to respond positively when they encounter setbacks in mathematics, and least likely to blame their teacher (projection). Unfortunately, in both Grade 6 and Year 7 for all groups, the second most common reaction was to exhibit signs of anxiety. At both Grade 6 and Year 7 levels, the *consistently high* group show the highest levels of positive coping and the lowest levels of the other three less constructive strategies, while the reverse occurs for the *chronically low* group. The crossover between the *decliners* and *risers* was apparent with all variables, with the *decliners* showing less adaptive and the *risers* more adaptive patterns of beliefs in Year 7. Significant groups differences were seen for all variables in both Grade 6 and Year 7.

Table 9.13
Means for All Groups for Coping Style Variables: Grade 6 and Year 7

	Grade 6				$F_{3,286}$	*p*
	Consistently high	*Decliners*	*Risers*	*Chronically low*		
Anxiety	2.20	2.39	2.77	2.97	9.39	***
Denial	1.77	1.94	2.20	2.40	9.10	***
Positive	3.74	3.51	3.33	3.18	10.81	***
Projection	1.38	1.50	1.79	2.09	10.98	***
	Year 7					
Anxiety	2.11	2.49	2.36	2.88	8.10	***
Denial	1.70	2.20	2.03	2.54	12.81	***
Positive	3.78	3.28	3.30	3.01	16.73	***
Projection	1.35	1.80	1.55	2.22	19.81	***

*** $p < .001$

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In Grade 6, the coping strategies of these two groups differed only in that the *consistently high* group was more likely to respond positively to difficulties. This group remained stable over the transition to secondary school, while the *decliners* became more likely to deny that the difficulty mattered to them and more likely to blame the teacher for problems. The results of the t-tests examining the differences between these variables are shown in Table 9.14. From these tests it can be seen that at the Year 7 level, students in the *decliners* group show significantly less adaptive beliefs than the *consistently high* group on all of the coping variables.

Table 9.14
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Consistently High and Decliners Groups for Coping Measures

	consistently high vs decliners				*consistently high*		*decliners*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{182}	*p*	t_{182}	*p*	t_{76}	*p*	t_{106}	*p*
Anxiety	-1.46		-3.06	**	0.82		-1.08	
Denial	-1.72		-4.60	***	0.67		-4.06	***
Positive	2.83	**	5.75	***	-0.65		3.37	***
Projection	-1.24		-4.96	***	0.27		-4.48	***

** $p < .01$ *** $p < .001$

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Table 9.15 shows the results of the t-tests that tested for differences between the *chronically low* and *risers* groups. Again the two groups are not significantly different in Grade 6 but change enough over the transition for significant differences to be seen in all coping variables in Year 7.

Table 9.15
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Chronically Low and Risers Groups for Coping Measures

	chronically low vs risers				*chronically low*		*risers*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{104}	*p*	t_{104}	*p*	t_{37}	*p*	t_{67}	*p*
Anxiety	1.13		3.27	***	0.64		4.69	***
Denial	1.27		3.31	***	-0.96		1.23	
Positive	-1.21		-2.07	*	1.71		0.32	
Projection	1.79		5.37	***	-0.84		2.08	*

*$p < .05$, *** $p < .001$

The *chronically low* group was more likely to respond to problems anxiously "*I feel really stupid*", to deny that they have a problem "*I tell myself it didn't matter anyway*" or to blame the teacher "*I say the teacher didn't explain the topic properly*". This group showed a significant increase in anxiety and projection coping over the transition to secondary school, while the beliefs held by the *risers* remained the same over transition.

9.9 Views about mathematics

Table 9.16 shows differences consistent with those seen on other variables. Liking of mathematics, indicated by questions 1 and 7, shows that in both Grade 6 and Year 7 there are significant differences between groups. In both Grade 6 and Year 7 the *consistently high* group hold more positive views about mathematics than any of the other groups, and in general, the *chronically low* group hold consistently more negative views than any other group. For example, the *consistently high* group likes maths more, claim higher levels of persistence and see maths as having importance out of the school environment. On the other hand, the *consistently high* group showed some inflexibility, for example having stronger beliefs that mathematics problems can always be solved by following rules.

Table 9.16
Means for All Groups for Views About Mathematics: Grade 6 and Year 7

	Grade 6				$F_{3,286}$	*p*
	Consistently high	*Decliners*	*Risers*	*Chronically low*		
1. Maths is one of my favourite subjects	3.23	2.89	2.35	2.03	24.52	***
2. When a maths problem comes up that I can't solve immediately, I keep trying until I work it out	3.42	3.33	3.25	2.71	11.08	***
3. Maths is a subject that will be useful to me when I leave school	3.86	3.72	3.69	3.68		
4. Maths problems can always be solved by following rules	3.60	3.34	3.32	3.37	2.67	*
5. In maths it is possible to have more than one right answer	3.31	3.21	3.29	3.45		
6. I usually understand the work we do in maths	3.61	3.55	3.13	2.61	29.43	***
7. I like maths more than I like most other subjects	3.04	2.54	1.97	1.58	26.02	***
8. Maths is only important at school	1.23	1.37	1.81	1.89	11.17	***
9. Some people are good at maths and some just aren't	3.34	3.09	3.43	3.66	4.73	**
10. I give up working on maths problems when I can't understand them	1.82	1.78	2.29	2.68	13.95	***
11. In maths something is either right or it's wrong	3.19	3.02	3.21	3.50	2.58	
	Year 7					
1. Maths is one of my favourite subjects	3.38	2.45	2.51	2.00	28.08	***
2. When a maths problem comes up that I can't solve immediately, I keep trying until I work it out	3.48	3.07	3.16	2.89	8.64	***
3. Maths is a subject that will be useful to me when I leave school	3.82	3.64	3.67	3.63		
4. Maths problems can always be solved by following rules	3.61	3.26	3.43	3.29	4.93	**
5. In maths it is possible to have more than one right answer	3.29	3.14	3.32	3.32		
6. I usually understand the work we do in maths	3.79	3.44	3.49	2.74	29.04	***
7. I like maths more than I like most other subjects	3.16	2.28	2.24	1.79	22.05	***
8. Maths is only important at school	1.30	1.52	1.48	1.84	4.37	**
9. Some people are good at maths and some just aren't	3.01	3.01	3.10	3.61	4.61	**
10. I give up working on maths problems when I can't understand them	1.48	1.97	1.88	2.68	21.32	***
11. In maths something is either right or it's wrong	2.84	2.87	3.23	3.29	4.47	**

* $p < .05$, ** $p < .01$ *** $p < .001$

The *chronically low* group hold some particularly debilitating views about mathematics, in particular the belief that "some people are good at maths and some just aren't", coupled with a viewpoint that states "I'm not very smart at maths". Belief in innate ability in subjects such as mathematics, and the concurrent belief that one does not possess this innate ability, means that there is really no incentive to try any harder, since without ability success is impossible.

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Table 9.17 shows the differences between the *consistently high* and the *decliners* groups. There are few differences between the groups in Grade 6, one of the few being that the *consistently high* group generally like mathematics more, however in Year 7 there are many more differences. *Decliners* are more likely to believe in the importance of mathematics to their lives, they are less persistent and less confident, however the *consistently high* group are far more likely to say that "*mathematics problems can always be solved by following rules*".

After transition, students in the *consistently high* group feel that they understand and like mathematics more and they are less likely to believe in innate ability. The differences for the *decliners* group are negative: they like mathematics less and feel they are less persistent.

Table 9.17

t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Consistently High and Decliners Groups for "Views About Mathematics" Measures

	consistently high vs decliners				*consistently high*		*decliners*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{182}	*p*	t_{182}	*p*	t_{76}	*p*	t_{106}	*p*
1. Maths is one of my favourite subjects	2.73	**	7.45	***	-1.42		4.72	***
2. When a maths problem comes up that I can't solve immediately, I keep trying until I work it out	0.88		4.42	***	-0.73		3.47	***
3. Maths is a subject that will be useful to me when I leave school	1.71		2.21	*	0.77		1.38	
4. Maths problems can always be solved by following rules	2.53	*	3.64	***	-0.14		0.82	
5. In maths it is possible to have more than one right answer	0.66		1.02		0.18		0.67	
6. I usually understand the work we do in maths	0.67		4.30	***	-2.56	**	1.62	
7. I like maths more than I like most other subjects	3.30	***	6.10	***	-0.90		2.46	*
8. Maths is only important at school	-1.50		-2.20	*	-0.80		-1.88	
9. Some people are good at maths and some just aren't	1.79		0.00		2.47	**	0.80	
10. I give up working on maths problems when I can't understand them	0.37		-4.48	***	2.94	**	-2.15	*
11. In maths something is either right or it's wrong	1.20		-0.17		2.74	**	1.44	

* $p < .05$, ** $p < .01$ *** $p < .001$

?4P4B Jdlkxktiky hkzy kkt inxutdigm; my gtj xqykxy

In Table 9.18 the differences between the *chronically low* and the *risers* groups are shown. These are again differences mainly in liking of mathematics, persistence and confidence, with the *risers* group showing more adaptive beliefs. After transition to secondary school, these problems become more obvious.

This is due to changes in the beliefs of the *risers* group, since the *chronically low* group shows no significant changes.

Table 9.18
t- values and Significance Levels for Paired Sample and Independent Groups t-tests Between Chronically Low and Risers Groups for "Views About Mathematics" Measures

	chronically low vs risers				*chronically low*		*risers*	
	Grade 6		Year 7		Grade 6-Year 7		Grade 6-Year 7	
	t_{104}	*p*	t_{104}	*p*	t_{37}	*p*	t_{67}	*p*
1. Maths is one of my favourite subjects	-2.02	*	-2.81	**	0.18		-1.33	
2. When a maths problem comes up that I can't solve immediately, I keep trying until I work it out	-4.49	***	-1.82		-1.36		0.93	
3. Maths is a subject that will be useful to me when I leave school	-0.05		-0.34		0.47		0.19	
4. Maths problems can always be solved by following rules	0.31		-1.09		0.52		-1.00	***
5. In mathematics it is possible to have more than one right answer	0.97		-0.05		0.93		-0.24	*
6. I usually understand the work we do in mathematics	-3.88	***	-6.09	***	-1.00		-3.61	*
7. I like maths more than I like most other subjects	-2.22	*	-2.29	*	-1.28		-2.50	**
8. Maths is only important at school	0.44		2.01	*	0.27		2.54	**
9. Some people are good at maths and some just aren't	1.49		3.04	**	0.42		0.42	
10. I give up working on maths problems when I can't understand them	2.14	*	4.85	***	0.00		3.27	
11. In maths something is either right or it's wrong	1.74		0.40		1.60		0.00	

*$p < .05$, ** $p < .01$ *** $p < .001$

Differences in beliefs for the *risers* focus on the areas of liking and understanding mathematics, as well as more adaptive beliefs about flexibility of mathematics (see questions 4 and 5).

9.10 Summary

In order to provide evidence for the validity of the clustering solution, means were examined for other variables to see if the same between-group differences existed. There were found to be significant between-group differences on most variables examined. In all cases, the *consistently high* group held the most constructive views, while the *chronically low* group held the most damaging views in terms of motivation and engagement. It was clear from the data analysis conducted so far that if there were significant between-group differences, these would almost inevitably be apparent between the *chronically low* and *consistently high* groups, and many of these differences would be quite obvious to classroom teachers.

Of greater interest then, were the differences between the groups similar in grade six but not in grade seven; between the *consistently high* and *decliners* and between the *chronically low* and *risers*. The differences between these groups may provide the key to identifying students who have potential problems in the transition to secondary school.

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The following table (Table 9.19) summarises the differences between the *chronically low* and *decliners* and between the *consistently high* and the *risers* on variables other than the perceived control variables used to define the clusters. This provides both evidence of generality of the cluster solution and additional knowledge about the belief systems of the students involved in this study over the transition to secondary school. Combined with the findings from the earlier discriminant analyses, these provide an overall characterisation of students in each of the four groups. While some differences are apparent in Grade 6, many more are evident in Year 7, after the transition to secondary school. It may be that the combined pressures of adolescence and transition to secondary school have a conjoint detrimental effect and lead to the deterioration of student beliefs about themselves as learners of mathematics. If these problems could be addressed either in primary school or early in secondary school, it may act to mediate some of the problems encountered by this large group of students.

In Grade 6, the *consistently high* group felt that learning mathematics was within their sphere of control; "*I can succeed if I want to*". They felt more confident of their own ability in mathematics, and felt that their teachers would help them if they needed help. These students feel more engaged with their work, that their teacher provided them with clear structure, and that their teacher is involved with them on a personal level; that their teacher cares about how well they do in mathematics. These students have a higher level of relatedness to themselves and to their teachers, reflecting higher levels of self-esteem and self-satisfaction. They have higher levels of intrinsic motivation, and a more positive way of coping with failure, indicating that "*I'll try harder next time*".

More differences are apparent between the *chronically low* and *risers* groups in Grade 6. The *risers* had higher levels of control beliefs, combined with higher levels of Capacity effort beliefs. This combination of beliefs may be linked; for example perhaps these students feel greater control over their learning because they feel they are able to put in the required level of effort to learn. The *chronically low* group, in contrast, show much higher levels of not knowing how to do well in maths (high strategy unknown), and a greater reliance on luck (*I have to be lucky, by getting asked the right questions, to do well in maths*).

Table 9.19
Summary of Differences Between Consistently High and Decliners, and Between Chronically Low and Risers Groups.

	Consistently high vs. decliners		*chronically low vs. risers*	
	Grade 6	Year 7	Grade 6	Year 7
Engagement				
Student-rated engagement	CH>D	CH>D	R>CL	R>CL
Teacher-rated engagement		CH>D	R>CL	R>CL
Perceptions of teachers				
Teacher structure	CH>D	CH>D	R>CL	R>CL
Autonomy support				
Teacher involvement	CH>D	CH>D	R>CL	R>CL
Relatedness				
to self	CH>D	CH>D		R>CL
to peers		CH>D		R>CL
to teachers	CH>D	CH>D	R>CL	R>CL
"How Good"				
HGS	CH>D	CH>D	R>CL	R>CL
HGSW		CH>D		R>CL
HGT		CH>D	R>CL	R>CL
HGP		CH>D	R>CL	R>CL
HGPW			CL>R	CL>R
HGC	CH>D	CH>D	R>CL	R>CL
Autonomy				
External		D>CH		CL>R
Identified		CH>D		R>CL
Intrinsic	CH>D	CH>D		
Introjected				CL>R
Coping Style				
Anxiety		D>CH		CL>R
Denial		D>CH		CL>R
Positive	CH>D	CH>D		R>CL
Projection		D>CH		CL>R

The final chapter of this thesis will provide a summary and a discussion of the results obtained from this research and their implications for classroom practice and further research. There are many separate threads involved in a research study such as this one, and it is essential that these are woven together in a way that provides a model of perceived control beliefs for interpretation in the classroom.

Chapter 10

Summary and Discussion

10.1 Summary

In Chapter 1 of this thesis it was stated that the major focus of the research in this study was to be:

> *Are there identifiable groups of students whose beliefs about learning mathematics could be recognised as indications of potential problems with motivation in secondary school?*

In order to investigate this challenge to teachers it was necessary to first set the research in context. The first chapter outlined the approaches that have been directed by various government forums and projects, underlining the significance of the period of transition to secondary school.

Governments and researchers have recognised that transition to secondary school is one of the "key times" in a student's life, occurring as it does at approximately the same time as the transition from childhood to adulthood. It is argued that a greater focus on the middle years of schooling may help to alleviate some of the problems seen in later secondary school, when disaffected students opt out of the educational system (Australian Curriculum Studies Association, 1996). This is in itself a problem, but another is the number of students who develop a strong dislike for mathematics and drop out of it as soon as they can.

A variety of studies have examined transition from different vantage points. There are not a large number of these studies however, and fewer still focus on mathematics in particular, despite research indicating that reactions to transition vary within different learning areas (see for example Midgley *et al.*, 1989b). Several Australian studies have examined transition (Clarke, 1989; Ellerton and Clements, 1988; Power and Cotterell, 1981) however none have been conducted within the last few years in Victoria, years that have seen unprecedented changes to the school system and to curriculum in this State.

The focus of the study was not on achievement, as is often the case with studies on transition, but on engagement with learning. Engagement and subsequent motivation to learn are fundamental to the concept of education as developing a love of learning, and make it possible for all children to find learning meaningful (Nicholls *et al.*, 1989).

Chapter 2 examined the literature pertaining to issues about transition to secondary school in general and then focussed on transition studies in mathematics as a particular case. The primary education system is generally seen as child-focussed and caring, while the secondary education system is perceived as subject oriented and driven by largely external forces. Secondary school teachers are seen as less caring, less warm and less supportive than their primary school counterparts. While it is not the aim of this thesis to examine the rights and wrongs of these positions it is certainly an area in which secondary schools need better public relations.

A number of studies that examined transition in different subject areas found that attitudes towards mathematics declined over the period of transition, whereas attitudes towards English improved (Eccles *et al.,* 1983). This underlined the need to examine perceptions about subjects and beliefs about learning those subjects separately, which provided the research design for this study. Reactions to mathematics are often quite emotive, and is was argued that negative beliefs and attitudes towards mathematics may actually constrain mathematical learning (de Abreu, Bishop and Pompeu, 1997).

Several major changes that occur after transition are outlined in Chapter 2; these include the need adolescents have for closer relationships with role models such as teachers, changes in the school environment, and changes in the mathematics curriculum, which becomes more formal and abstract. If these are teamed with perceptions about secondary school teachers being more distant and less helpful, as previous research and the comments Grade 6 children in this study made on their questionnaires would indicate, then it is no wonder that a great many students worry about transition.

The focus of Chapter 3 was on the motivational framework of this thesis. It was argued in the literature that education should be seen as more than a means to an end, and that it is more important to have learning goals than performance goals. The difference between these is described by Dweck (1985) as the difference between looking smart and being smart. Students oriented towards learning goals were reported as using cognitive and metacognitive goals more frequently and being better motivated.

Metacognition was discussed in some detail, and it was argued that it is important that students become more aware of their own beliefs about success and failure in school. Paris and Winograd (1990) argued that metacognition helps students "become active participants … rather than passive recipients of instruction and imposed experiences" (p. 18). Some studies suggest that students' beliefs about effort and ability become more fixed at about the age of transition, giving another reason to set the study at this point of time. Selection of goals and tasks in school are a reflection of how students believe they learn, and for teachers to develop appropriate interventions it is necessary that they also understand students' beliefs about how they learn.

To examine changes in beliefs about mathematics for this study, a relatively new instrument, the *Student Perceptions of Control Questionnaire*, was used to examine perceived control beliefs over the Grade 6 to Year 7 year. This instrument had been used in the USA and in Germany, but never with Australian students, and never within a specific subject area. The perceived control model was originally developed from locus of control, attributional, learned helplessness and self-efficacy theories, and contends that engagement is maximised when the social context (in this case the mathematics classroom) fulfils students' basic psychological needs for competence, autonomy and relatedness. The model examines students' beliefs about the amount of *control* they feel they have over events in their lives, their beliefs about the effectiveness of particular strategies for succeeding (*strategy* beliefs), and whether they feel they are able to enact these strategies (*capacity* beliefs). The known causes examined were ability, effort, powerful others and luck.

Skinner argued that competence research is important because a need for competence "gives ultimate power to individuals as sources and agents of their own motivation" (Skinner, 1995, p. 15). Perceived control acts on engagement, and as such cannot increase ability but allows people access to all the resources available to them. Patterns with perceived control are cyclical; beliefs that one is unable to control outcomes leads to patterns of action that reinforce this belief, so intervention into the cycle is vital.

A summary of perceived control profiles optimal for engagement was given: high control beliefs, high effort strategy and capacity beliefs, low strategy ability and high capacity ability beliefs, high capacity luck and capacity powerful others beliefs. In contrast, the students most likely to be disaffected are those who essentially feel that they are unable to control success and failure, those with low capacity effort and ability beliefs, high strategy beliefs paired with low capacity beliefs for powerful others and luck, and high unknown strategy beliefs.

In order to investigate the applicability of the perceived control model to students' beliefs about learning mathematics, a longitudinal study was developed in which students would complete questionnaires at three stages; early in Grade 6, late in Grade 6 and mid Year 7. The methods and instruments used in this study are described fully in Chapter 4.

Three schools participated in the initial stage of the study, involving 154 students. When it became evident that due to attrition a large proportion of these students would be lost from the study, a further 7 primary schools were contacted and 510 students participated in the second stage of the study. In the following year 302 of these students completed the questionnaire at their secondary school.

The questionnaire contained scales measuring beliefs about mathematics, perceptions of teacher involvement, autonomy, support and provision of structure, perceived control, coping style, relatedness to self, teachers and peers, autonomy, engagement, classroom environment and ratings in mathematics. Teachers were asked to complete a questionnaire on each student that measured engagement in mathematics.

Chapter 5 described the validation of the scales used in the questionnaire. Principal components analysis and reliability analysis were carried out on the engagement questionnaire and on each section of the student questionnaire to assess uni-dimensionality and reliability. This was especially important with the perceived control questionnaire as it had never been used in Australia before.

The principal components analysis of the perceived control questions provided evidence that a three factor solution was appropriate, corresponding to strategy, capacity and control beliefs. Reliability was found to be acceptable for the perceived control scales. Most of the other scales were found to be reliable and principal components analysis showed that the factors loaded as predicted from prior research.

It was disappointing however, to find that the ICEQ questions did not load as expected. This instrument is in wide use in Australia and overseas, and yet the factor structure for this sample was completely different to that published. As this instrument did not possess the uni-dimensionality required for a summated scale those data were not subject to any further analysis.

Chapter 6 reported on the cross-sectional analysis of the data obtained from the student and teacher questionnaires. It was important at this stage of the study to examine the relationships that existed between the perceived control variables and teacher ratings of student engagement, and to see whether similar relationships between these variables existed before and after transition. Some of the data analysis replicated that of prior research studies which used the same instrument, in order to compare the results obtained from a particular subject domain with those from general beliefs about education. Initial data analysis consisted of descriptive statistics, correlations and regression on the entire data set at each stage of the study.

At each stage of the study effort was seen as the most important strategy for success, and the cause that most students felt they had access to. Teacher-rated student engagement was found to be strongly correlated positively with teacher rating of student ability, control, capacity effort, capacity ability and capacity luck, and negatively with strategy luck and strategy unknown. Interestingly, strategy effort was not correlated with engagement, and it could be inferred that knowing that effort is an appropriate strategy is not in itself enough; students have to believe that they can exert enough effort to succeed. Teacher-rated student engagement was also strongly correlated with teacher ratings of ability and was also quite strongly correlated with the PAT-Mathematics score. Teachers' rating of ability was also strongly correlated with the PAT-Mathematics result.

Strategy ability was found to correlate negatively with both achievement and teacher rating of ability, suggesting that weaker students may rely on ability as a strategy. These are the students who are least likely to say that they are smart at mathematics, so one wonders what incentive they have to try very hard. As has been found in other studies, perception of autonomy support was found to be negatively correlated with strategy unknown, implying that students whose teachers don't let them make decisions about their work are most likely to be unsure of how to achieve success. Perceived teacher involvement was positively correlated with control beliefs, indicating that students who felt that their teachers were involved also felt in control of their learning.

Strategy and capacity beliefs for each of the known causes were separately entered into a regression equation with teacher-rated student engagement. Strategy luck and strategy unknown were both found to be significant negative predictors of engagement at both stages 1 and 2, while only strategy unknown was a predictor (negative) at stage 3. Capacity ability and capacity effort were both significant positive predictors at stage 1, capacity ability and luck at stage 2 while at stage 3 capacity ability, effort and powerful others were all significant positive predictors. Regression was also carried out within pairs of strategy and capacity belief for each known cause, and for each the strategy and capacity belief loaded differently at each stage of the study, demonstrating that the strategy and capacity beliefs are empirically distinct from each other.

It can be concluded from the results of the regression and correlational analyses that in mathematics, as other studies have shown for school in general, particular combinations of beliefs about how to succeed can have positive or negative effects on student engagement. Despite some changes, it can be seen that similar relationships occur within cohorts before and after transition to secondary school. In order to investigate longitudinal changes more closely, three separate data sets were created, consisting of

a) the 74 students common to stages 1, 2 and 3, which were used for illustrative purposes,
b) the 143 students common to stages 1 and 2, and
c) the 302 students common to stages 2 and 3 of the study.

From stage 1 to 2, capacity powerful others was the only significant change, and between stage 2 and 3 it was only capacity powerful others and capacity effort that declined. The overall perceived control measure CONMAX however reflected negative motivational trends in many of the variables by significantly declining over transition. Significant declines over transition were also seen for perceived teacher provision of structure, autonomy support and involvement, and both teacher and student ratings of engagement. This latter result is disappointing, since teachers would hope students would be most engaged at the start of secondary school. The results are also consistent with previous research that has characterised secondary school as more impersonal and less supportive than primary school.

Analysis of gender differences found that boys felt ability to be more important than girls did, however they also rated their own ability at a higher level. Girls felt that their primary teachers were more involved with them than their secondary teachers, but their self-esteem was lower than the boys' at both primary and secondary school. After transition, boys were found to be more confident of their ability than girls, they had higher aims than girls, and they believed that their teachers and parents would rate them more highly than the girls did.

In primary school, students were most likely to work in mathematics because they feel that it is important, however after transition students were found to be more likely to work for external reasons and significantly less likely to be intrinsically motivated. This is precisely the opposite to what teachers would hope to be happening at this stage of students' lives.

The changes that could be seen between stage 2 and 3 of the study support the belief that there are differing reactions to transition. The nature of analysis of variance however, means that differences in subgroups may be masked by a "cancelling out" effect between groups that increase with groups that decrease. In order to investigate whether these groups existed, the data were subject to cluster analysis.

Hierarchical cluster analysis was used first, applying Ward's minimum variance method with Mojena's stopping rule to determine an approximate number of clusters, then convergent *k* - means cluster analysis was used to investigate two, three and four cluster solutions. Thee smaller group from the stage 1-2-3 data set was clustered first and it was found that the four cluster solution looked the most promising in that interesting group differences became apparent as the solution moved from a two to three to four cluster solution.

The clustering process was then repeated on the larger stage 2-3 data set, as it was argued (Aldenderfer and Blashfield, 1984) that the degree of replicability of a cluster solution is best examined by repeating the clustering process on different subsets from a population. The stage 1-2-3 data and the stage 2-3 data fit this criterion, and hence duplication of the solution for the smaller data set would provide evidence of replicability of the solution.

Using an identical clustering procedure to that used previously, *k* – means cluster analysis was used to investigate two, three and four-cluster solutions. Again, the four cluster solution was found to be most representative of the data, confirming replicability of the solution, and so analysis proceeded with the four cluster solution. These four clusters were labeled with fairly self-explanatory labels for easier reference: *consistently high*, *decliners*, *risers*, and *chronically low*.

It was evident with both samples of students that a significant number (107 out of 302) were classified as *decliners* with this procedure, indicating that they may be at-risk of alienation at secondary school.

As the predictor variable CONMAX was a combination of strategy, capacity and control beliefs, discriminant analysis was carried out using cluster membership as the grouping variable and the perceived control beliefs from time two as the independent variables. The discriminant function derived maximally separated the *chronically low* from the *risers*, and the *consistently high* from the *decliners*. The best predictors were found to be control beliefs, capacity ability, capacity effort and capacity luck, while strategy unknown was a significant negative predictor. Again, strategy effort contributed least as a predictor.

The *consistently high* group presented a more positive profile across all significant predictor variables at the Grade 6 level, followed by *decliners*, *risers* and then the *chronically low* group. It was found to be more difficult to separate the groups that were close together; the *chronically low* and *risers* groups and the *consistently high* and *decliners* groups. Further discriminant analyses were carried out to investigate the differences between these pairs of groups.

Between the *consistently high* and *decliners* groups only control, capacity ability and capacity powerful others separated the groups, however between the *chronically low* and *risers*, control, capacity effort, capacity luck, strategy luck and strategy unknown (both negatively) were discriminators. An investigation of gender differences found that differences were only apparent within the *decliners* group, where it was found that males were more likely to believe in their ability and females in their luck.

Chapter 9 examined the validity of the cluster solution as advocated by Aldenderfer and Blashfield (1984). This entailed examining means for the separate groups for variables other than the perceived control variables used to define the clusters. It was found that the *consistently high* group had the highest levels of engagement, and the *chronically low* had the lowest levels. A crossover between the *risers* and the *decliners* groups was seen with these variables as with the perceived control variables, where the *risers* were rated as less engaged at Grade 6 but more engaged at year 7 than the *decliners* group. In general, these patterns were repeated with all variables examined in this chapter. The *consistently high* group showed the most positive profile of beliefs over all variables and the *chronically low* the least positive. The *decliners* showed the next most adaptive profile in Grade 6 but deteriorated over transition, while the beliefs of the *risers* group became far more adaptive.

What can be learnt from these results, and how can this be applied to classrooms? The discussion section of this chapter will deal with these issues.

10.2 Discussion

The results of this study illustrate the multiple dimensions and relationships that may combine to influence students' beliefs about learning mathematics. The model used in the study describes a system of actions and beliefs that is assumed to interact dynamically within the social context of the classroom. Skinner

(1990b) argued that students' control-related beliefs shape development by impacting on motivational aspects of action. Action then effects subsequent performances, the actual successes and failures resulting from these performances further effect subsequent perceived control, and so the cycle continues.

Motivational problems with students in the age group examined in this study (11-13 years) become more critical as these students are capable of "regulating their own actions to a standstill" (Skinner, 1990b, p. 203). Owing to the increasing differentiation apparent in their belief systems, it also becomes more difficult for teachers to promote engagement. Skinner argued that "interventions would need to be more powerful and more subtle as children reach adolescence … [which] underscores the need for early detection and treatment of motivational problems" (p. 210).

Such early detection may be facilitated by an awareness of the perceived control model. Awareness, for example, of students' needs for autonomy, competence and relatedness, and the possible effects on motivation of these requirements not being met, form a basis of understanding student belief systems.

In answer to the research question posed in Chapter 1, yes, there are identifiable groups of students whose beliefs about learning mathematics could indicate potential problems with motivation in secondary school. The perceived control model presents a useful method of identifying groups of students who react in differing ways to transition.

The *consistently high* group of students are similar to those students that have been referred to by Harter and Connell (1984) as "a kind of academic super-star whom teachers adore" (p. 247). Before and after transition this group had high control beliefs, high capacity beliefs for effort, ability and luck, and a low score on unknown strategy beliefs. It should be noted that these students do not necessarily think that they are highly intelligent, just that they are smart enough to succeed. It may say more about the level of ability these students feel is necessary to do well in mathematics than about their own intelligence. These students have the highest levels of engagement, and feel that their teachers provide them with structure, autonomy support and are involved with them. They have the highest levels of self-esteem, and get on well with their teachers and peers. They have the lowest levels of external motivation and the highest levels of intrinsic motivation, the lowest levels of anxiety and the highest levels of positive coping.

In contrast, the *chronically low* group shows the most maladaptive profile of all, and it is clear that these students are in great need of intervention strategies. The profile presented by these students both before and after transition includes low control beliefs, low capacity beliefs particularly for ability, effort, luck and powerful others, combined with high strategy beliefs for luck and a high unknown strategy score. These students are the least engaged and perceive the least amount of structure, autonomy support and involvement. They have the lowest levels of self-esteem and the lowest ratings for their relationships with peers and teachers. Fortunately, and perhaps surprisingly, they still want to do well in mathematics, and still feel that mathematics will be useful to them when they leave school. However they don't like mathematics, they show high levels of anxiety, and high levels of external motivation. This illustrates neatly the recursion of the model, as it is hard to imagine how any child with problems such as those described could like the particular subject matter.

The other two groups fall somewhere between these two extreme profiles. On most variables the *decliners'* means are slightly below those for the *consistently high* group in Grade 6, while the *risers'* means are slightly above those for the *chronically low* group. In Year 7 however the means for the beliefs held by the *decliners* fell while those for the *risers* increased so that their roles were essentially reversed. An anomaly was found on only one variable, and that was for anxiety. Anxiety decreased for all groups over transition except for the *decliners* group, for whom it rose substantially. In contrast, the mean for anxiety decreased by an even larger amount for the *risers* group.

These findings are similar to those from studies such as those conducted by Skinner, Wellborn & Connell (1990), Connell (1991), Connell and Wellborn (1991), and Deci and Ryan (1991). Students' engagement in the present study was found to be undermined by beliefs in luck as a strategy for success and by reports of not knowing what strategies are effective. The highest levels of engagement were seen with students who held high strategy and capacity beliefs for effort, low strategy and high capacity beliefs for ability, luck and powerful others.

If mathematics teachers wish to promote the development of metacognitive skills and motivation in their classrooms, to allow all students to become active participants rather than passive recipients in their own learning experiences, there needs to be a clear understanding of the psychological processes that underpin student beliefs. The implications for teaching to try and address some of these issues are discussed in the following section of this chapter.

10.3 Implications for teaching

The three critical antecedents to perceived control were said to be competence, autonomy and relatedness. Competence is fostered by the provision of a structured working environment, where expectations are realistic, consequences are consistent and feedback is accurate and non-judgemental. Autonomy is facilitated by autonomy support, where an individual's perspective is acknowledged, opportunities are provided for initiative and choice is allowed. Relatedness develops when teachers and peers provide an involvement with the student, when students feel that they are in an environment where others care what happens to them.

It is also possible for school systems to block the development of competence, autonomy and relatedness by "providing inconsistency, or chaos, coercion, or neglect, respectively" (Miserandino, 1996, p. 203). It is consistently emphasised in the literature, for example, that when teachers feel pressured by the school system towards particular outcomes, such as being responsible for their students performing to certain standards, they will be more controlling towards their students. The result of this is that teachers tend to not want to take risks with student learning, and so they lecture more and give their students less choice and fewer opportunities for autonomous learning.

In order to foster motivation and enhance perceived control, it is important for children to be made aware of the connections between their efforts and outcomes. They should be encouraged to focus on their successful performances, and should be encouraged to interpret them in terms of high effort and ability. Instead of focussing on attributions for errors, analysis of failures should involve learning from the error and planning strategies for dealing with the problem next time.

These research findings may not be able to be translated directly into classroom practice. Practitioners need to "make decisions about how to manage the trade-offs involved in allocating limited teacher attention and classroom time to competing goals" (Brophy, 1983, p. 283). Patrick *et al.* (1993) suggested that when it is not feasible to measure perceived control, autonomy, relatedness and engagement directly, research such as that reported in this study can be used as a guide to the diagnosis of students' problems directly from their behaviour.

For example when students enter secondary school full of confidence and with good reports from their primary schools, then become disaffected and anxious during the early stages of secondary school, teachers might suspect that these students are similar to those from the *decliners* group. To increase motivation, teachers may need to provide these students with more structure, autonomy support and involvement, reduce their anxiety, and be explicit with them to think about the reasons to which they attribute success and failure, and their own beliefs about their capacities. In particular the strategy unknown belief needs to be explicitly addressed. For the students in the *chronically low* group, there is still hope, but major interventions need to be made into all facets of the competence system, similar to those described for the *decliners* students. It is vital to intervene in the self-system process because of the cyclicity of teachers' responses to children's own level of engagement. Students with high engagement are treated in ways that are more likely to increase their engagement, while teachers deal with students with low engagement in ways that will exacerbate their problems and lead to lower engagement (Skinner and Belmont, 1993).

There have been a variety of strategies proposed for teachers to use to foster engagement and promote perceived control in all students. These include

- Giving students options; about what, where, with whom, or how work is done. Highlighting choice rather than using a controlling style encourages the autonomous regulation of the activity,
- Letting students know what is expected and why – providing a clear structure within which students are able to learn what it takes to do well,
- Assigning tasks that are realistic and challenging for students. Dweck (1986) argued that success on easy tasks was ineffective in producing stable confidence; students need tasks that incorporate challenges, even failures, within a context that explicitly addresses motivational factors,
- Encouraging attitudes where learning is valued in its own right rather than as a means to an end. Deci, Vallerand, Pelletier and Ryan (1991) explained that external events designed to motivate or control people, including awards, threatened punishment or competition, have been shown to decrease intrinsic motivation. The common thread between these events is that each is typically used to pressure a person to think, feel or behave in a certain way,
- Communicating high expectations. Connell and Wellborn (1991) found that some children "receive implicit and explicit communications of low

expectations, disinterest and suppressed opportunities that clearly inhibit these children's experiences of competence, autonomy and relatedness in the school setting" (p. 72),

- Holding students accountable for learning and understanding, not just remembering and getting the right answers,
- Encouraging students to "learn how to learn", by encouraging them to be explicit about their beliefs about learning,
- Giving students opportunities to take risks and be wrong and learn from negative feedback. Students must learn to accept negative feedback as a source of information that may enable them to improve rather than see it as a negative judgement of their ability,
- Providing students with specific, constructive feedback when performance goals have not been met,
- In mathematics in particular many students are afraid of getting the wrong answer and will not guess because they fear this. Students need to be reminded that the learning process is incremental, and that they *can* learn and become better at a subject. Borkowski *et al.* (1990) argued that "… students need to be convinced that effort is an investment in cognitive development rather than a risk to self-esteem. It should be made clear that the road to consistent strategy use is often filled with errors and that failure does not imply low ability" (p. 82).

In addition to applying the psychological constructs of the perceived control model to students, it should be noted that they are just as applicable to teachers, who have similar motivational requirements. Teachers must also experience autonomy support, relatedness and perceive themselves as competent if they are to support the autonomy and competence of their students and provide them with structure.

The next section provides a discussion of several issues regarding directions for future research arising from this study, as well as a discussion of the limitations of the present study.

10.4 Implications for research

While this study certainly extends previous research, the implications of its findings should be discussed in light of its strengths and limitations. In particular, the measure of student engagement rated by their teachers is problematic. On one hand, teachers can be considered to be expert raters of their students' behavioural and cognitive engagement. On the other hand there is a hint of cyclicity about this, especially considering the findings from other studies about teachers reinforcing the beliefs of highly engaged students while behaving in ways that continue to undermine the beliefs of weakly engaged students. Observer reports of children's affect and behaviour in the classroom would add a great deal of information about their engagement.

Another limitation is that there were no schools involved in the study that dealt with transition internally. The Department of School Education was contacted at the beginning of this research study to find out where Prep – 12 schools in Victoria were located, however during the previous year they had apparently been closed or converted to primary or secondary schools. Some Prep - 12 schools are now being re-established, and a similar investigation in these schools would answer questions about the effect of the "school switch" factor in transition. However at the time this study was carried out, the only schools that catered for the entire age range were in the non-government school system, and the inclusion of these schools into the present study would have introduced many more confounding variables.

Although not practical for a study for this purpose, a longer longitudinal study would be most valuable. To follow these students into the post-compulsory years of mathematics education could provide valuable insights and may provide critical points at which beliefs change.

There are many directions that research into the perceived control area could move forward. As previously mentioned, a study following students from primary school into the later years of secondary school would be valuable. Similarly, transition to tertiary education is another of those 'critical points' at which huge changes are made in students' lives, and at which belief structures are particularly vulnerable.

An investigation and comparison of perceived control in a variety of academic areas, just as is common in attributional research, might provide clues as to why problems occur in mathematics that do not occur in other subject areas.

The relationship between perceived control beliefs and classroom environment was to have been examined in this study, however problems with the instrument chosen precluded this. If an instrument was available that could reliably measure students' beliefs about their classroom environment this would provide more useful data.

This study also has a number of strengths. The use of a longitudinal study design provides data about beliefs of students as they mature. The study used a new model, that of perceived control, which had not been used in Australia before, and provided evidence of the validity of that model in Australian classrooms. Cluster analysis is not a common tool of analysis in educational research, but for data such as these, examining trends longitudinally, it has been shown to be most valuable.

10.5 Final words

The present study was structured around an exploration of the perceived control model (Skinner, Wellborn & Connell, 1990) as applied to a particular educational context over a period of great change in a child's life. Certain beliefs about how to succeed in mathematics and one's capacity to achieve that success were found to be strong predictors of engagement, a construct that is argued mediates between perceived control and achievement. A large number of students were found to hold beliefs about learning mathematics that put them at-risk of disaffection after transition to secondary school, into an environment which is often perceived as distant and difficult. If it is true that "an overarching objective for most classroom teaching is the development of capable, responsible, *self*-motivated human beings who can carry out a variety of complex tasks as situations demand" (Corno & Mandinach, 1983, p. 105), then classroom teachers need to be aware of the psychological processes that underpin motivation to learn. It is hoped that the model presented in this study can be seen as useful to practitioners to improve student engagement and thus to foster the love of learning.

Appendix 1

Kzncigr Gvvxuxgr@O utgyn [tcxkxycz¡ Yzgtjctm Ius s czzkk ut Kzncdy ct Xkykgxin ut N{s gty

Appendix 2

Rkzzkx ul Gvvxuxgr zu iutj{iz xkykgxin @ Jkvgxzs ktz ul Yinuur

Kj{igzout

Appendix 3

Kzvıgtgzux¡ Yzgzks ktzy lux Yz{jktzy gtj Vgxktzy

Student (Parents) Explanatory Letter

Dear Student (Parent)

As part of a research project being conducted at Monash University, I would like to ask you (your child) some questions about your feelings and beliefs about maths. I believe that it's important for researchers to ask students how they feel about school so that we can all work together to make your (their) school life successful and rewarding.

This project involves following groups of students from primary to secondary school, and asks them simple questions about what they believe it takes to do well in mathematics and how they feel about mathematics.

There is no compulsion to participate in this study, but I would greatly appreciate it if you (your child) could, as it is important to find out what many students think. The answers that you (your child) gives on the questionnaires will not be seen by your (their) teachers, parents, other students, or anyone else connected with yourself (your child) or your (their) school. The answers will have no effect on your (their) grades, and you (they) are free to withdraw from the study at any time without any consequences.

I hope that you (and your child) do decide to participate in this project, and I look forward to working with you. If you agree (for your child) to be a part of the project, could you please fill in the form below and return it to your (your child's) teacher.

Thanks a lot,

Sue Fullarton

I .... (name), of ....(school), having had the research fully explained to me, agree (for my child) to participate in the project being conducted by Sue Fullarton from Monash University.

Signed ....

Appendix 4

Yz{jktz W{kyzouttgoxky@Yzgmky 7.8 gtj 9

MATHS IN TRANSITION PROJECT

STAGE 1

Student Background Information

Office use only

Name of School: ______________________________ ☐☐☐

Student's Name : ______________________________ ☐☐☐☐

Sex : ☐ Female ☐ Male

Age :

Teacher's name : ______________________________ ☐☐☐☐

Year level at school: ______________________________

Today's date: ______________________________

MATHS IN TRANSITION PROJECT

WAVE 1

General Instructions for completing this questionnaire

This questionnaire is designed to measure your attitudes and beliefs about mathematics. Please answer the questions honestly; there are no right or wrong answers. It is more important for me to find out how you really are, not how you would like to be or how you think you should be. Remember that other people will answer these questions differently to you, and that all the information you give to me is private.

Make sure you answer all the questions, but don't spend too much time thinking about your answers - the first answer that pops into your head is what is needed. Make sure that you read the instructions for each of the different sections as they may vary.

Thank you very much for your participation in this project.

YOUR VIEWS ABOUT MATHEMATICS

Read each of the following statements and decide how you feel about it. Tick the box that you feel best reflects how true you feel that the statement is for you.

	Very True	**Sort of true**	**Not very true**	**Not at all true**
1. Maths is one of my favourite subjects				
2. When a maths problem comes up that I can't solve immediately, I keep trying until I work it out				
3. Maths is subject that will be useful to me when I leave school				
4. Maths problems can always be solved by following rules				
5. In maths it is possible to have more than one right answer				
6. I usually understand the work we do in maths				
7. I like maths more than I like most other subjects				
8. Maths is only important at school				
9. Some people are good at maths and some just aren't				
10. I give up working on maths problems when I can't understand them				
11. In maths something is either right or it's wrong				

The next group of questions refers to maths and how you feel when doing maths at school. Tick the box that you feel best reflects how true you feel that the statement is for you.

		Very True	Sort of true	Not very true	Not at all true
12.	My teacher cares about how I do in school				
13.	My teacher talks about the connections between maths in school and things in my life				
14.	I'm not sure what my teacher expects of me in maths				
15.	The rules in my classroom are clear				
16.	My teacher lets me make decisions about my work in maths				
17.	My teacher has plenty of time for me in maths				
18.	My teacher tells me exactly how to do everything in maths				
19.	My teacher doesn't explain why we have to learn certain things in maths				
20.	My teacher never seems to have enough time for me in maths				
21.	My teacher is fair with me in maths				
22.	My teacher doesn't know me very well				
23.	My teacher expects too much from me in maths				
24.	I can do well in maths if I want to				
25.	The best way for me to get good grades in maths is to get my teachers to like me				
26.	I don't know what it takes to do well in maths				
27.	I am bored in maths				
28.	Trying hard is the best way for me to do well in school				
29.	If I'm not smart, I won't do well at maths				
30.	If I'm unlucky (and get asked questions about things I haven't studied) I won't get good grades in maths				
31.	I don't know how to keep myself from doing badly in maths				
32.	If I don't do well in maths, it's because I didn't try hard enough				
33.	I get angry easily in maths				
34.	I have to be smart to do well in maths (If I want to do well in maths, being smart is what counts the most)				
35.	I can't do well in maths				

	Very True	Sort of true	Not very true	Not at all true
36. I have to be lucky (by getting asked the right questions) to do well at maths				
37. I won't do well in school if the teachers don't like me				
38. I can get my teacher to like me				
39. I'm not very smart in maths				
40. I can work really hard in maths				
41. I am unlucky in maths				
42. When I'm in maths classes I usually feel happy				
43. I'm pretty smart at maths				
44. I can't get my teacher to like me				
45. I'm pretty lucky at getting good grades in maths				
46. I try and learn as much as I can about the maths we do				
47. When I'm in maths classes, I try very hard				
48. I pay attention in maths				
49. I don't work very hard in maths				
50. I enjoy doing school work				
51. I work very hard in maths				
52. When I'm in maths, I usually just pretend that I'm working				
53. I don't try very hard in maths				
54. I can't work really hard in maths				
55. I don't think about maths when I'm not at school				

When I'm with my maths teacher I feel

	Very True	Sort of true	Not very true	Not at all true
56. Relaxed				
57. Ignored				
58. Happy				
59. Tense				

Think of the last time something bad happened in maths (like not doing well on a test, not understanding what the teacher was explaining, or not being able to answer the questions). Here are some things that other students have said that they think and do after things like this happen. How true are these for YOU?

When something bad happens to me in maths

	Very True	Sort of true	Not very true	Not at all true
60. I tell myself it didn't matter anyway				
61. I feel really stupid				
62. I say the teacher didn't explain the topic properly				
63. I worry that the other students will think I'm dumb				
64. I tell myself I'll do better next time				
65. I say I didn't care about it anyway				
66. I say it was probably the teacher's fault				
67. I try to see where I went wrong				

I wish:

	Very True	Sort of true	Not very true	Not at all true
68. I felt better about myself				
69. My teacher would spend more time with me				
70. I could talk about more things with my classmates				

When I'm with my classmates I feel

	Very True	Sort of true	Not very true	Not at all true
71. Relaxed				
72. Ignored				
73. Happy				
74. Tense				

When I think about myself I feel:

	Very True	Sort of true	Not very true	Not at all true
75. Happy				
76. Important				
77. Unhappy				
78. Bad				

Why do I work in maths classes?

	Very True	Sort of true	Not very true	Not at all true
79. So that the teacher won't get mad at me				
80. Because the teachers say we have to				
81. Because I'll feel guilty if I don't				
82. Because doing well in school is important to me				
83. Because it's fun				
84. Because I want to learn new things				
85. Because I think it's important				
86. Because it is interesting				
87. Because I'll be ashamed of myself if I don't				

88. How important is it to you to do well in maths? Please circle how you feel.

Very Important **Sort of Important** **Not very Important** **Not at all Important**

The next questions are to find out your opinions about what your maths classroom is like. Again, remember that there are no right or wrong answers.

Place a tick in the box under the alternative that you feels best describes your maths classroom.

	Very often	Often	Some-times	Seldom	Almost never
89. The teacher considers students' feelings					
90. Students discuss their work in class					
91. The teacher decides where students sit					
92. Students work at their own speed					
93. The teacher talks with each student					
94. The teacher talks most of the time rather than listens					
95. Students choose their own partners for group work					
96. The teacher cares about each student					
97. Most students take part in discussions					
98. Students are told exactly how to do their work					
99. Students are encouraged to test their ideas when solving problems					
100. All the students in the class do the same work at the same time					
101. The teacher helps each student as much as possible					
102. Students give their opinions during discussions					
103. Students are told how to behave in the classroom					
104. Different students do different work					
105. The teacher is not very helpful to students					
106. Students do not ask or answer questions in the class					
107. The teacher decides when students are to be tested					

	Very often	Often	Some-times	Seldom	Almost never
108. Students are asked to think about their work rather than just find the answers to questions					
109. Different students do different tests					
110. The teacher helps all students who are having trouble with their work					
111. Students are asked questions					
112. Students are punished if they behave badly in class					
113. Different students use different books, equipment and materials					
114. Students who have finished their work wait for others to catch up					
115. The teacher remains at the front of the class rather than moving about and talking with students					
116. Students sit and listen to the teacher					
117. The teacher decides which students should work together					
118. Students are encouraged to be considerate of other people's feelings and ideas					
119. Students' ideas and suggestions are used during class discussions					
120. Students are told what will happen if they break the rules					
121. Students who work faster than other go on to the next topic					
122. The teacher tries to find out what each student wants to learn about					
123. Students ask the teacher questions					
124. Students who break the rules get into trouble					
125. The teacher uses tests to find out where each student needs help					
126. There is classroom discussion					
127. The teacher decides how much movement and talk there should be in the classroom					
128. All students are expected to do the same amount of work in the lesson.					

For each of the following questions, circle one of the numbers to indicate how you feel.

5 means 'excellent', 3 is 'average', and 1 means 'weak'.

	Excellent		Average		Weak
129. How good are you at maths?	5	4	3	2	1
130. How good would you like to be at maths?	5	4	3	2	1
131. Where would your teacher put you on this scale?	5	4	3	2	1
132. Where would your parents put you on this scale?	5	4	3	2	1
133. How good do you think your parents would like you to be at maths?	5	4	3	2	1
134. Where would your classmates put you on this scale?	5	4	3	2	1

135. Do you like maths? Explain why or why not.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

136.Do you think your teacher likes teaching maths? Explain why you think this.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

137. What do you think makes a person good at maths?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

138. Do you think you are good at maths? Explain why you think this.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

Thank you for completing this questionnaire.

Maths in Transition Project

Stage 2 1995

Student Background Information

Office use only

Name of School: ______________________________

Student's Name : ______________________________

Sex : ☐ Female ☐ Male

Age :

Teacher's name : ______________________________

Year level at school: ______________________________

Today's date: ______________________________

MATHS IN TRANSITION PROJECT

STAGE 2

General Instructions for completing this questionnaire

This questionnaire is designed to measure your attitudes and beliefs about mathematics. Please answer the questions honestly; there are no right or wrong answers. It is more important for me to find out how you really are, **not** how you would like to be or how you think you should be. Remember that other people will answer these questions differently to you, and that all the information you give to me is private.

Make sure you answer all the questions, but don't spend too much time thinking about your answers - the first answer that comes into your head is what is needed. Make sure that you read the instructions for each of the different sections as they may vary.

Thank you very much for your participation in this project.

YOUR VIEWS ABOUT MATHEMATICS

Read each of the following statements and decide how you feel about it. Tick the box that you feel best reflects how true you feel that the statement is for you.

		Very True	Sort of true	Not very true	Not at all true
1.	Maths is one of my favourite subjects				
2.	When a maths problem comes up that I can't solve immediately, I keep trying until I work it out				
3.	Maths is subject that will be useful to me when I leave school				
4.	Maths problems can always be solved by following rules				
5.	In maths it is possible to have more than one right answer				
6.	I usually understand the work we do in maths				
7.	I like maths more than I like most other subjects				
8.	Maths is only important at school				
9.	Some people are good at maths and some just aren't				
10.	I give up working on maths problems when I can't understand them				
11.	In maths something is either right or it's wrong				

The next group of questions refers to maths and how you feel when doing maths at school. Tick the box that you feel best reflects how true you feel that the statement is for you.

		Very True	Sort of true	Not very true	Not at all true
12.	My teacher cares about how I do in school				
13.	My teacher talks about the connections between maths in school and things in my life				
14.	I'm not sure what my teacher expects of me in maths				
15.	The rules in my classroom are clear				
16.	My teacher lets me make decisions about my work in maths				
17.	My teacher has plenty of time for me in maths				
18.	My teacher tells me exactly how to do everything in maths				
19.	My teacher doesn't explain why we have to learn certain things in maths				
20.	My teacher never seems to have enough time for me in maths				
21.	My teacher is fair with me in maths				
22.	My teacher doesn't know me very well				
23.	My teacher expects too much from me in maths				
24.	I can do well in maths if I want to				
25.	The best way for me to get good grades in maths is to get my teachers to like me				
26.	I don't know what it takes to do well in maths				
27.	I am bored in maths				
28.	Trying hard is the best way for me to do well in school				
29.	If I'm not smart, I won't do well at maths				
30.	If I'm unlucky (and get asked questions about things I haven't studied) I won't get good grades in maths				
31.	I don't know how to keep myself from doing badly in maths				
32.	If I don't do well in maths, it's because I didn't try hard enough				
33.	I get angry easily in maths				
34.	I have to be smart to do well in maths (If I want to do well in maths, being smart is what counts the most)				
35.	I can't do well in maths				

	Very True	Sort of true	Not very true	Not at all true
36. I have to be lucky (by getting asked the right questions) to do well at maths				
37. I won’t do well in school if the teachers don’t like me				
38. I can get my teacher to like me				
39. I’m not very smart in maths				
40. I can work really hard in maths				
41. I am unlucky in maths				
42. When I’m in maths classes I usually feel happy				
43. I’m pretty smart at maths				
44. I can’t get my teacher to like me				
45. I’m pretty lucky at getting good grades in maths				
46. I try and learn as much as I can about the maths we do				
47. When I’m in maths classes, I try very hard				
48. I pay attention in maths				
49. I don’t work very hard in maths				
50. I enjoy doing school work				
51. I work very hard in maths				
52. When I’m in maths, I usually just pretend that I’m working				
53. I don’t try very hard in maths				
54. I can’t work really hard in maths				
55. I don’t think about maths when I’m not at school				

When I’m with my maths teacher I feel

	Very True	Sort of true	Not very true	Not at all true
56. Relaxed				
57. Ignored				
58. Happy				
59. Tense				

Think of the last time something bad happened in maths (like not doing well on a test, not understanding what the teacher was explaining, or not being able to answer the questions). Here are some things that other students have said that they think and do after things like this happen. How true are these for YOU?

When something bad happens to me in maths

	Very True	Sort of true	Not very true	Not at all true
60. I tell myself it didn't matter anyway				
61. I feel really stupid				
62. I say the teacher didn't explain the topic properly				
63. I worry that the other students will think I'm dumb				
64. I tell myself I'll do better next time				
65. I say I didn't care about it anyway				
66. I say it was probably the teacher's fault				
67. I try to see where I went wrong				

I wish:

	Very True	Sort of true	Not very true	Not at all true
68. I felt better about myself				
69. My teacher would spend more time with me				
70. I could talk about more things with my classmates				

When I'm with my classmates I feel

	Very True	Sort of true	Not very true	Not at all true
71. Relaxed				
72. Ignored				
73. Happy				
74. Tense				

When I think about myself I feel:

	Very True	Sort of true	Not very true	Not at all true
75. Happy				
76. Important				
77. Unhappy				
78. Bad				

Why do I work in maths classes?

	Very True	Sort of true	Not very true	Not at all true
79. So that the teacher won't get mad at me				
80. Because the teachers say we have to				
81. Because I'll feel guilty if I don't				
82. Because doing well in school is important to me				
83. Because it's fun				
84. Because I want to learn new things				
85. Because I think it's important				
86. Because it is interesting				
87. Because I'll be ashamed of myself if I don't				

88. How important is it to you to do well in maths? Please circle how you feel.

Very Important **Sort of Important** **Not very Important** **Not at all Important**

The next questions are to find out your opinions about what your maths classroom is like. Again, remember that there are no right or wrong answers.

Place a tick in the box under the alternative that you feels best describes your maths classroom.

	Very often	**Often**	**Some-times**	**Seldom**	**Almost never**
89. The teacher considers students' feelings					
90. Students discuss their work in class					
91. The teacher decides where students sit					
92. Students work at their own speed					
93. The teacher talks with each student					
94. The teacher talks most of the time rather than listens					
95. Students choose their own partners for group work					
96. The teacher cares about each student					
97. Most students take part in discussions					
98. Students are told exactly how to do their work					
99. Students are encouraged to test their ideas when solving problems					
100. All the students in the class do the same work at the same time					
101. The teacher helps each student as much as possible					
102. Students give their opinions during discussions					
103. Students are told how to behave in the classroom					
104. Different students do different work					
105. The teacher is not very helpful to students					
106. Students do not ask or answer questions in the class					
107. The teacher decides when students are to be tested					

	Very often	Often	Some-times	Seldom	Almost never
108. Students are asked to think about their work rather than just find the answers to questions					
109. Different students do different tests					
110. The teacher helps all students who are having trouble with their work					
111. Students are asked questions					
112. Students are punished if they behave badly in class					
113. Different students use different books, equipment and materials					
114. Students who have finished their work wait for others to catch up					
115. The teacher remains at the front of the class rather than moving about and talking with students					
116. Students sit and listen to the teacher					
117. The teacher decides which students should work together					
118. Students are encouraged to be considerate of other people's feelings and ideas					
119. Students' ideas and suggestions are used during class discussions					
120. Students are told what will happen if they break the rules					
121. Students who work faster than other go on to the next topic					
122. The teacher tries to find out what each student wants to learn about					
123. Students ask the teacher questions					
124. Students who break the rules get into trouble					
125. The teacher uses tests to find out where each student needs help					
126. There is classroom discussion					
127. The teacher decides how much movement and talk there should be in the classroom					
128. All students are expected to do the same amount of work in the lesson.					

For each of the following questions, circle one of the numbers to indicate how you feel.

5 means ‘excellent’, 3 is ‘average’, and 1 means ‘weak’.

	Excellent		Average		Weak
129. How good are you at maths?	5	4	3	2	1
130. How good would you like to be at maths?	5	4	3	2	1
131. Where would your teacher put you on this scale?	5	4	3	2	1
132. Where would your parents put you on this scale?	5	4	3	2	1
133. How good do you think your parents would like you to be at maths?	5	4	3	2	1
134. Where would your classmates put you on this scale?	5	4	3	2	1

135. Do you like maths? Explain why or why not.

136. What secondary school do you plan to go to next year?

137. What do you think will be the best things about going to secondary school?

138. Is there anything about secondary school that you aren’t looking forward to?

139. What will you miss about primary school?

140. Do you think that maths classes will be different in secondary school than they are in primary school?
If so, how do you think things will be different?

☺ Thank you for completing this questionnaire! ☺

Maths in Transition Project

Stage 3 1996

Student Background Information

Office use only

Your Name : ____________________

Name of School: ____________________

Sex : Female ☐ Male ☐

Your Age: ____________________

Teacher's name : ____________________

Year level at school: ____________________

Today's date: ____________________

MATHS IN TRANSITION PROJECT

STAGE 3

General Instructions for completing this questionnaire

This questionnaire is designed to measure your attitudes and beliefs about mathematics. Please answer the questions honestly; there are no right or wrong answers. It is more important for me to find out how you really are, **not** how you would like to be or how you think you should be. Remember that other people will answer these questions differently to you, and that all the information you give to me is private.

Make sure you answer all the questions, but don't spend too much time thinking about your answers - the first answer that comes into your head is what is needed. Make sure that you read the instructions for each of the different sections as they may vary.

Thank you very much for your participation in this project.

YOUR VIEWS ABOUT MATHEMATICS

Read each of the following statements and decide how you feel about it. Tick the box that you feel best reflects how true you feel that the statement is for you.

		Very True	Sort of true	Not very true	Not at all true
1.	Maths is one of my favourite subjects				
2.	When a maths problem comes up that I can't solve immediately, I keep trying until I work it out				
3.	Maths is subject that will be useful to me when I leave school				
4.	Maths problems can always be solved by following rules				
5.	In maths it is possible to have more than one right answer				
6.	I usually understand the work we do in maths				
7.	I like maths more than I like most other subjects				
8.	Maths is only important at school				
9.	Some people are good at maths and some just aren't				
10.	I give up working on maths problems when I can't understand them				
11.	In maths something is either right or it's wrong				

The next group of questions refers to maths and how you feel when doing maths at school. Tick the box that you feel best reflects how true you feel that the statement is for you.

		Very True	Sort of true	Not very true	Not at all true
12.	My teacher cares about how I do in school				
13.	My teacher talks about the connections between maths in school and things in my life				
14.	I'm not sure what my teacher expects of me in maths				
15.	The rules in my classroom are clear				
16.	My teacher lets me make decisions about my work in maths				
17.	My maths teacher has plenty of time for me				
18.	My maths teacher tells me exactly how to do everything				
19.	My teacher doesn't explain why we have to learn certain things in maths				
20.	My maths teacher never seems to have enough time for me				
21.	My maths teacher is fair with me				
22.	My maths teacher doesn't know me very well				
23.	My maths teacher expects too much from me				
24.	I can do well in maths if I want to				
25.	The best way for me to get good grades in maths is to get my teachers to like me				
26.	I don't know what it takes to do well in maths				
27.	I am bored in maths				
28.	Trying hard is the best way for me to do well in maths				
29.	If I'm not smart, I won't do well at maths				
30.	If I'm unlucky (and get asked questions about things I haven't studied) I won't get good grades in maths				
31.	I don't know how to keep myself from doing badly in maths				
32.	If I don't do well in maths, it's because I didn't try hard enough				
33.	I get angry easily in maths				
34.	If I want to do well in maths, being smart is what counts the most				
35.	I can't do well in maths				

	Very True	Sort of true	Not very true	Not at all true
36. I have to be lucky (by getting asked the right questions) to do well at maths				
37. I won't do well in maths if the teachers don't like me				
38. I can get my maths teacher to like me				
39. I'm not very smart in maths				
40. I can work really hard in maths				
41. I am unlucky in maths				
42. When I'm in maths classes I usually feel happy				
43. I'm pretty smart at maths				
44. I can't get my maths teacher to like me				
45. I'm pretty lucky at getting good grades in maths				
46. I try and learn as much as I can about the maths we do				
47. When I'm in maths classes, I try very hard				
48. I pay attention in maths				
49. I don't work very hard in maths				
50. I enjoy doing maths				
51. I work very hard in maths				
52. When I'm in maths, I usually just pretend that I'm working				
53. I don't try very hard in maths				
54. I can't work really hard in maths				
55. I don't think about maths when I'm not at school				

When I'm with my maths teacher I feel

	Very True	Sort of true	Not very true	Not at all true
56. Relaxed				
57. Ignored				
58. Happy				
59. Tense				

Think of the last time something bad happened in maths (like not doing well on a test, not understanding what the teacher was explaining, or not being able to answer the questions). Here are some things that other students have said that they think and do after things like this happen. How true are these for YOU?

When something bad happens to me in maths

	Very True	Sort of true	Not very true	Not at all true
60. I tell myself it didn't matter anyway				
61. I feel really stupid				
62. I say the teacher didn't explain the topic properly				
63. I worry that the other students will think I'm dumb				
64. I tell myself I'll do better next time				
65. I say I didn't care about it anyway				
66. I say it was probably the teacher's fault				
67. I try to see where I went wrong				

I wish:

	Very True	Sort of true	Not very true	Not at all true
68. I felt better about myself				
69. My maths teacher would spend more time with me				
70. I could talk about more things with my classmates				

When I'm with my classmates I feel

	Very True	Sort of true	Not very true	Not at all true
71. Relaxed				
72. Ignored				
73. Happy				
74. Tense				

When I think about myself I feel:

	Very True	Sort of true	Not very true	Not at all true
75. Happy				
76. Important				
77. Unhappy				
78. Bad				

Why do I work in maths classes?

	Very True	Sort of true	Not very true	Not at all true
79. So that the teacher won't get mad at me				
80. Because the teachers say we have to				
81. Because I'll feel guilty if I don't				
82. Because doing well in school is important to me				
83. Because it's fun				
84. Because I want to learn new things				
85. Because I think it's important				
86. Because it is interesting				
87. Because I'll be ashamed of myself if I don't				

88. How important is it to <u>you</u> to do well in maths? Please circle how you feel.

Very Important **Sort of Important** **Not very Important** **Not at all Important**

The next questions are to find out your opinions about what your maths classroom is like. Again, remember that there are no right or wrong answers.

Place a tick in the box under the alternative that you feels best describes your maths classroom.

	Very often	**Often**	**Some-times**	**Seldom**	**Almost never**
89. The teacher considers students' feelings					
90. Students discuss their work in class					
91. The teacher decides where students sit					
92. Students work at their own speed					
93. The teacher talks with each student					
94. The teacher talks most of the time rather than listens					
95. Students choose their own partners for group work					
96. The teacher cares about each student					
97. Most students take part in discussions					
98. Students are told exactly how to do their work					
99. Students are encouraged to test their ideas when solving problems					
100. All the students in the class do the same work at the same time					
101. The teacher helps each student as much as possible					
102. Students give their opinions during discussions					
103. Students are told how to behave in the classroom					
104. Different students do different work					
105. The teacher is not very helpful to students					
106. Students do not ask or answer questions in the class					
107. The teacher decides when students are to be tested					

	Very often	Often	Some-times	Seldom	Almost never
108. Students are asked to think about their work rather than just find the answers to questions					
109. Different students do different tests					
110. The teacher helps all students who are having trouble with their work					
111. Students are asked questions					
112. Students are punished if they behave badly in class					
113. Different students use different books, equipment and materials					
114. Students who have finished their work wait for others to catch up					
115. The teacher remains at the front of the class rather than moving about and talking with students					
116. Students sit and listen to the teacher					
117. The teacher decides which students should work together					
118. Students are encouraged to be considerate of other people's feelings and ideas					
119. Students' ideas and suggestions are used during class discussions					
120. Students are told what will happen if they break the rules					
121. Students who work faster than other go on to the next topic					
122. The teacher tries to find out what each student wants to learn about					
123. Students ask the teacher questions					
124. Students who break the rules get into trouble					
125. The teacher uses tests to find out where each student needs help					
126. There is classroom discussion					
127. The teacher decides how much movement and talk there should be in the classroom					
128. All students are expected to do the same amount of work in the lesson.					

For each of the following questions, circle one of the numbers to indicate how you feel.

5 means ‘excellent’, 3 is ‘average’, and 1 means ‘weak’.

	Excellent		Average		Weak
129. How good are you at maths?	5	4	3	2	1
130. How good would you like to be at maths?	5	4	3	2	1
131. Where would your teacher put you on this scale?	5	4	3	2	1
132. Where would your parents put you on this scale?	5	4	3	2	1
133. How good do you think your parents would like you to be at maths?	5	4	3	2	1
134. Where would your classmates put you on this scale?	5	4	3	2	1

135. Do you like maths? Explain why or why not.
....
....

136. What have you liked **most** about going to secondary school?
....
....

137. What have you liked **least** about going to secondary school?
....
....

138. Do you miss anything about primary school?
....
....

139. Have you found maths classes are different than they were in primary school? If you have, what would you say is the difference?
....
....
....

140. How do you think you are doing in maths compared to primary school? Circle one of these ..

Better **About the Same** **Worse**

If this is better or worse, why do you think this is?
....
....
....

☺ Thank you for completing this questionnaire! ☺

Appendix 5

Teacher-rated Student Engagement Questionnaires: Stages 1, 2 and 3

MATHS IN TRANSITION PROJECT

STUDENT ENGAGEMENT

STUDENT: .... DATE:

....

In this questionnaire, classroom teachers are asked to rate a variety of behaviours in **mathematics** for individual students. Just tick the box under the descriptor that, in your experience, best describes the typical behaviour of this student. Please only put ticks **in** boxes, and make sure that you respond to every question.

In maths classes, this student:

		Very often	**Often**	**Some-times**	**Seldom**	**Almost never**
1.	is anxious					
2.	is frustrated, angry or irritable					
3.	is involved with their work					
4.	is confident of success					
5.	is passive					
6.	is attentive					
7.	is bored					
8.	is relaxed					
9.	is happy					
10.	is discouraged					
11.	is easily distracted					
12.	uses their own judgement					
13.	works independently					
14.	lacks perseverance; becomes frustrated or impatient with difficult or challenging work					
15.	copes positively with failure (ie tries harder subsequently)					
16.	is a flexible problem solver (is willing to adapt strategies or to					

	use multiple strategies rather than give up if one method doesn’t work)					
17.	contributes actively to class or group work					
18.	relies on others					
19.	needs constant direction					
20.	perseveres in the face of difficult or challenging work					
21.	copes negatively with failure					

		Very often	Often	Some-times	Seldom	Almost never
22.	Enjoys being presented with a challenge					
23.	Works as hard as he/she can in maths					
24.	Is persistent; has a sustained attention span					
25.	Is interested in how maths is used outside the classroom					
26.	Does just enough to get by					
27.	Volunteers answers in class					
28.	Approaches maths problems in a purposeful manner					
29.	Organises their work well					
30.	Shows signs of curiosity (ie with problem solving)					

How would you rate this student's ability in maths? Please circle the most appropriate:

Well above average	Above average	Average	Below average	Well below average

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