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Factors that Influence Year 7 Students’
Engagement and Achievement in Mathematics

A thesis submitted in fulfilment of the requirements
for the degree of Doctor of Philosophy

Karen G. Skilling
B Comm, A.T.C.L, Dip Ed (Prim), M Ed

Faculty of Education and Social Work
The University of Sydney

September 2013

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Statement of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original, except as acknowledged in the text. I hereby declare that I have not submitted this material, either in whole or in part, for a degree at this or any other institution.

I thank Belinda Walker for proof-reading and editing this thesis. The proof-reading and editing followed the guidelines set out by The University of Sydney.
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Background: The Teachers and their Classrooms

Mrs Church
Miss Field
Mr Tower
Miss Marsh

Teacher Beliefs and Knowledge

Beliefs about learning mathematics
Beliefs about engagement in mathematics

Teacher Knowledge

Knowledge of content and pedagogy
Knowledge of students

Summary of Teacher Beliefs and Knowledge

Teacher Engagement Practices

Practices that Promote Emotional Engagement
Practices that Create Engaging Classroom Environments
Practices that Promote Task Importance and Value
Practices that Promote Content Goals
Practices that Promote Varied Strategy Use and Self-Regulation
Practices that Promote Competency
Practices that Promote Autonomy
Practices that Promote Collaboration
Practices that Promote Monitoring and Feedback

Summary of Teacher Practices

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Abstract

Improving student engagement in mathematics, particularly during the critical transition from primary to secondary school, is a significant issue in education. Addressing this challenge requires a clearer understanding of the motivational and contextual factors influencing student engagement and achievement outcomes in mathematics. The aims of this research are to explore the factors that contribute to shifts in student engagement in mathematics as they move from primary to secondary school and to examine teacher practices that promote higher levels of engagement in mathematics by first year high school (Year 7) students. The investigation comprised two qualitative studies. Study 1 utilised semi-structured interviews to elicit perceptions about the factors influencing student engagement from 36 Year 7 students and 31 teachers across 10 secondary schools in the Sydney metropolitan area. Low and high achieving students whose engagement levels in mathematics had shifted to being significantly more engaged or disengaged in the past year (from primary to secondary school) were interviewed. Importantly, factors relating to student interest, enjoyment, persistence and study management skills were found to impact differently on students displaying upward or downward shifts in engagement regardless of their achievement levels. Study 2 used case study to investigate the beliefs and practices of four teachers of low and high achieving ‘engaged’ Year 7 mathematics classes. Data gathered from lesson observations, pre- and post-lesson interviews and a survey highlighted teacher beliefs and practices that were uniquely tailored to specific class contexts. In particular, instructional strategies that directly addressed students’ interests, values, competencies and their self-efficacy were crucial for promoting engagement in mathematics. Together, these findings extend our understanding of the engagement construct and provide further clarity to practical issues surrounding improving student engagement levels in mathematics for high and low achieving students.
Introduction

This introduction provides contextual information about the research project and outlines the purpose and significance of the topic in relation to previous research. It explains how this project seeks to enhance educators’ understanding of student motivation and engagement relevant to mathematics achievement as students make the transition from primary to secondary school. Issues affecting student participation and achievement in mathematics, types and levels of student engagement, the role of motivationally supportive teaching strategies and student responsiveness to classroom contexts are raised. The structure of the thesis is also described.

This research comprises two qualitative studies and is nested within a larger project known as the Middle Years Transition, Engagement and Achievement in Mathematics (MYTEAM Project) (Martin, Anderson, Bobis, Way, & Vellar, 2012) that commenced in 2009. The key aim of the MYTEAM Project is to improve academic engagement in mathematics. The project combines the disciplines of mathematics education and psychology to examine the experiences and practices of students and teachers in the middle years of school with a particular focus on the transition from primary to secondary school.

The two qualitative studies reported in this research are designed to connect students and teachers perceptions of engagement and achievement through an Interview Study (Study 1) to teacher beliefs and practices for engaging students during mathematics instruction in Year 7 classrooms through a Case Study (Study 2). The aim of this research is twofold: (a) to explore the factors that contribute to shifts in student engagement and achievement in mathematics as students move from primary to secondary school; and (b) to describe teacher practices that are effective for promoting high levels of student engagement in mathematics during the middle years of schooling, being Years 5 to 8.

Student Participation and Achievement in Mathematics

Student engagement is a significant issue in mathematics classrooms. This project addresses reports that have identified declines in student engagement and

---

1 Year 7 is the first year of secondary school in New South Wales, Australia. Students are approximately 11-13 years of age.
motivation as a crucial issue for mathematics education (McPhan, Morony, Pegg, Cooksey, & Lynch, 2008; Tytler, Osborne, Williams, Tytler, & Cripps Clark, 2008). Contemporary conceptualisations of engagement build upon earlier conceptions, which had placed emphasis on student behaviours and level of participation (Finn, 1989), to include emotional and cognitive factors (Fredricks, Blumenfeld, & Paris, 2004). Therefore, student participation reflects student behaviour toward mathematics but importantly, acknowledges that student behaviours are influenced by their thoughts and feelings about mathematics.

Research indicates that a disproportionate number of students are disengaging from mathematics (Sullivan, Tobias, & McDonough, 2006) and that many students are not inclined to pursue further study of mathematics in later secondary school or beyond (Brown, Brown, & Bibby, 2008; Mack & Walsh, 2013). There are also reports revealing declining numbers of students enrolling in advanced and intermediate mathematics courses in the final years of secondary school (Barrington, 2006, 2011;Forgasz, 2006; Murray, 2011). Recent investigations indicate that this extends to a decline in students taking a combination of mathematics and science courses, most markedly amongst female students (Mack & Walsh, 2013).

Coupled with declines in the number of students participating in mathematics courses are concerns about the low proportion of students achieving acceptable levels of proficiency in mathematics. Results from international tests show falls in mathematics achievement in Australia over the last decade (Thomson & De Bortoli, 2007; Thomson, De Bortoli, Nicholas, Hillman, & Buckley, 2010; Thomson et al., 2012) and that Australian students are being out-performed by students in other countries. For example, in Korea, Singapore and Chinese Taipei almost half of the students are performing at ‘advanced’ levels (Thomson et al., 2012) compared to only nine percent of Australian students. Under-participation and low achievement is likely to influence the supply of mathematics graduates in the future and has implications for the national labour market. The less than optimal progress in mathematics is a major concern during the middle years of schooling as reported dips in learning (Hill, Holmes-Smith, & Rowe, 1993; Siemon, 2001) come at a time when students’ attitudes and engagement toward mathematics are also in decline.

Although levels of student engagement in mathematics are declining, a proportion of students report valuing it (Thomson et al., 2012). Therefore, it is worth exploring why students choose not to study mathematics beyond the years that it is a
compulsory subject. One study that researched students’ intent to continue with mathematics courses found that it was the students who had confidence in their ability and received support from significant others that chose to pursue mathematics beyond compulsory years (Lantz & Smith, 1981). Findings such as these highlight the need to better understand the range of motivational factors operating that may influence students and the role that teachers play in student engagement in mathematics.

Increasingly, educational research is taking note of motivation and engagement and how these factors influence student learning (Hardré, Sullivan, & Crowson, 2009) and achievement outcomes (Boaler, 2000; Brown et al., 2008; Forgasz, 2006; Fredricks et al., 2004; McLeod, 1992; Nardi & Steward, 2003; Sullivan & McDonough, 2007). Additionally, the significance of students’ emotions (Linnenbrink-Garcia & Pekrun, 2011; Pekrun & Linnenbrink-Garcia, 2012), their identification with school (Finn & Zimmer, 2012) and interpersonal relationships with teachers and peers within the mathematics classroom, are central to student engagement (Martin, 2003, 2007; Zan, Brown, Evans, & Hannula, 2006).

To address falling participation and engagement in mathematics there is an increasing need to precisely identify factors that influence student motivation and engagement in mathematics and investigate motivationally supportive teaching practices that promote engagement and achievement. The present study contributes to research about student engagement in mathematics by investigating the relationship of specific underlying motivation factors and types of engagement relative to varying levels of student achievement.

There is a general consensus that motivation underpins engagement and affects learning outcomes (Martin, 2012). This follows arguments that students who are motivated and engaged are more often intrinsically orientated towards learning and use effective learning strategies in their quest for understanding that results in higher academic outcomes. However, research in mathematics education has shown that high achieving students do not always exhibit high levels of motivation and engagement. In fact, they too are susceptible to disengagement in mathematics, which is more pronounced during the middle years of schooling (McPhan et al., 2008; Thomson et al., 2012; Tytler et al., 2008). It is also noted that some low achieving students continue to persevere and stay engaged and motivated to learn mathematics.

Since high and low achievement levels do not necessarily equate respectively with high and low levels of engagement, an ambiguous picture of student engagement
in mathematics learning is presented. With the exception of a few studies (Grootenboer & Hemmings, 2007; Schweinle, Meyer, & Turner, 2006), the engagement of students with differing levels of achievement in mathematics has received little attention. The present study pursues the engagement/achievement relationship in greater depth because it investigates students with varying levels of engagement/achievement characteristics. Furthermore, through examining different combinations of student engagement and level of achievement, it investigates the influence of factors underlying engagement and achievement separately. In short, this study explores in detail the types and levels of student engagement relative to low and high levels of mathematics achievement.

**Examining Student Engagement and Disengagement**

Current literature views engagement as being composed of different ‘types’, with each type operating together but, potentially, at different levels of intensity (Fredricks et al., 2004; Skinner & Pitzer, 2012). Despite being viewed as interrelated and influenced by many factors, research reporting student engagement in mathematics tends to do so only in general terms—referring to students as being ‘engaged’ or ‘disengaged’. Whilst it may be more conventional to use broad and typical terms to describe student engagement, this restricts the way educators talk about and recognise different types of engagement and the degree to which these different types operate for individual students when learning mathematics. For example, students who are behaviourally and emotionally engaged (actively participating, demonstrating interest and enjoyment) in mathematics classes may not necessarily be cognitively engaged (effectively planning and managing their learning). Teachers who are accustomed to assessing a student’s ‘overall’ engagement (e.g., ‘mostly engaged’ or ‘a little bit disengaged’) or by measuring engagement based on the most obvious or overt signs, such as student behaviours in the classroom, run the risk of overlooking other influencing factors or fluctuations in factors that may indicate a decline in engagement (Kong, Wong, & Lam, 2003; Marks, 2000).

Teacher knowledge about expected types of student engagement and the likely motivational factors influencing them is in need of further study. Increasingly teacher perceptions of student engagement have been sought through mixed quantitative and qualities measures (Hardré, Davis, & Sullivan, 2008; Hardré & Sullivan, 2008). The present study draws on quantitative data to identify teacher participants and through
in-depth interviews explores how and to what degree they perceive students are engaged in mathematics learning.

In this study, perceptions of students and teachers are sought at the same time and within the same setting. It is important to understand what teachers take notice of in deciding whether or not students are engaged (Lee & Reeve, 2012) and how teachers describe the types and intensity of student engagement in mathematics classes. This research seeks teacher perceptions of engagement through to disengagement and the area between engagement and disengagement is examined more closely to uncover factors that indicate changes or variations in types and levels of student engagement. Students’ perceptions of their feelings and beliefs of their ability as well as their views of mathematics teaching provide a vital perspective for understanding this construct.

It is recognised that engagement reflects a pattern of involvement in a variety of activities rather than being static and invariable (Schorr & Goldin, 2008; Smith, Sheppard, Johnson, & Johnson, 2005). Views concerning fluctuating engagement levels are consistent with research that has identified changes in students’ engagement levels over time (Brown et al., 2008; Martin et al., 2012; Sullivan et al., 2006). However, further research is needed to assess the stability of cognitive and emotional factors influencing engagement as students progress through school (Finn & Zimmer, 2012).

The present study investigates both upward and downward shifts in student engagement in mathematics as they transition from primary to secondary school eliciting factors that students perceive as influential. Reasons for shifts in engagement are sought from students of both high and low achievement levels with the precise aim to disentangle student achievement in mathematics from student engagement in mathematics. Since the teacher’s perceptions of student engagement are also sought, this research reveals how teachers describe students displaying different engagement and achievement characteristics. The purpose is to draw out detailed perceptions of how students with varying achievement levels behave, feel and think about mathematics. Therefore this study seeks a clearer understanding of the relationship between engagement and achievement and is in line with research indicating that student engagement has a positive effect on student learning outcomes (Reeve, 2012).

Another aim of this research is to provide clarity about the relationship between motivational factors and engagement. The present study uses two
complementary frameworks that relate particular motivation factors drawn from Martin’s (2007) 11-factor motivation and engagement framework (herein referred to as the Motivation and Engagement Wheel) to the types of engagement described by Fredricks et al., (2004). Using the two frameworks together means that the presence or relative absence of adaptive and maladaptive motivational factors and how they influence levels of behavioural, cognitive and emotional types of engagement can be considered more clearly. Recent quantitative research has used the Motivation and Engagement Wheel to identify specific motivational factors that lead to changes in middle year students’ motivation and engagement particular to mathematics (Plenty & Heubeck, 2013). The benefits of the present qualitative inquiry are to examine the influence of motivational factors specific to types of student engagement in mathematics.

Examining Motivationally Supportive Practices for Mathematics Learning

Student engagement in mathematics classrooms inevitably influences mathematical learning. This necessitates an examination of teacher beliefs (Askew, Rhodes, Brown, Wiliam, & Johnson, 1997) that are significant for guiding teacher practices for teaching and engaging students in mathematics. Several researchers have identified mathematics practices noting key principles for effective mathematics teaching (Sullivan, 2011) and competencies to benefit students’ mathematical thinking (Anthony & Walshaw, 2007). Further, specific cognitive difficulties that students have to overcome as they progress to secondary school mathematics requiring them to perceive, reason and conceptualise mathematics in ways not previously demanded of them, have also been noted (Watson, 2010). Teachers need to know not only what mathematics to teach students but how to engage them cognitively in tasks designed to improve their mathematical knowledge. The elements for effective mathematics learning highlight the importance of instruction that considers the motivational needs of students.

Instructional practices that meet the motivational needs of students include those that promote student autonomy (Reeve, 2009, 2012), provide scaffolds for engagement (Lutz, Guthrie, & Davis, 2010) and a range of other instructional elements considered important, particularly for students in the middle years of schooling (Dinham & Rowe, 2007). Several studies have considered instructional practices for promoting engagement in mathematics by converging elements of
motivation within mathematics education. For example Stipek, Salmon, Givven, Kazemi, Saxe and MacGwyers (1998) identify motivation-related variables to consider when teaching mathematics; Turner, Warzon and Christenson (2011) propose several principles of motivational and instructional strategies; and Raphael, Pressley and Mohen (2008) list categories of teacher practices that support student engagement. Together, this research confirms the benefits of including motivationally supportive practices as a way to promote student engagement in mathematics.

To date, research identifying certain strategies as more and less productive for inducing student motivation has not been specific to individual student characteristics such as varying achievement levels. It has been noted that unless teachers are aware of individual student needs (including achievement levels), it is difficult to effectively promote student engagement (Hardré & Sullivan, 2009). Teacher perceptions of student characteristics are therefore vitally important as they influence the strategies they use to promote engagement.

Although some studies of student engagement take account of student achievement levels, none have been found to specifically differentiate between the factors influencing the engagement and disengagement of students with high and low levels of achievement in mathematics. The present study seeks to extend previous work in this field by examining the motivationally supportive practices of teachers and investigating the degree to which students perceive these practices to meet their motivational needs in mathematics. The study reveals the extent to which teachers share common beliefs and practices or whether they differ according to student characteristics, such as achievement level. High and low levels of achievement do not necessarily result in high and low levels of engagement or vice versa. Therefore, investigating why it is that some students continue to engage in mathematics despite achieving poorly while others who achieve well begin to disengage is important to understand. It is anticipated that a comprehensive approach, including teacher beliefs and practices for students with differing achievement levels, will provide clearer guidance for the use of effective strategies that promote student engagement in mathematics.

Research Questions Addressed through Study 1 and Study 2

This research specifically addresses the following questions:
1. What individual and classroom level factors do Year 7 students perceive as influencing their engagement, motivation and achievement in mathematics?

2. How do teachers perceive students’ levels of engagement and motivation in mathematics and how is this reflected in their teaching practices?

3. How do teachers motivate and engage middle years students in mathematics?

(a) What beliefs do teachers who are effective at promoting engagement hold about students’ motivation and engagement in mathematics?

(b) How do teachers differentiate their practices to motivate and engage students of varying levels of achievement?

The first two research questions are investigated through an Interview Study (Study 1) with the specific purpose of establishing the factors that contribute to shifts in student engagement and achievement in mathematics when they transition from their last year of primary school (Year 6) to their first year of secondary school (Year 7). It does this through in-depth interviews with a diverse range of students and their teachers that elicit details of those students’ perceptions about mathematics. The thoughts, feelings and behaviours about mathematics from both male and female students with high and low levels of engagement and varying levels of achievement from ten secondary schools are investigated. Their perceptions about the mathematics class climate and their relationships with teachers and other students are explored. Teachers’ perceptions of student engagement, achievement, classroom climate, and interpersonal relationships with their students are also examined. School level factors were not considered for this study as the schools belonged to the same school system and fell within similar socio-economic brackets, suggesting there was not enough variance to warrant a detailed investigation.

The third research question and sub questions are explored through a Case Study (Study 2) approach that seeks to identify the beliefs and practices of teachers considered effective at maintaining engaged mathematics classes. Teachers’ beliefs and practices are investigated using a combination of interviews (relating to both pre- and post-lesson observations), observations of lessons and a teacher survey. Teachers’ beliefs about how to teach and how to engage students in mathematics are central to the practices employed in the classroom. How classroom environments and teacher
practices are conducive to engagement in mathematics are therefore important elements to investigate.

The two studies are designed to connect student and teacher perceptions of engagement and achievement to teachers’ beliefs and practices for engaging students during mathematics classes in Year 7. The findings of the studies are expected to contribute to a deeper understanding of reasons behind the shifts in student engagement and achievement and of effective practices for promoting engagement in the middle years of schooling.

Outline of the Thesis

This introduction has outlined the background to the study and its main aims. Chapter 1 orientates the reader to the purpose of this study by identifying important issues affecting student participation, interest and achievement in mathematics. Chapter 2 reviews current literature on engagement and motivation. The engagement construct is reviewed including types of engagement and its relevance to academic achievement and to motivation. The development of motivational theories is discussed with an emphasis on achievement motivation and the theoretical frameworks used for both engagement and motivation are presented. Each framework is justified and followed by an explanation for using the two frameworks in the current research. Chapter 3 considers teacher beliefs and practices for mathematics instruction and the use of motivational teaching strategies that are deemed effective for promoting student engagement in mathematics.

Chapter 4 presents the methods used for conducting Study 1 and the data analysis. The research design is outlined, including the selection of student and teacher participants. This is followed by an explanation of the interview procedures, the instruments for data collection, the selection of data for analysis and the methods used for analysis. Chapter 5 reports the results of the student interview analysis using four themes: student beliefs about their mathematics achievement; their emotional responses towards mathematics; their perceptions of mathematics teaching; and their behaviours while learning mathematics. Chapter 6 reports the results of the teachers’ interviews and identifies and describes three types of engagement (behavioural, emotional and cognitive) that operate at three levels (engagement, variable engagement and disengagement).
Chapter 7 explains the methods used for conducting Study 2 and the data analysis. The research design is outlined including the process for selecting teachers and their classrooms for observation. This is followed by details of the data collection procedures and an analysis of teacher survey data, pre- and post-lesson interviews with teachers and the lesson observations. Chapter 8 reports the results of the case studies using two overarching themes: (a) teacher beliefs and knowledge; and (b) teacher engagement practices.

Chapter 9 summarises the research findings from both studies, draws conclusions from the findings and discusses implications arising from the findings including the significance for both researchers and practitioners. The chapter concludes by considering the limitations of the study and suggestions for further research in this field.
Chapter 1

Student Engagement and Achievement in Mathematics

The aim of this chapter is to establish a rationale for the present study by identifying current issues relevant to student engagement and achievement in mathematics. Specifically, the present study seeks to gain a broader and balanced understanding of individual and class level factors influencing student engagement and achievement in mathematics by examining the perceptions of Year 7 students and their teachers. The study also explores how teachers identify and describe student engagement and disengagement, whether or not they associate engagement with achievement (and/or vice versa) and the approaches to teaching they perceive as motivating and engaging students in mathematics.

Interpreting the influence of these issues is particularly relevant during the late primary and early secondary school years because this is the time that many students make decisions to engage in further study of mathematics. Understanding key factors that influence student engagement in mathematics can assist in establishing clear rationales for interventions designed to address declining student engagement. Seminal issues related to student engagement include falling enrolments in higher-level mathematics courses, declining interest in mathematics during secondary years of school and dips in achievement in early secondary school. Related issues also include the link between achievement in mathematics and future intentions to study mathematics and other interrelated subjects such as science, technology and engineering (collectively known as STEM subjects). Consideration is also given to factors other than achievement such as the needs of adolescent students, teacher pedagogy and the nature of mathematics itself.

Falling enrolments and Interest in Mathematics

There was an 18.8% increase in enrolments in total mathematics courses in Australian schools in the decade between 1990 and 1999, as shown by enrolments in Year 12\(^2\) mathematics courses (Forgasz, 2006). By comparison, the increase in

\(^2\) Year 12 is the final year of secondary school in all Australian states and territories.
enrolments in mathematics courses was only 0.9% in the five years between 2000 and 2004. This data indicates substantial changes in Year 12 enrolments in mathematics courses since 1990 as the proportion of students choosing to enrol in mathematics in upper secondary years decreased (Forgasz, 2006; Murray, 2011). Concerns about falling enrolments have led to further investigations of student enrolments in different types of mathematics courses.

Between 1995 and 2010, a decrease in the proportion of Year 12 students studying mathematics at an ‘advanced’ or ‘intermediate’ level and an increase in the proportion of students studying mathematics at an ‘elementary’ level has been observed in Australia (Barrington, 2006, 2011). Advanced and intermediate level courses are those expected to provide students with sufficient mathematical knowledge for pursuing courses such as economics, engineering and mathematics at university level. Although differences in enrolment reflect various local demographic situations and educational conditions, there is an overall national trend of falling enrolments in more advanced levels of mathematics in upper secondary school (Barrington, 2006). Ainley, Kos and Nicholas (2008) observe that decreasing enrolments in high level mathematics courses has been accompanied by a corresponding increase in the number of enrolments in elementary level course, with nearly 80% of all students enrolled in mathematics studying at the elementary level between 1998 and 2008. This trend is viewed positively in some Australian states such as Victoria where the rigour of its elementary mathematics course is emphasised (Sullivan, 2011). Maintaining student enrolments in mathematics regardless of the level taken is also important because enrolment in mathematics courses provides opportunities for continued participation as students progress through upper secondary school (from Year 11-12) and beyond (Sullivan, 2011).

Conversely, there is some concern that increases in enrolments in elementary courses is at the expense of enrolments in advanced courses as students who are capable of achieving in advanced level courses choose not to enrol in them (Prince, 2012). Student choice of mathematics course level has implications relating to preparation for future study, entry into university courses and career options linked to mathematics (Higgins, 2011; McPhan et al., 2008; Stanley, 2008; Tytler et al., 2008). Students’ study of mathematics is often associated with other STEM-related subjects and attrition rates in these areas have also been noted (Tytler et al., 2008). Student aspirations are a significant factor as they affect the subject choices made, often
decided at critical transition periods during schooling. The consequence of students’ developing aspirations for non-STEM related subjects as they move from primary to secondary school, is that the majority of the population are lost to STEM careers by the age of twenty (Tytler et al., 2008).

Although many students in Australian secondary schools believe mathematics is important and would like to do well, many also feel ambivalent towards it and do not find it interesting (Higgins, 2011). The same trends, however, are not replicated in all Western education systems. For example, a report by the National Council of Teachers of Mathematics [NCTM] (Dossey, Halvorsen, & McCrone, 2008) found that in the United States of America (USA), high school graduation requirements for mathematics have increased over the last twenty-five years, along with public awareness of the importance of mathematics for future careers. This has resulted in fewer students discontinuing early courses of mathematics such as Algebra 1 and 2, and a steady but significant increase of students taking high-level (equivalent to ‘intermediate’ and ‘advanced’) mathematics courses in later secondary school years (Dossey et al., 2008). Stakeholders in Australia have expressed a desire to understand why declining trends in mathematics participation have developed and aim to address the underlying issues to set the future direction for mathematics education on a national basis (COAG, 2008; 2005; Luke et al., 2003; Morony & Stocks, 2005; Tytler et al., 2008).

Prior achievement in mathematics also influences participation in related disciplines, notably science and technology (McPhan et al., 2008; Tytler et al., 2008). Ainley et al. (2008) found that levels of Year 12 student participation in science (particularly physics and chemistry) were strongly related to earlier achievements in Year 9 mathematics. Their research also found that between 2004 and 2006, students achieving highly in mathematics were eleven times more likely to study chemistry and up to fifteen times more likely to study physics in upper secondary years of school. This indicates a significant link between achievement in mathematics and science and emphasises the importance of student achievement in early secondary years in light of its influence on future subject choices.

*Declines in Mathematics Achievement*

It is during the transition from upper primary to lower secondary schooling that the most significant dips in learning are observed. Siemon (2001) reported a
statistically significant dip in numeracy performance when conducting a large-scale study of 7000 Year 5 to Year 9 Victorian school students. She found that between Years 6 and Year 7\(^3\) mean scores of basic numeracy tests fell from 55.7% to 52.7%, recovering somewhat to 54.7% in Year 8 and 55.9% in Year 9. A study by Cooney (2006) exploring the state-based standardised Basic Skills Tests in New South Wales (NSW) for Years 3, 5 and 7, found evidence that the benchmarks for each year level were not always set on the same foundations, thus obscuring the results. Williams, Wo and Lewis (2007) considered mathematics progression in a United Kingdom study (referred to as the ‘MaLT project’) and found that rates of progress in mathematics declined as students moved from primary to secondary school. The changes in median ability between Years 7, 8 and 9 were interpreted by Williams et al. (2007) as being influenced by older students’ exposure to a “different history of curriculum and instruction (and perhaps significantly a different relationship with a different peer group: the big fish/little pond effect)” (p. 136). While these studies present some ambiguity about dips in learning as students transit from primary to secondary school, they demonstrate the need to be vigilant about student mathematics progress (or lack of it) and to contemplate the possible reasons for fluctuations in students’ mathematics achievement over time.

Standardised national numeracy tests have been implemented in Australia for Years 3, 5, 7 and 9 since 2008. Initial national numeracy results revealed that although there was a slight fall in achievement of 2.4% between Year 3 (95%) and Year 5 (92.6%), there was a recovery of 2.8% in Year 7 (95.4%) before another fall of 1.8% in Year 9 (93.6%) (MCEETYA, 2008). The results of the national testing in 2011 indicated that on a national scale there were no gains in numeracy achievement from Years 3 to Year 5 or Year 7 to Year 9 between 2009 and 2011. Small gains were recorded for the cohort who was in Year 5 in 2009 and Year 7 in 2011. The time series data, which considers the result of national testing between 2008 and 2011, shows that there were no changes in Year 3, Year 7 or Year 9 numeracy achievement scores during this period. Improvements in Year 5 between 2008 and 2011 arise from gains in the period between 2008 and 2009, which were maintained (Australian Curriculum Assessment and Reporting Authority, 2011). The results indicate that numeracy achievement, as measured by these national tests, has been maintained (but

\(^3\) Year 6 is the last year of primary school and Year 7 is the first year of secondary school in Victoria.
not increased) over a four year period, however it is unclear if this is a positive result particularly in light of comparative and international testing regimes.

Results of Australian student performance in mathematics are also reflected in international comparative tests such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). The TIMSS and PISA tests allow for the tracking of student cohort performances over time. This provides information about trends in results and establishes a basis for comparing the performance of students in Australian schools to students in schools outside Australia.

The mathematics results of the 2007 TIMSS test confirmed that, although average scores for Year 4 students had increased since the last study undertaken in 2003, Australia was out-performed by England, the USA and all countries in Asia. The study of the results found that only 9% of Year 4 students in Australian schools reached the ‘advanced’ benchmark, which was below that of the highest scoring countries (Thomson, Wernert, Underwood, & Nicholas, 2007). More recent results for Year 8 mathematics students in Australian schools show that although achievement scores in 2011 were similar to those in 2003, they were below the mean score of six other countries. Achievement scores for mathematics have increased in a number of countries, particularly countries in Asia and the Russian Federation. As a result, these nations now significantly out-perform Australian students (Thomson et al., 2012).

A cause of further concern shown by the TIMSS results is the increased number of students not achieving proficiency levels, with 11% of students in Australian schools performing at low levels and another 26% below the intermediate levels. Although 9% of Australian students performed at advanced levels in mathematics, the top performing countries, being Korea, Singapore and Chinese Taipei dominated with almost half of their students performing at advanced levels (Thomson et al., 2012).

Findings from the PISA assessment carried out in 2009 reveal a statistically significant decline in the average performance of students in Australian schools in mathematical literacy. Overall, the 2009 PISA results show that Australia was outperformed by twelve countries, falling in both rank and mean score since the previous assessment. Further results show that, while there was no significant change in results between the 2003 and 2009 PISA tests at a level two proficiency (i.e., fairly proficient), proficiency at level five and above (i.e., very high proficiency) decreased
from 20% to 16% (Thomson et al., 2010). Falls in achievement since 2003 evidenced by the 2007 and 2011 TIMSS results and the 2009 PISA results signify a decade of falling performance in mathematics for students in Australian schools.

Declines in student mathematics achievement during primary and early secondary years of schooling (i.e., between Year 4 and Year 8) are particularly worrying when combined with evidence of deteriorating student interest in mathematics and the decrease in enrolments in advanced and intermediate mathematics courses in upper secondary years. However, factors other than achievement have also been considered as influencing student participation in mathematics and are discussed in the next section.

Other Factors Influencing Students’ Engagement in Mathematics

Fullarton (2002) who conducted longitudinal research involving Year 9 students using survey and telephone interviews, considered a range of student and school-level variables that might influence student engagement at school. School-level factors included characteristics of the school (e.g., school sector, gender mix and size) and teacher factors such as perceived class and school climate, parental involvement, work relationships and success of the school. Fullarton aggregated the school-level factors to become a “proxy, contextual measure of a school’s normative environment” (2002, p. vi). This measure was useful for determining that a school’s environment does influence student engagement. It was found that some schools were more effective at promoting student engagement than others.

Student-level factors identified in Fullarton’s study (2002) included background and contextual factors such as gender, socioeconomic status, indigenous status, the parent’s education level, home language, the student’s aspirations and the parent’s birthplace. Other student-level factors included the student’s attitudes, self-concept of ability, perceptions of class and school climate, quality of school life and their achievement. Fullarton found that student’ perceptions of school climate, self-concepts of ability and intrinsic motivation had an effect on student engagement in addition to their gender and parents’ educational level.

Fullarton’s (2002) report highlights factors for individual students such as their self-concept and intrinsic motivation that influence student engagement in mathematics classrooms. More recent research suggests that a student’s attitudes, values, interest and emotions also influence their learning outcomes (Hannula, 2004;
Understanding the range of factors perceived by students is relevant and beneficial, as school cultures that acknowledge individual students’ views and perceptions have a better chance of engaging and motivating students to be active participants in their learning (Boaler, 2002; Martin & Marsh, 2005).

Student perceptions of mathematics are particularly significant because “mathematics is not generally perceived as a popular subject among young people” (COAG, 2008, p. 1). Students are less likely to continue studying mathematics voluntarily if they do not enjoy mathematics, fail to see its relevance and lack confidence about their achievement (Sullivan et al., 2006). Therefore students’ perceptions of mathematics are relevant both for their immediate learning outcomes and for maintaining participation in mathematics study in the longer term. Those students who are realistic about their ability in mathematics and have positive expectations are more likely to engage and persevere with challenging courses and better understand the role of mathematics beyond school (McPhan et al., 2008).

Emotions are understood to be integral to cognitive processing and guide self-regulated behaviours and cognitive goals (Hannula, 2006a). Therefore a student’s emotions may be aroused when trying to recall mathematical facts, procedures or more complex mathematics such as solving problems or ‘understanding’ concepts. Different norms and individual coping strategies for emotions mean that it is difficult to determine if certain emotions facilitate types of cognitive processing. However, research has confirmed that awareness of student emotions is important and addressing student emotional needs is one way that teachers can support their motivation and engagement in mathematics tasks (Hannula, 2006a; Linnenbrink-Garcia & Pekrun, 2011).

Studies (Khoo & Ainley, 2005; Rothman & McMillan, 2003) have established that student attitudes toward school influence their intentions to stay at school and their level of participation while at school. Further, positive attitudes towards school in Year 9 have been found to have a significant influence on participation in late secondary school. Positive attitudes are related to supportive relationships with teachers, as well as interest and value in applying learning outside of school (Hillman, 2010). Importantly, intentions to stay at school are formed early in secondary schooling, suggesting that engagement in school and positive attitudes also contribute to the decision to complete Year 12 (Hillman, 2010; Khoo & Ainley, 2005; Martin et al., 2012; McPhan et al., 2008). This is significant given that the students most at risk
of becoming disengaged from school, whether through at-risk behaviours or passively through withdrawal or failure to learn, are those in the middle years (Russell, Mackay, & Jane, 2003).

**Students in the Middle Years**

The association between achievement in mathematics and future intentions of studying mathematics highlights a need to examine mathematics instruction and student perceptions of mathematics specific to student groups, such as those in the middle years. The middle years of schooling are those between late primary to early secondary schooling when students are approximately 10-15 years of age. The middle years include the transition from one school setting to another and generally reflect a period of marked change for students. Changes in students’ physical, cognitive, social and psychological characteristics and needs as they experience adolescence are well documented (Arnold, 2000; Barratt, 1998; Dinham & Rowe, 2007; Hill & Russell, 1999).

A major concern during the middle years of schooling is the less than optimal progress in literacy and mathematics, when assessed by both national tests such as NAPLAN, and international tests such as TIMSS and PISA. In addition, attitudes and behaviours of students reflect declining engagement in school during this period. While many students may be distracted from academic achievement in the middle years, the reported dips in learning (Hill et al., 1993) appear to be more significant than can be accounted for as a stage in development. In their report on middle schooling, Dinham and Rowe (2007) identify the transition from primary to secondary school as a key concern, noting evidence of student achievement levels reaching a plateau or beginning to decline. Dinham and Rowe suggest that while some students find academic content in secondary school to be more conceptually difficult, others find expectations and standards too low. The wide range of achievement often found in classrooms, presents a dichotomy as students may disengage either because they struggle to understand or are bored by the lack of challenge. This underscores the need for using effective teaching practices to maintain engagement in mathematics.

Raphael, Pressley and Mohen (2008) summarised literature about middle school instructions and found that many middle school environments can potentially undermine student engagement. For example, low level tasks can reduce on-task behaviour and the size and impersonal structure of middle school may fail to meet
students’ relational needs. Increased workloads, more difficult content and rigorous grading structures are also noted during this time (Jang, 2008). Raphael et al. (2008) also note that teacher practices in early secondary years tend to emphasise competitive learning environments with goal orientations focused on gaining ‘good’ grades rather than understanding and can lead to students giving up if they fail or feel they cannot achieve expected grades. The image of mathematics has also been noted as problematic amongst students to the extent that peers can negatively influence mathematics engagement (McPhan et al., 2008; Sullivan & McDonough, 2007).

Although there are numerous school, classroom and individual-level factors that potentially threaten student engagement, the fact that many middle years students are academically engaged indicates that there are also factors that can enhance student engagement. A key purpose of the present study is to identify the factors that students perceive as relevant to their mathematics experiences so that factors that inhibit and promote engagement can be effectively addressed. Additionally, identifying teaching practices that support student motivation for learning mathematics is important and hence another aim of this study is to investigate the beliefs and practices of teachers for promoting engagement when supporting students with different levels of achievement.

The Nature of Mathematics

Another consideration for mathematics learning and achievement is the nature of mathematics as a subject distinct from other disciplines. Mathematics requires an “understanding and reasoning about real and imagined objects, and is defined by a range of different kinds of knowledge…” (Higgins, 2011, p. 5). Students need to be appropriately guided to make connections between mathematical components and build a hierarchical understanding of the kinds of mathematical knowledge to develop proficiency and its appropriate application (Higgins, 2011).

Watson (2010) identifies difficulties adolescent students may encounter with mathematics as they enter secondary school that often require students to think differently about mathematics compared to primary school mathematics. She suggests that students need help to: (a) deal with unfamiliar and familiar situations; (b) deliberate on imagined and abstract ideas; (c) use informed reasoning and intuition; and (d) consider abstract and social implications and not just react or act on immediate responses (Watson, 2010). Therefore, teacher practices that support
students’ thinking and reasoning about mathematics help meet their cognitive needs as well as motivational needs and are an important aspect of mathematics learning.

Despite perceptions of mathematics as being a difficult discipline to master and teach (COAG, 2008), many students perceive it as being useful, valuable and worthy of investing time and effort (Hardré, 2011). With a view to supporting and maintaining student engagement over time in mathematics, Sullivan (2011) proposes different perspectives of mathematics based on its purpose at different stages of schooling. In one sense, the goal of mathematics is viewed as being functional or practical, while in another, the aim is to maintain mathematical rigor. Sullivan argues that both can be addressed and “that all students should experience not only practical uses of mathematics but also the more formal aspects that lay the foundations for later mathematics and related study” (2011, p. 4). Sullivan proposes that the practical perspective of mathematics is the appropriate priority in the compulsory years. By contrast, in post compulsory years, specialised mathematics knowledge (more suited to university courses such as engineering and mathematics) such as an ability to pose and solve problems, appreciate the contribution of mathematics to culture, the nature of reasoning and the appreciation of mathematical ideas should be the focus. This suggests ways to maintain student participation and interest in mathematics throughout the years when mathematics is compulsory and to potentially influence students’ decisions about future mathematics study.

Conclusion

This chapter has discussed a range of issues that are currently relevant to student engagement and achievement in mathematics particularly in the middle years. Concerns about falling participation and achievement have been well documented and there is little to suggest that these declines will abate. Further, identification of the issues surrounding declines in participation and achievement do not explain why students are failing to remain engaged in mathematics learning. Issues other than achievement have been identified as important for students, such as their interest, values, and interactions with teachers and how their motivational and learning needs are being met. Despite identifying these issues, the causes of student disengagement and engagement in mathematics are still not clear. There is need for further research
that not only identifies factors influencing student engagement but also explores the importance of particular factors and how they may be relevant to individual students.

In light of this, a central aim of the present study is to better understand students’ experiences with school mathematics by obtaining detailed information about their engagement. To do this, perceptions of student engagement are sought from two perspectives to establish a comprehensive range of individual and classroom level factors influencing student engagement in mathematics. Students’ perceptions of their mathematical ability, their feelings and behaviours towards mathematics and their views about mathematics teaching are sought to elicit the most significant experiences and contextual factors relevant to engagement. To complement information from students, teachers’ perceptions of student engagement and disengagement in mathematics are also sought. The teacher is a central factor to students’ mathematical experiences. Understanding how teachers perceive student engagement and how they motivationally support student engagement in mathematics is a significant part of this inquiry.

This present study is therefore interested in exploring underlying motivational and contextual factors to understand those that are most significant for influencing student engagement and achievement in mathematics. The next chapter explores in detail the relationship between motivation, engagement and achievement.
Chapter 2

Engagement and Motivation

A key challenge and arguably one of the most pivotal for student educational outcomes is identifying the appropriate factors that influence student engagement in academic settings. The aim of the present research is to investigate the factors that influence student engagement in mathematics from a qualitative perspective to elicit more concise and intricate descriptions of how motivational factors influence engagement that, in turn, facilitate or inhibit mathematics achievement.

The purpose of this chapter is to explore relevant literature and to justify the use of two complementary frameworks used to investigate student engagement and motivation in mathematics. First, the relationship between engagement and motivation is clarified. Next, definitions and conceptualisations of engagement and motivation are reviewed. Then, the choice of frameworks used for the theoretical perspective of the present study are described and justified.

As there are no existing theoretical frameworks for motivation and engagement that specifically relate to mathematics, two complementary frameworks are used. The first framework describes and clarifies types of student engagement (Fredricks, Blumenfeld, Friedel, & Paris, 2005; Fredricks et al., 2004), framing it as a meta-construct. The second organises dimensions of academic motivation and engagement within a higher and lower order construct framework (Martin, 2003, 2007). The two frameworks discussed throughout this chapter are used as guiding scaffolds to consider constructs that span adaptive and maladaptive dimensions. This provides a basis for deeper inquiry by assessing underlying motivational factors for engagement and disengagement in mathematics.

The Relationship between Engagement and Motivation

Although researchers adopt different conceptual approaches when investigating motivation and engagement, the relationship between the two constructs is broadly agreed upon. Motivation is concerned with psychological processes that are the underlying sources of energy displayed by visible engagement characteristics
(Skinner & Pitzer, 2012). Motivation is considered to underpin engagement, creating a cycle or loop in which motivation and engagement are inherently linked to learning outcomes (Martin, 2012). Although linked, motivation and engagement are viewed as distinct: motivation is viewed as encompassing the internal, private and unobservable factors of the outer, public and observable engagement.

Certain features are shared between engagement and motivation because motivation refers to the underlying sources of energy that are reflected as engagement characteristics. For example, persistence (being an adaptive motivation) may be observed by time spent on tasks and asking questions, which are also characteristics of behavioural engagement. However, because engagement reflects an individual’s interaction within contexts it is more obviously connected to the learning environment (Fredricks & McColskey, 2012; Fredricks et al., 2004), while the underlying motivational processes influencing engagement may be harder to determine.

The close relationship between motivation and engagement highlights the difficulties of distinguishing between the two and how they are differentiated ultimately depends on the conceptualisation and definitions applied by researchers. The focus of researchers on either motivation or engagement influences their perspective because “those who study motivation are interested in engagement mostly as an outcome of motivational processes, whereas those who study engagement are interested mostly in motivation as a source of engagement” (Reeve, 2012, p. 151).

Therefore, the present study seeks to consider engagement and motivation together, by using two frameworks. One framework provides detailed definitions of the types of engagement and the other identifies motivational factors underlying engagement. These two frameworks complement each other and add clarity about specific motivational sources of student engagement in mathematics. The following sections of this chapter address engagement and motivation in a context specific to the present study.

Engagement

Development of the Engagement Construct

Early conceptualisations of engagement emphasised student behaviour in and identification with school, measured by variables of engagement relevant to school dropout and completion (Finn, 1989). The concept of engagement was extended by
Finn and Voelkl (1993) to include both behavioural and affective or psychological components that are viewed as mutually beneficial. For example, participation over time leads to school identification and a sense of identification can perpetuate active participation. Accordingly, indicators of behavioural engagement include attendance at school, tardiness in class, preparedness for learning, and misbehaviour. Emotional indicators of engagement incorporate student-teacher relationships and include a sense of school community (Finn & Voelkl, 1993).

Contemporary conceptualisations of student engagement emphasise its influence on academic achievement rather than behaviours. Contributions to the development of the engagement construct arise from two different sources. First, from the interest of educators who seek to better understand student achievement in learning contexts, and secondly, from educational and development psychologists in the field of motivation who are interested in achievement motivation.

**Academic Achievement**

Newmann, Wehlage and Lamborn (1992) describe engagement in academic work as the “student’s psychological investment in and efforts directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote” (p. 12). This indicates that engagement in academic work requires action and thoughts and that the psychological investment of engagement extends beyond striving to complete tasks or to achieve high grades (Newmann et al., 1992). Further, since characteristics of engagement such as effort and investment in learning are not readily observable, “levels of engagement must be estimated or inferred from indirect indicators such as the amount of participation, the intensity of student concentration, the enthusiasm and interest expressed, and the degree of care shown in academic work” (Newmann et al., 1992, p. 13). Therefore, recognising that student engagement is informed by emotions and thoughts about learning as well active participation, has contributed to theorising and defining types of engagement.

**Defining Engagement**

Despite variations in terms and definitions for engagement used by researchers, there is a general agreement that engagement includes behavioural, emotional, and cognitive components that operate together and reflect students’
engagement in school activities. The comprehensive review of engagement by Fredricks et al. (2004) has been pivotal in establishing a framework that delineates the distinctions between types of engagement and the multidimensional ways in which they operate. Their review establishes key conceptual factors relevant to engagement such as its duration, frequency and intensity. Importantly Fredricks et al. (2004) also consider student achievement in academic settings and contextual factors that influence student engagement. A main aim of the present research is to explore student engagement from a multidimensional perspective and to illuminate how particular types of engagement and varying levels of intensity operate in mathematics classrooms. The definitions and conceptual factors of engagement that form the basis of the Fredricks et al. (2004) framework are therefore appropriate to use in the present study.

*Types of Engagement*

Fredricks et al. (2004) define behavioural engagement as the participation and involvement of students in academic, social or extra-curricular activities associated with school. This includes participation in class, observing school rules and classroom norms and taking part in school related activities outside of the classroom. The idea of involvement goes beyond mere positive conduct extending to students’ application of learning and activities which may require “effort, persistence, concentration, attention, asking questions and contributing to class discussion” (Fredricks et al., 2004, p. 62).

Fredricks et al. (2004) found overlaps with motivation research concerned with psychological investment in learning when considering cognitive engagement, namely intrinsic motivation (where a person is motivated by internal factors e.g., for mastery), goal theory and self-regulated learning. Investment in thinking, processing and managing information and a willingness to master difficult skills and comprehend complex ideas are therefore seen to be hallmarks of cognitively engaged students (Fredricks et al., 2005).

Emotional engagement is concerned with students’ positive and negative affective reactions to teachers, schoolwork, class peers and school. Fredricks et al. (2004) found that many of the constructs reviewed as part of emotional engagement (including interest, boredom, happiness, sadness, anxiety, feelings of identification, belonging and value) were linked to constructs used in motivation research on
attitudes, interest and value. At the time of their research, Fredricks et al. (2004) discovered that definitions of emotion in engagement research were not particularly elaborate and lacked clear differentiation. However, since 2004, research exploring the role of emotions on levels of motivation and achievement outcomes has flourished (Linnenbrink-Garcia & Pekrun, 2011; Linnenbrink, 2006; Schorr & Goldin, 2008). Although emotions have been characterised as relatively unstable and short lived (McLeod, 1992), there is increasing interest in the longer term effect of emotions and how they shape student engagement. This includes considering the range of emotions and the level of specificity by which to consider their function as influencing academic outcomes (Linnenbrink-Garcia & Pekrun, 2011; Skinner & Pitzer, 2012). Additionally, factors such as attitudes, interest, beliefs and identity have all been noted by researchers as important issues for mathematics education (Grootenboer, Lomas, & Ingram, 2008; Lomas, Grootenboer, & Attard, 2012).

A summary of the three types of engagement described by Fredricks et al. (2004) is presented in Table 2.1. The adoption of the Fredricks et al. (2004) engagement framework by other researchers in the field is helpful in establishing its appropriateness for concepts associated with engagement. The framework has been adopted in various ways including extending our understanding of the range of student engagement (Bryson & Hand 2007); developing instruments and methods to measure (Appleton, Christenson, Kim, & Reschly, 2006; Fredricks et al., 2005; Kong et al., 2003; Lutz et al., 2010) and perceive (Hardré, 2011; Hardré et al., 2008) student engagement; appreciating the influence of engagement on learning and achievement (Frydenberg, Ainley, & Russell, 2005); viewing the relationship between goal orientations and engagement (Anderman & Patrick, 2012); academic emotions and their function for engagement (Pekrun & Linnenbrink-Garcia, 2012) and methods to improve engagement through teacher-student relationships (Marshman, 2010).

<table>
<thead>
<tr>
<th>Table 2.1 Types of Engagement (Fredricks et al., 2004)</th>
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<tr>
<td><strong>Types of Engagement</strong></td>
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<tr>
<td>Behavioural Engagement</td>
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<td>Cognitive Engagement</td>
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<td>Emotional Engagement</td>
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<td>Participation Involvement</td>
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<td>Goals</td>
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<td>Motivation</td>
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Justification of the First Theoretical Framework

Although Fredricks et al. (2004) provide definitions of three types of engagement they emphasise that what makes engagement unique is its potential as a multidimensional construct. As all types of engagement are seen to operate within individuals this is one of the reasons that the Fredricks et al. (2004) engagement framework has been selected for the present qualitative investigation of student engagement in mathematics.

A further reason for selecting the Fredricks et al. (2004) engagement framework is the emphasis it places on engagement occurring in context. As students are engaged in tasks, activities and relationships within school settings, engagement is seen as inseparable from the classroom environment. Although the Fredricks et al. (2004) engagement framework is generalised, it considers a multitude of factors influencing educational outcomes and these can be applied to specific subject areas including mathematics. As a result classroom level factors such as the influence of the classroom environment, teacher instruction, and inter-personal relationships, in addition to individual factors are accommodated within the framework.

Another reason for using the Fredricks et al. (2004) engagement framework is that student actions and the way they approach tasks are seen to be influenced by what they think and feel (motivation). Therefore engagement reflects more than participatory components and includes cognitive and emotional aspects fuelled by a “proliferation of motivational constructs” and “underlying psychological processes” (Fredricks & McColskey, 2012, p. 765). The importance placed on the relationship between motivation and engagement emphasises individual differences amongst students and the underlying direction, intensity, and quality of the energies that drive action. Measures of motivational factors have been incorporated to assess behavioural, emotional and cognitive dimensions of engagement in more recent engagement research (Fredricks & McColskey, 2012). The inclusion of motivational measures reflects the distinct and formative relationship between motivation and engagement.

Perceptions of Student Engagement

Investigating student and teacher perceptions of engagement and motivation in mathematics is a major focus of this study. Perceptions are understood to be personal in nature because individuals interpret factors and respond to their environments
through personal ‘filters’ (Broadbent, 1958; Spudich & Spudich, 2009). For research purposes self-reports provide accurate and detailed sources of information because perceptions are highly individualistic. Self-reports are commonly used for assessing student engagement and are upheld as appropriate methods for sourcing perceptions because “students are able to accurately report on their own engagement and environments” (Reschly & Christenson, 2012, p. 9). Some researchers view student self-reports as critically important for assessing aspects of engagement that are not easily observable, such as emotional and cognitive engagement (Appleton et al., 2006; Fredricks & McColskey, 2012). This includes gaining insight into students’ subjective experiences of negative emotions and motivations that are central to understanding disaffection in school mathematics (Attard, 2011; Lewis, 2013).

Insights into teacher perceptions of student engagement are also important. Hardré (2011) argues that if teachers know how their students are motivated they will be able to motivate them more effectively. The present study seeks perceptions of student engagement from both the student’s and their teacher’s view from within the same classroom setting. Both views are sought to gain a more accurate account of student engagement from divergent perspectives, rather than assuming that students and teachers perceive student engagement in one or the same way.

Self-report assessments for engagement have often been obtained through survey measures, sampling, teacher ratings, and interviews. Although time consuming, interviews allow for detailed and descriptive accounts of how students explain their school experiences. Therefore, in qualitative studies such as the present one, using in-depth interviews with both the students and their teachers is critical for eliciting individual and classroom level perceptions of engagement, motivation and contextual factors. Specifically, sources of complexity relating to engagement, such as its duration, intensity and variability can be pursued through in-depth interviewing.

**Characteristics of Engagement**

**Duration and intensity**

Duration of engagement considers whether it is specific to a moment in time and a particular event or whether it is thought of more long term being something that individuals develop over time or with repeated experiences of engagement. Research undertaken for the National Survey of Student Engagement (NSSE) views student
engagement as dynamic and ongoing, “not just a single course … but a pattern of involvement in a variety of activities” (Smith et al., 2005, p. 87).

The intensity of the experiences students encounter is also an important consideration. Fredricks et al. (2004) discuss the possibility that degrees of investment or commitment in engagement exist—and exist for all types of engagement. For example, in relation to behavioural engagement, a student may complete work as required (low investment) or take a proactive role such as asking questions (high investment). Or, in relation to cognitive engagement, a student may memorise information (low investment) or use learning strategies to develop understanding and expertise (high investment). Hughes, Luo, Kwok and Loyd (2008) also acknowledge and differentiate between the quality and intensity of engagement. They use the term ‘effortful engagement’ to denote the volition of students to direct their attention to instructional activities and to try hard and not give up when facing difficulties. Effort and persistence reflect motivational factors and although based on an individual’s temperament and attention capacities these tend to develop over time and in conjunction with classroom experiences and interaction with teachers.

Changeability and variability

Students may at any one time exhibit different types of engagement at varying levels of intensity that suggests a complex matrix of permutations. For example, a competent mathematics student who does not particularly enjoy mathematics (low emotional engagement) but who is learning to apply Pythagoras’ theorem for the first time, may actively listen (high behavioural engagement) and take notes as they are aware that the current topic is an important part of the curriculum (high cognitive engagement). In the following lesson, the same student may exhibit happiness (high emotional engagement) at having mastered applying the theorem when completing homework (high cognitive engagement) and subsequently pay less attention in class, taking no notes but answering questions when asked (low behavioural engagement). Williams and Ivey (2001) report on the changing patterns of engagement for one student, Bryan. They observed Bryan’s variable behaviour in mathematics classes and were interested to explore the cause of changes in types and levels of his engagement, concluding that his engagement was of a “personal idiosyncratic nature” (2001, p. 76).
It is proposed that the same student may engage at a number of levels, exhibiting different degrees or intensities of engagement towards an activity, module, course and university (Bryson & Hand 2007). It is because of these infinite variations in the underlying causes of types and intensities of engagement that it is difficult if not erroneous, to label a student as being ‘engaged’ or ‘disengaged’ in mathematics.

Influential external factors including the context in which the student is operating, interactions with peers and teachers within the classroom and relationships with parents and school, also influence student engagement. William and Ivey (2001) suggest that as internal and external factors fluctuate, with some more stable than others, engagement is expected to oscillate. There are potential benefits to the changeable nature of engagement, as the idea that engagement is variable also implies that it is malleable (Fredricks et al., 2004). Malleability is viewed as a positive phenomenon because planning and implementation of intervention programs to address underlying factors of engagement, achievement, intentions and future aspirations can occur (Hardré & Sullivan, 2009).

This present research seeks to identify the range of internal motivational factors that influence student engagement particular to mathematics to better understand the idiosyncratic nature of individual engagement. This includes investigating varying levels of student engagement between ‘full engagement’ and ‘disengagement’.

Continuum and continua

Researchers hold divergent views of the engagement construct. Some view engagement as a separate construct from disengagement, while others interpret it as belonging to a continuum ranging from disengagement to engagement. Newmann (1992) regards engagement as lying on a “continuum from more or less…not as a state of being engaged or unengaged” (p. 13). Fredricks et al. (2004) discuss qualitative differences in levels of engagement at length and note the importance of being able to “distinguish the degree of behavioural, emotional or cognitive investment or commitment” (p. 69) that supports the view that degrees or levels of intensity apply not just to engagement but also to specific types of engagement. Bryson and Hand (2007) propose that student engagement lies on a continuum from disengaged to engaged and that it exists at a number of levels with students exhibiting different degrees of engagement.
Whether engagement is viewed as a single continuum or separate engagement and disengagement continua (Reschly & Christenson, 2012) clear demarcations for distinguishing between students who are becoming more or less engaged are important for addressing student learning outcomes. From a practical perspective the types of support and interventions for students with different engagement levels in mathematics are likely to vary. For example, students with low levels of engagement may exhibit behaviours, emotions and thoughts about mathematics less positively than students who are highly engaged but more positively than students who are disengaged. Alternatively students who are disengaged may present with a set of unique factors that require addressing in distinct ways (Martin et al., 2012).

For example, specific factors such as mathematics self-efficacy, value, enjoyment perceived classroom enjoyment and parent interest are found to be significant predictors for future intent and disengagement (Martin et al., 2012). Further investigation reveals that adaptive behavioural factors such as planning and task management decrease during early secondary school and an increase in maladaptive factors such as anxiety, uncertain control and failure avoidance are also evident (Plenty & Heubeck, 2013). This research further suggests “relative deficits in mathematics motivation may be construct specific rather than generalised across all aspects of motivation” (Plenty & Heubeck, 2013, p. 15) and illustrates the importance of research that investigates links between motivational factors and types of student engagement. This is critical for uncovering influential factors specific to mathematics that may not necessarily arise in generalised motivation and engagement research.

Many authors view engagement and disengagement as complex concepts and not as simple ‘on/off’ states (Hockings, Cooke, Yamashita, McGinty, & Bowl, 2008). Students who took part in Nardi and Steward’s (2003) study indicated low levels of academic engagement—behavioural, emotional and cognitive factors and were all described as disaffected. However, disaffected students were seen as distinct from students who were disengaged as they were overtly disruptive or often absent from classes or school. By contrast, Nardi and Steward (2003) report disaffected students being behaviourally compliant but appear to have low levels of interest and investment in learning (Hockings et al., 2008; Nardi & Steward, 2003). This research confirms that levels of student engagement and disengagement are difficult to determine because types of engagement fluctuate. A key to understanding why and how the degree of engagement and disengagement fluctuates is to explore the causes
and reasons which lie beneath it (Hockings et al., 2008) and is a central focus of the present study.

Distinguishing between the characteristics of students who are not academically engaged, disaffected or alienated from school, as distinct from those who are deemed ‘disengaged’ is critical for mathematics education. An important part of this research is to investigate causes of shifts in levels of engagement, with the view to addressing declines in engagement before students become “seriously” or “chronically” disengaged (Hardré & Sullivan, 2008) or start to “switch off” (Hockings et al., 2008; Martin et al., 2012) in mathematics. Hence, the terms ‘engaging’, ‘disengaging’ and ‘achieving’ are used in the present study, rather than ‘engaged’, ‘disengaged and ‘achievement’ as these represent the shifting rather than fixed nature of these student characteristics.

**Motivation**

The role motivation plays in student engagement is an important foundation for the present study. Motivation explains why individuals behave in certain ways in certain situations and is “used to describe, literally, what moves learners” (Mason & Johnston-Wilder, 2004a, p. 99). As motivation drives action, it reflects an individual’s beliefs about what is and is not important, therefore determining if one will or will not engage (Middleton & Spanias, 1999). However, motivation reflects internal characteristics (Hardré et al., 2008) that are “only partially accessible to introspection” (Hannula, 2006b, p. 166; Newmann et al., 1992) and therefore determining key motivational factors influencing individual engagement is complex.

*Developments in Motivation*

In the past, motivation for learning was viewed in a mechanistic way, implying that a student’s drive (linked to their needs) was the source of energy for behaviour that varies both in terms of its intensity and duration. From this viewpoint, the teacher’s role is to facilitate learning and student outcomes that are essentially dependent on the degree to which motivated students take advantage of learning experiences. Therefore, although teachers were seen to influence learning, this did not necessarily extend to motivation (Galloway, Rogers, Armstrong, Leo, & Jackson, 2004).
Over time, research from the field of psychology, primarily interested in academic motivation has influenced thinking about student engagement (Reschly & Christenson, 2012; Stipek et al., 1998). The motivation perspective on engagement identifies that sources of motivation can arise from different foundations such as needs, goals, cognitions, emotions and environmental factors. The majority of motivation theories tend to focus on one source of motivation to understand the psychological characteristics that influence academic success.

For example, achievement goal theorists are concerned with examining avoidance and approach components of mastery and performance goal orientations that influence student academic achievement and engagement (Anderman & Patrick, 2012). Needs theory, which form part of Self Determination Theory, identifies three basic psychological needs of individuals—autonomy, competence and relatedness—as inherent sources of internal motivation that need to be met (Deci & Ryan, 2000). Expectancy-value theory considers an individual’s perspective on task choice and task engagement taking into account personal agency, external forces and contexts for determining levels of motivation (Eccles & Wang, 2012; Eccles & Wigfield, 2002). Self-regulation theory is essentially concerned with how individuals engage in strategic thinking, encompassing processes such as how information is stored, which cognitive strategies are used, as well as self-efficacy beliefs, interest, values and goals (Cleary & Zimmerman, 2012; Zimmerman, 2002). Although only a few motivational theories have been mentioned here, each emphasise that motivation arises from different sources, such as needs, cognitions, goals and emotions and involve some form of action that share features with engagement (Skinner & Pitzer, 2012).

Emotions are also viewed as providing clues for behaviours given their influence on motivation (Linnenbrink-Garcia & Pekrun, 2011). Emotions are seen to derive from different origins but are often viewed as positive (e.g., enjoyment, pride, satisfaction) or negative (e.g., anger, anxiety and frustration). Further, emotions linked to content or topics are also relevant as they can strongly influence engagement by affecting a student’s interest and motivation in particular domains. This is particularly relevant to subjects such as mathematics where previous research has identified students’ dislikes, frustrations and boredom as influencing their views about mathematics (Brown et al., 2008).

Emotions are important when considering classroom activities as they are bound to the context (Meyer & Turner, 2006) and “infused in classroom life, playing
central roles in social interaction (both peer-to peer and teacher–student), cognitive processing, and student engagement” (Linnenbrink-Garcia & Pekrun, 2011, p. 3). Importantly, Hannula (2006a, 2006b) argues that in terms of learning processes, cognition, motivation and emotion should be considered as integrated and the relations between them better understood. This is because emotional responses, which are intrinsically linked to motivation, can influence cognitive processing. This draws attention to the role of emotions and their effect on cognitive processing which Hannula suggests can be positively influenced by creating learning contexts that sustain engagement such as staying on tasks and working intensely when students “find a safe environment and support for their emotional regulation” (2006b, p. 226).

Research in the field of psychological motivation is also associated with academic motivation in learning environments. Examining student motivation and engagement within learning contexts is viewed as critically important from socio-cognitive research perspectives. For example, Anderman and Patrick (2012) whose research is grounded in goal theory, observe overlaps with constructs from engagement theory. They also view achievement theory as related to student engagement, and adopt Fredricks et al. (2004) engagement framework to explore the relations between goal orientations and engagement (Anderman & Patrick, 2012). Cleary and Zimmerman (2012) acknowledge that engagement is a broad multidimensional construct and that student self-regulation emphasises cognitive processes and related motivation beliefs that influence the strategies that students use for cognitive engagement.

Sources of student motivation are tempered by experiences of success and failure (Anderman & Patrick, 2012). How students attribute success and failure to ability and effort ultimately determines how an individual will engage in tasks and activities. Therefore, there is a need to more clearly understand how motivational factors and processes influence student engagement in educational settings. This is because individual differences in motivation are due to “how children adapt to a particular situation” rather “than in terms of their level of motivations” (Galloway et al., 2004). In learning contexts, this extends to include the classroom environment and interpersonal relationships as “teachers, and the school ethos and setting play a significant role in motivating and demotivating … through subtle, covert features of ways of working and interacting with learners, and overtly through the provisions of examples and contexts” (Mason & Johnston-Wilder, 2004a, p. 99).
In summary, two important aspects of motivation are identified: (a) that promoting effective motivation and engagement are important objectives of learning in addition to being important processes for improved learning outcomes and (b) that the influence of motivational factors are highly individualistic and therefore are as important for low achieving students as they are for high achieving ones. These aspects are relevant to the present study as factors influencing individual levels of motivation are sought with a focus on establishing if these are similar or different amongst low and high achieving students. Another aim of the present research is to identify motivational factors that are effective for maintaining engagement by determining the presence and prevalence of adaptive and maladaptive factors and how these influence individual achievement outcomes.

In the present study, contemporary views of motivation acknowledge cognitive elements and the importance of context and factors influencing students in learning settings. Current views of achievement motivation are relevant to the present study as individual and classroom level factors are examined to determine the influence they have on student engagement and achievement in mathematics classrooms. It is also pertinent to consider all sources of student motivation, rather than focus on just one or two. This justifies the need for a framework to bring together motivational theories and synthesise the range of factors prominent in motivational research. Comprehensive frameworks considering multiple theories of motivation are also consistent with the multidimensional view of engagement theory.

The Motivation and Engagement Wheel

A framework for considering multiple motivation theories is posited by Martin (2003, 2007), who extends the idea of motivation and engagement as a multidimensional construct (Martin, Bobis, Anderson, Way, & Vellar, 2011). Martin notes significant commonalities across a number of psychological theories and models and blends them into one framework, known as the ‘Motivation and Engagement Wheel’ (2007). It is both this diversity of motivational and engagement factors and conceptualisation of them as adaptive or maladaptive that renders Martin’s Motivation and Engagement Wheel (2007) an appropriate framework to consider student engagement in mathematics. For these reasons, Martin’s Motivation and Engagement Wheel (2007) is included as the second framework supporting the theoretical approach of the present research.
The Motivation and Engagement Wheel (Martin, 2007) captures eleven factors influencing student engagement and motivation and organises these according to adaptive and maladaptive cognitions and behaviours. It therefore presents a structure by which students’ thoughts and actions can be ascertained. The supporting measurement instrument for Martin’s Wheel is the Motivation and Engagement Scale (MES) (Martin, 2003). While the MES is domain general, it can be tailored to specific subjects and is linked to one of the theoretical frameworks for the present study.

The Motivation and Engagement Wheel (Martin, 2007) as set out in Figure 2.1, reflects three levels of thinking about the relationship between factors of engagement and motivation. The first level outlines elements of cognition and behaviour dimensions derived from research in learning strategies, environmental demands, engagement and academic engagement. The second level demonstrates distinct aspects of motivation and engagement as being adaptive or maladaptive. The third level determines the structure of motivation and engagement frameworks, which essentially depicts hierarchical models of thinking and behaviour with broad characteristics supported by specific factors (Martin, 2009).

The framework, directed by the three levels of thinking are synthesised by Martin (2007, 2009). He proposes that motivation and engagement can be characterised in terms of both cognitive and behavioural constructs, therefore reflecting the relationship between motives and actions. At the same time, Martin (2007, 2009) captures the breadth of each of the constructs by including both adaptive and maladaptive dimensions. There are four ‘higher-order dimensions’; ‘adaptive cognition’, ‘adaptive behaviour’, ‘maladaptive cognition’ and ‘maladaptive behaviour’. Each of these higher-order dimensions encompass several first-order factors that are the specifics of an individual’s thoughts and actions drawn from relevant research.

There are many theoretical orientations underpinning the component first-order factors identified on the Motivation and Engagement Wheel (Martin, 2007) and it is therefore proposed as an “encompassing and integrative way to understand the diversity of psychological and engagement dimensions” (Martin & Marsh, 2006, p. 268). As described in Martin (2003, 2009), these include: self-efficacy (Bandura, 1997) represented in the ‘self-efficacy’ dimension; expectancy-value theory (Eccles & Wigfield, 2002) represented in the ‘valuing of school’ dimension; attribution theory and control theory (Connell, 1990; Skinner, Wellborn, & Connell, 1990) represented

The underlying theoretical orientations are reflected in the four higher-order and eleven first-order factors. The adaptive cognitions include self-efficacy, mastery orientation and valuing. Self-efficacy reflects a student’s belief in their ability to understand and succeed in their schoolwork. Mastery orientation refers to a student’s focus on understanding and mastery over performance, learning and developing skills and on solving problems. Valuing refers to how much students believe that school is useful, important and relevant. The adaptive behaviours include persistence, planning and task management. Persistence reflects a student’s propensity to persevere with a task even when facing difficulties. Planning refers to how much a student plans his or
her work and monitors his or her own progress. Task management reflects how students organise their time, their subject timetable and choices about completing tasks and activities for school.

The maladaptive cognitions include anxiety, failure avoidance and uncertain control. Anxiety comprises both feeling nervous and worry that reflects affective and cognitive components. Nervousness is indicated by feeling uneasy; worrying is a fear of not doing well. Students who signal a failure avoidance orientation are those who emphasise performance and grades that inhibit academic mastery and learning. Uncertain control reflects uncertainty about outcomes, that is, not knowing how to do well or how to avoid failure. The maladaptive behaviours include self-handicapping and disengagement. Self-handicapping occurs when a student reduces their chances of success by avoiding work or diverting their attention away from the required tasks. Disengagement refers to when students have given up or are at risk of giving up on a task or subject or at school altogether.

As noted above, Martin developed the MES instrument to accompany Motivation and Engagement Wheel (Martin, 2003, 2007). This instrument ascertains scores of each factor. These scores are combined to determine adaptive and maladaptive measures for individual students. The instrument can be adapted to specific educational domains (such as mathematics) and is therefore appropriate for providing measures of student motivation and engagement. Further, mapping of an individual’s engagement and motivation profile is possible (Martin, 2009) as is tracking changes over time if the instrument is used in succession.

**Justification of the Second Theoretical Framework**

Martin’s Motivation and Engagement Wheel (2007), selected as the second theoretical orientation guiding the present research, and captures the complexities of key factors—behavioural, cognitive and to some degree emotional—that are relevant to students’ motivation and engagement within adaptive and maladaptive dimensions. There are several reasons why the Motivation and Engagement Wheel (2007) is used as the second framework for this research. First, it integrates key motivational theories and therefore the major elements of behaviour (engagement) and cognition (motivation) are represented within a multidimensional framework, without any one theoretical approach dominating another. Second, the adaptive and maladaptive dimensions reflect ‘positive’ and ‘negative’ connotations, indicating a range of
behaviours and cognitions that one may expect from individuals. Further, the first-order factors, being aligned to quadrants (behaviours/cognitions) and hemispheres (adaptive/maladaptive), presents the opportunity to examine measures of individual factors in relation to the broader higher-order dimensions. Eliciting information about individual student motivational characteristics is viewed in the present study as potentially informative for understanding factors (both alone and in combinations) that influence engagement.

The two theoretical frameworks used in this thesis are considered to complement each other. The following section outlines how the Fredricks et al. (2004) engagement framework and the Motivation and Engagement Wheel (Martin, 2007) inform each other and how this contributes to theorising about engagement and motivation.

Using Two Complementary Frameworks

While recognising there are numerous approaches to interpreting motivation and engagement, the present research focuses on two complementary frameworks. The frameworks function together to organise and extend thinking around student engagement making clear links between motivation and types of student engagement. Using the frameworks of Fredricks et al. (2004) and Martin (2007) is beneficial for exploring the influence of specific psychological factors on levels of engagement. The two frameworks are presented side by side in Table 2.2, with ‘types of engagement’ (Fredricks et al., 2004) represented on the x-axis and the adaptive and maladaptive dimensions of the Motivation and Engagement Wheel (Martin, 2003) represented on the y-axis.

Contribution of Each Framework

Fredricks et al. (2004) provide clear definitions and explanations about types of engagement that are inclusive of motivational factors. The inclusion of a range of emotional factors such as interest, attitudes, feelings and values supplements the factors described in Martin’s (2007) Motivation and Engagement Wheel. Fredricks et al.’s (2004) view of behavioural, emotional and cognitive engagement being interrelated and dynamic is congruent with the structure of Martin’s Motivation and
Engagement Wheel (2007), as the eleven first-order factors present multiple aspects of an individual’s behavioural, cognitive and emotional conduct.

Table 2.2

Two Complementary Frameworks

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<thead>
<tr>
<th>Motivation and Engagement Wheel</th>
<th>Types of Engagement</th>
<th>Behavioural Engagement Low to High Intensity</th>
<th>Cognitive Engagement Low to High Intensity</th>
<th>Emotional Engagement Low to High Intensity</th>
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<tr>
<td>Maladaptive Dimensions</td>
<td>Disengagement</td>
<td>Anxiety</td>
<td>Failure Avoidance</td>
<td>Uncertain Control</td>
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<td></td>
<td>Self-handicapping</td>
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<tr>
<td>Adaptive Dimensions</td>
<td>Persistence</td>
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<td>Self-efficacy</td>
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<td></td>
<td>Planning</td>
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<td>Task Management</td>
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In addition, Fredricks and colleagues’ (2004) engagement framework perceives a range of intensity for engagement (low to high), providing a basis to further explore movement within and between engagement and disengagement. Each type of engagement offers potential for a range of intensities for engagement. For example, behavioural engagement can range from full participation and involvement to non-participation and refusal; cognitive engagement can range from setting clear goals and using multiple regulation strategies to having no goals and not using any regulation strategies; and emotional engagement can range from high interest, positive attitudes, liking, enjoying and placing high value on the task or subject to disinterest, negative attitudes, dislike, anxiety and having a low value on tasks and subjects. Similar ranges are reflected in the adaptive and maladaptive factors on Martin’s Motivation and Engagement Wheel (2007).
The Motivation and Engagement Wheel (Martin, 2007) complements Fredricks et al. engagement framework (2004) as it explicitly integrates motivation (cognition) and engagement (behavioural) constructs. The higher and lower order structure that Martin uses to frame the various components of motivation and engagement adds detail by aligning particular factors within two dimensions—cognitive/behavioural and adaptive/maladaptive. Not only do these effectively capture the essence of the main components of motivation and engagement, they also provide a basis for matching factors of engagement and motivation and thereby directly linking action to motives.

In Table 2.2, the eleven factors on The Motivation and Engagement Wheel (2007) have been assigned to one of the Fredricks and colleagues’ (2004) three types of engagement based on Martin’s broad dimensions of ‘behaviours’ and ‘cognitions’. Behavioural engagement includes five ‘behaviour’ factors: ‘self-handicapping’ and ‘disengagement’ are maladaptive behaviours while ‘persistence’, ‘planning’ and ‘task management’ are identified as adaptive behaviours. The remaining six ‘cognitive’ factors are assigned across the ‘cognitive’ and ‘emotional’ engagement categories of the Fredricks et al. (2004) engagement framework, with ‘failure avoidance’, ‘uncertain control’ and ‘anxiety’ viewed as impeding factors and ‘self-efficacy’, ‘valuing’ and ‘mastery’ considered adaptive motivation factors.

The assignment of these six factors across the ‘cognitive’ and ‘emotional’ types of engagement in Table 2.2 suggest that they could be evident in both categories, which reflects their inter-relatedness. For example, anxiety and valuing are factors that influence cognitive engagement but are very much linked to students’ emotional states. Similarly failure avoidance, uncertain control, self-efficacy and mastery are often considered as firm indicators of cognitive engagement but they also influence emotions, consistent with views that factors are inter-related and operate in dynamic ways rather than in a linear cause and effect trajectory (Fredricks et al., 2005; Fredricks et al., 2004; Martin, 2003, 2007).

The Inter-relationship between the Two Frameworks

By utilising both the Motivation and Engagement Wheel (2007) and Fredricks et al. (2004) engagement framework the present study proposes a refined way of operationalising motivation and engagement whereby information about specific motivational factors (both adaptive and maladaptive) are aligned to types of
engagement. Combining information from both frameworks allows links between motivations and types of engagement to be made that result in an engagement ‘profile’ of a student (e.g., high behavioural + low emotional + medium cognitive) that is underscored by clear and specific motivational factors.

This ‘profile’ provides information that neither framework alone can provide and is potentially useful to teachers in two ways. First, if measures of motivational factors are obtained (e.g., by using the MES and qualitative inquiry) they can be matched to types of engagement, and therefore supply teachers with information about students’ motivation that may be more accurate than that gleaned purely from teacher observations of engagement in the classroom. Second, if signs of observable student engagement in the classroom are noted likely motivational factors underlying particular behaviours can be investigated. In both circumstances, intentional monitoring provides teachers with more detailed information about student engagement and its links to underlying motivational factors.

In summary, combining the two frameworks in the present study has led to more detailed information about individual student engagement and addresses several gaps in research. The combined frameworks provide a way to consider broader levels of student engagement. The two frameworks can be used together to interpret motivational factors gleaned from perceived engagement or to investigate motivational factors to determine engagement levels.

Conclusion

This chapter established definitions and concepts surrounding engagement and motivation. A justification for combining Fredricks and colleagues’ (2004) engagement framework and Martin’s Motivation and Engagement Wheel (2007) is provided and the benefit of each is explained. Using these two frameworks links were made between adaptive and maladaptive factors of motivation and specific types of engagement (behavioural, emotional and cognitive). Examples were given of particular sets of combined adaptive and maladaptive factors that are linked to types of engagement and different levels of intensity illustrating that knowledge about students’ underlying motivation contributes to understanding the extent to which they may be engaged. Further, changes in underlying motivational factors and qualitative aspects of engagement may also provide other significant information such as where
variations and changes in types and levels of student engagement occur and whether this is a signal that students are slipping toward disengagement.

The following chapter reviews literature related to teacher beliefs and practices used in mathematics learning and engagement. The aim is to draw attention to the issues underlying potential causes of student engagement and disengagement in mathematics with a particular focus on students at the beginning of secondary schooling. The way in which teacher beliefs and practices in mathematics influence student motivation and promote student engagement will be examined.
Chapter 3

Teacher Beliefs and Practices for Promoting Student Engagement in Mathematics

The purpose of this chapter is to review literature concerning teachers’ beliefs and practices in mathematics and the extent to which they consider factors that influence students’ engagement when planning and executing instruction. It is critical to explore the ways teachers differentiate their practices according to individual student characteristics such as varying achievement levels. Accordingly, this chapter considers teacher ‘beliefs’ in mathematics education, including how these beliefs are defined and conceptualised in the context of teaching and learning about mathematics. Connections are made between teacher beliefs and their practices for mathematics teaching with a particular focus on those likely to effectively address student engagement. To locate where there is congruence in practices that support motivation and promote engagement in mathematics, research from both mathematics education and academic motivation are drawn upon.

Teacher Beliefs

Definitions

It is necessary to consider how beliefs are defined and described in relation to knowledge (Grootenboer et al., 2008) before considering teacher beliefs specific to mathematics teaching and learning. Beliefs can be defined as “psychologically held understandings, premises, or propositions about the world that are thought to be true” (Philipp, 2007, p. 259). Knowledge can be defined as “beliefs held with certainty or justified true belief” (Philipp, 2007, p. 259). Philipp (2007) distils the work of several researchers and notes that differences between beliefs and knowledge are distinguished in the following way: beliefs reflect degrees of one’s conviction, whereas knowledge is concerned with the concept of consensus.

Distinctions between beliefs and knowledge arise from different ideologies about what constitutes ‘truth’, as well as conceptualisations about the variable ‘strength’ of beliefs, the episodic nature of beliefs versus knowledge, and that beliefs
are regarded as having greater affective and less cognitive components than knowledge (Beswick, 2010; Grootenboer et al., 2008). Although beliefs are viewed as being linked to powerful emotional events, Beswick (2010), argues that emotions are “not a valid basis for arguing a distinction between beliefs and knowledge” (2010, p. 3). Instead of equating beliefs with emotions, beliefs are equated with knowledge, viewing both as cognitive and involving neural activity, whereas emotions are seen to reflect psychological processes that interact with cognitive activity. Therefore, beliefs/knowledge and emotions operate together (Beswick, 2010), a view that is consistent with multidimensional conceptualisations of engagement and the relationship between cognitive and emotional motivational factors.

Teacher Beliefs for Teaching and Learning

In keeping with viewing beliefs and knowledge as combined, beliefs are considered by some researchers as subsets of individuals’ “knowledge structures” (Goldin, Bettina, & Torner, 2009). Beliefs/knowledge constructs are therefore “highly subjective”, varying according to the bearer of the beliefs and likened to an individual’s personal possessions. This view of beliefs is particularly relevant when considering the role they play in teaching and learning because beliefs influence perceptions (Leder, 2006; Lomas et al., 2012).

As discussed in Chapter 2 of this thesis, perceptions are also personal because they reflect an individual’s interpretation of factors and their responses to situations via personal ‘filters’ (Broadbent, 1958). Phillipp (2007) suggests that beliefs also filter perceptions because they serve as a model or theory, affecting what one sees or notices, that is, what one perceives. Distinctions between perceptions and beliefs are important at a micro level because the present study is interested in understanding both teacher perceptions of student engagement and beliefs that underlie their practices for engagement. More broadly, beliefs fundamentally reflect a relationship between teacher thinking and student learning (Forgasz & Leder, 2008). Teachers’ beliefs/knowledge about mathematics “mediates practices and modulates what is attended to” (Mason, 2008, p. 303) which in turn influences student learning (Stacey, 2008). Therefore, teacher beliefs may lead to students in mathematics classes developing different strengths because of the particular beliefs that inform an individual teacher’s practice (Stacey, 2008). Stacey (2008) also notes that a teacher’s beliefs can be influenced by students’ needs in that they can be mediated by what
teachers believe are in the best interests of their students and learning outcomes. It follows that teacher beliefs are adapted according to the learning contexts and needs of students, reflecting and emphasising the connection between teacher thinking and student learning.

Teacher beliefs about pedagogy and learning, the nature of mathematics and content areas, technology, gender and equity issues and aspects of mathematics achievement have been the subject of investigation (Forgasz & Leder, 2008). Forgasz and Leder (2008) argue that teacher beliefs influence and are influenced by their circumstances and by the students they teach, therefore the construct of ‘belief’ clearly has a practical place in classrooms as it is “closely interwoven” in how students learn (p. 177). Although teacher beliefs about motivating and engaging students in mathematics were not identified in Forgasz and Leder’s (2008) review, as beliefs are embedded in affective and cognitive belief structures, further inquiry into teachers’ beliefs and links to their practices have been called for (Lomas et al., 2012). For the present study, teacher beliefs about motivating and engaging students in mathematics is viewed as critical, particularly in light of concerns about declines in student interest, participation and achievement in mathematics.

A central aim of the present study is to investigate the beliefs teachers hold about motivating and engaging students in mathematics and how these beliefs are promoted through their teaching practices. Additionally, the present study focuses on the middle years of schooling, a school stage identified as crucial in students’ mathematics careers in relation to establishing interest, achievement and future intentions to participate in mathematics. The present study recognises that cognitive and emotional beliefs are embedded within teachers’ belief structures relating to mathematics and are mediated by sociocultural learning contexts and student needs (Bobis, Higgins, Cavanagh, & Roche, 2012).

The Relationship between Teacher Beliefs and their Practices

The mismatch between a teacher’s personal theory of learning and their actual teaching practices is often raised when researching teachers’ beliefs. It is suggested that teachers’ espoused beliefs represent their intentions of their practice rather than predictors of their practice. This is not because teachers’ beliefs are unauthentic but because they are influenced by various reasons. One reason for the disjunction between teacher beliefs and practice is because of the challenges novice teachers face
when their intentions of mathematics teaching do not meet with the realities of learning contexts (Liljedahl, 2009).

Another suggested reason for inconsistencies between teacher beliefs and practices is that beliefs about mathematics rather than beliefs about mathematics teaching and learning and other environmental and educational issues are advocated (Philipp, 2007). These inconsistencies led Philipp (2007) to conclude that teacher beliefs are better understood once the teacher’s way of thinking is probed, ultimately resulting in resolving any inconsistencies. This confirms the relevance of considering teachers’ beliefs about the cognitive and emotional aspects of learning mathematics, in conjunction with their practice because it is appropriate to regard them as informing each other. Increasingly, the interplay between teacher beliefs and practices emphasise the importance of teacher confidence about their mathematical knowledge and how this acts to regulate practice, ultimately influencing student learning outcomes (Bobis et al., 2012).

Research by Askew, Rhodes, Brown, Wiliam and Johnson (1997) begins with the assumption that classroom practice is the major influence on student learning outcomes. Askew et al. (1997) propose a model that is centred around teachers’ classroom practices and informed by two aspects. First, a set of ‘beliefs’ and collection of knowledge (including subject knowledge) and second, understandings that teachers have about numeracy and its teaching, referred to as ‘pedagogic content knowledge’ (Askew et al., 1997). Central to the model is the relationship between three components—beliefs, knowledge and practice—as each informs and is informed by the other. While Askew et al. (1997) recognise that teacher beliefs and knowledge are important for informing students’ learning, teaching practice in the classroom is identified as the major factor influencing learning outcomes and the interactions between students and teachers that take place in the classroom will have the most significant influence on student learning. They conclude that teachers who are “highly effective [have] a particular set of coherent beliefs and understandings which underpin their teaching of numeracy” (1997, p. 3).

Askew et al. (1997) found, similar to Ball and colleagues (2008), that it was not so much the teachers’ formal subject knowledge that made them more effective but their knowledge and beliefs about mathematics and how they were able to use this to help students develop understanding. Paying attention to student understanding was identified as another significant feature of highly effective teachers as evidenced by
the careful documentation of student learning which was used to inform and develop subsequent teaching.

The following section considers frameworks of effective mathematics practices, from two perspectives. First, effective practices from the perspective of mathematics educators assess the extent to which emotional and cognitive components are considered. Subsequently, contributions from those interested in academic motivation are included as these help inform effective mathematics practices for motivating and engaging students in mathematics.

Teacher Practices

*Effective Mathematics Practices*

Teacher practices that include dynamic and active instruction involving interactions between the teacher and their students, “shape what gets taught and learned” (Hill, 2010). Reform-orientated research identifies quality features of teaching of mathematics (National Council of Teachers of Mathematics, 1991) that are effective for enhancing student understanding. Often characteristics or elements of quality practices incorporate approaches to instruction that influence the way students are taught. Some examples include: using group work, encouraging discourse and questioning, strategy use and development and task design. In this section, effective practices for mathematics that integrate features of mathematical quality instruction are reviewed and key elements identified.

Sullivan and Mousley (1994) surveyed 200 primary and secondary teachers on aspects of teaching mathematics to determine if there was a consensus among mathematics teachers about the features of quality mathematics lessons. Six major categories emerged from their survey: building understanding, communicating, engaging, problem solving, nurturing, and organising for learning. The researchers suggest that one component on its own may not be enough or necessarily provide evidence of effective learning—however, if a teacher understands how various components interact with each other, he or she can use and develop each during instruction cumulatively to build student understanding when learning mathematics.

In later research, Sullivan (2011) advocates six key principles for the effective teaching of mathematics: articulating goals, making connections, fostering engagement, differentiating challenges, structuring lessons, and promoting fluency.
and transfer. These principles draw on research from several models of recommended practice for teaching used in a number of Australian states including ‘Productive Pedagogies’ (Education.Queensland, 2010) and Hattie’s (2009) synthesis of teaching approaches. The six principles are also influenced by the work of Clarke and Clarke (2004) that emerged from research surrounding the Early Numeracy Research Project (ENRP). The ENRP recommended a range of effective practices important to mathematics teaching including: mathematical focus, features of task, materials, tools and representations, adaptations, connections, organisational style, learning community, classrooms interactions, expectations, reflections, assessment methods and personal attributes of the teacher.

Anthony and Walshaw (2008) isolated effective practices that that they believe teachers should convey to students in order to develop student competency and identity with mathematics. The recommended practices include: building productive relationships and patterns of active participation based on caring about student engagement; using individual and group work to enhance student cognitive thinking while constantly monitoring the structural and participation arrangement so that all students are engaged; shaping mathematics languages by sharing meaning and technical use; providing cognitive structure and feedback by modelling exchanges for communication and high levels of cognitive growth; using tasks to allow students access to important mathematical concepts, relationships and to investigate structures; adapting tasks to learner needs based on their competencies, experiences and interests; creating appropriate challenge for diverse learners making mathematics more meaningful and accessible; and enhancing learning opportunities through the effective selection and use of tools and representations. The range of practices recommended by Anthony and Walshaw (2008) illuminate links between teacher practices and promote active participation, the development of thinking and strategy use as well as attending to students’ interests and needs, thereby directly and indirectly promoting all types of student engagement in mathematics.

Watson (2010) places emphasis on cognitive engagement in relation to students’ mathematical needs. She shifts attention to the subject matter and teaching of mathematics that is qualitatively different in secondary mathematics classrooms by requiring students to adopt “new kinds of classification, new kinds of perception and interpretation, and new representational tools” (2010, p. 137). Watson argues that, while some students will change the way they perceive and interpret mathematics
concepts, changes in thinking will not happen spontaneously for others. Therefore, supportive emotional and social teacher practices are required as students cope with the cognitive demands for perceiving and interpreting mathematics in new ways.

From this review of effective teacher practices for mathematics proposed by various researchers, a number of key practices for supporting student learning can be distilled. These include:

- Focusing on key mathematical ideas and tasks with ‘predictive purpose’ allowing access, exploration and investigation of mathematics relationships and new classifications to build cognitive thinking and mastery of concepts;
- Focusing on the quality of mathematical representations and explanations, meanings and language including adopting new perceptions and interpretations of these;
- Making connections through careful structuring of tasks, building on student knowledge and experiences, using strategies to build cognitive growth, mastery and higher levels of abstraction including treating mistakes and misunderstandings as part of mathematical learning;
- Differentiating student needs by offering support and challenge to achieve competency;
- Supporting students as they encounter new levels of relational complexity;
- Using formative feedback as learning opportunities for students to clarify their mathematical thinking;
- Using a range of standard and non-standard examples and counter examples;
- Focusing on classroom environments and use of teaching styles for positive and supportive learning that fosters communication and student inquiry; and
- Fostering engagement through active involvement, tasks that are personally relevant and enjoyable, and offering variable ways of working that include opportunities for students to make decisions.

At the core of best practices for mathematics instruction is an emphasis on the development of student understanding and proficiency. This includes not only the acquisition of knowledge and skills but their relevant application in mathematics. Proficiencies in mathematics develop over time and therefore mathematics teachers recognise that student engagement needs to be maintained not only over short periods
but over much longer time spans (sometimes years) because many mathematical concepts require the assimilation and practice of cumulative knowledge. The importance of developing engagement as a pattern of involvement (Newmann et al., 1992; Smith et al., 2005) emphasises instructional practices that promote different types of engagement in a variety of ways as these are likely to be more effective for establishing ‘engaging’ mathematics classrooms.

In the practices reviewed in this section, student engagement is considered as one of the elements for effective mathematics learning and is also embedded within other practices. To illustrate: behavioural engagement is reflected by teacher practices that encourage patterns of active involvement and working with other students; cognitive engagement is emphasised through the provision of rich and challenging tasks as well as allowing time and providing opportunities for students to think and make decisions; and emotional engagement is fostered by including personally relevant activities, linking tasks to the world outside of the classroom, and maintaining interest by varying activities.

Research in the field of academic motivation offer significant contributions for a deeper understanding the relationship between motivational factors and types of engagement. The next section addresses practices that recognise elements of motivation and their influence on engagement and emphasises the importance of identifying specific motivational factors.

Practices for Promoting Engagement and Motivation in Mathematics

Noticing the similarities between the instructional practices for achievement motivation and the practices promoted in mathematics instruction, Stipek, Salmon, Givvin, Kazemi, Saxe, and MacGyvers (1998) identified practices that positively affect student motivation and conceptual learning. The instructional practices promoted by mathematics educators seeking reform emphasise effort, learning and mastery orientations, all of which are associated with building understanding. Stipek et al. (1998) cite specific supporting instructional practices including: (a) encouraging readiness to take on challenging tasks and take risks; (b) cultivating understanding, evidenced by mastering concepts; (c) promoting active student engagement and autonomy, fostering feelings of control and greater enjoyment; and (d) cultivating feelings of competency for tasks that provide personal meaning, are moderately challenging and offer variety.
Teachers who use these approaches in instruction also tend to promote constructive learning environments and show positive affect towards their students. Students are encouraged to explain alternative strategies, evaluate their approach and appreciate the methods used by others when working to solve problems. This style of instruction conveys expectations that students are able to learn, that effort for explaining their thinking is required and that, despite confusion or setbacks, students should persist. Building on these instructional approaches, there are teachers who demonstrate positive affect by demonstrating interest in and respect for students, reveal their enjoyment and value of mathematics, care about student engagement and provide support for students’ learning as they require it. Turner and Meyer (2004) also note that the “link between achievement and motivation is important because it suggests that helping students understand will also support future motivation in mathematics” (p. 314). Schweinle, Meyer and Turner (2006) reach similar conclusions about student motivation and affect, observing that particular teacher practices—such as feedback and clarification, support for autonomy, cooperation, and emphasis on learning for its own sake—are related to student motivation in mathematics classroom.

Turner, Warzon and Christensen (2011) identify four principles for motivation and instruction drawn from a year long intervention study working with mathematics teachers. These four principles advocate elements of competency, autonomy, belongingness and meaningfulness that are central constructs of self-determination theory (Deci & Ryan, 2000). Competency is related to intrinsic motivation emphasising mastering of concepts. Therefore, mathematics instruction that presses for understanding and provides formative feedback, using informational language is viewed as supportive for students. When teachers use an autonomy approach as opposed to a controlling one, they offer students control over aspects of their learning such as pace and choice, and this is found to foster student motivation (Reeve, 2009). Specifically, teachers who act in autonomy-supportive ways nurture motivational factors such as interest and needs, explain the reasons for task requests, use informative language, and accept students’ expressions of negative affect as valid. This approach to instruction allows students to experience personal autonomy, satisfy psychological needs and generally experience positive learning (Reeve, 2009). By contrast, the consequence of controlling teaching styles determines an external locus
of control (rather than internal) which creates a compulsion to act out of guilt, shame or anxiety and can lead to negative functioning in learning settings (Reeve, 2009).

Belongingness can be described as the human need for feeling related to and accepted by others and is noted as particularly important during adolescence. Instructional practices that foster collaboration rather than competition and encourage positive outcomes through enhancing peer relationships and promoting achievement are important for attaining a sense of relatedness (Turner et al., 2011). Meaningfulness relates to the value students place on learning and is connected to students’ understanding in the sense of gaining intrinsic satisfaction from appreciating and understanding content that can be related to prior learning and leads to cognitive growth (Turner et al., 2011).

Several of the practices noted above such as belongingness, competency, relevance, and valuing are also consistent with literature that identifies motivating instruction effective for engaging middle year students (Dinham & Rowe, 2007). This is relevant to the present study because concerns about student engagement and achievement in mathematics during early secondary years highlight sensitivities to the cognitive demands and emotional challenges that influence student participation and interest in mathematics study.

Raphael, Pressley and Mohan (2008) considered the effectiveness of teachers using a range of practices. They noted that, where a wide range of research-based practices are used during instruction, students are engaged at least 90% of the time and the teachers are regarded as highly engaging. Teachers who used a smaller number of effective practices (moderately engaging teachers) engaged students 50% of the time while teachers who used only a few practices (low engaging teachers) engaged students less than 50% of the time. Raphael et al. (2008) also identified the effect of teachers using practices that were disengaging. Disengaging practices were identified as undermining student engagement and included decreases in levels of expectancy and task value, ineffective rewards, low monitoring and scaffolding, using low level tasks and negative classroom atmosphere and disciplining styles. While some disengaging practices were recorded for teachers in the medium engaging category, all of the disengaging practices were evident in the practices of teachers deemed as low engaging. Raphael et al. (2008) concluded that highly engaging teachers use a wide variety of instructional practices to encourage student engagement with academic content. Engaging teachers also cover more information in greater
depth and demand concentration from their students, resulting in students who were more behaviourally and cognitively engaged. Greater levels of positive affect were also noted, with boredom being less obvious in classrooms that used a greater variety of instructional practices.

Table 3.1 summarises the practices reviewed and links them to motivational factors and types of engagement to clarify the association between teacher practices and their influence on student motivation (Lutz et al., 2010; Raphael et al., 2008; Reeve, 2009; Schweinle et al., 2006; Stipek et al., 1998; Turner et al., 2011). Each of the motivational factors is coded as being behavioural (B), cognitive (C) or emotional (E) to indicate the type of engagement it is associated with. Non-supportive teacher practices discussed in the literature (Raphael et al., 2008; Reeve, 2009) are also linked to motivational factors and these too are presented and associated with types of student disengagement.

Table 3.1

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Motivational Practices Associated with Engagement</th>
<th>Motivational Practices Associated with Disengagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promote active participation</td>
<td>Persistence (B)</td>
<td></td>
</tr>
<tr>
<td>Foster autonomy/student choice</td>
<td>Self-regulation (B)</td>
<td></td>
</tr>
<tr>
<td>Expectations of effort/concentration</td>
<td>Persistence (B)</td>
<td></td>
</tr>
<tr>
<td>Provide feedback/informative praise</td>
<td>Self-efficacy (C)</td>
<td></td>
</tr>
<tr>
<td>Encourage explanations/evaluations of strategy</td>
<td>Self-efficacy (C)</td>
<td></td>
</tr>
<tr>
<td>Encourage challenge and risk taking</td>
<td>Self-efficacy (C)</td>
<td></td>
</tr>
<tr>
<td>Cultivate understanding/mastering concepts</td>
<td>Mastery Orientation (C)</td>
<td></td>
</tr>
<tr>
<td>Foster competency/intrinsic motivation</td>
<td>Self-efficacy (C)</td>
<td></td>
</tr>
<tr>
<td>Meaningful understanding</td>
<td>Valuing and Mastery Orientation (C)</td>
<td></td>
</tr>
<tr>
<td>Promote positive environments</td>
<td>Positive Emotions (E)</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.1 (cont’d)

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Motivational Practices Associated with Engagement</th>
<th>Motivational Practices Associated with Disengagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show interest and respect for students</td>
<td>Interest (E)</td>
<td></td>
</tr>
<tr>
<td>Offer task variety</td>
<td>Interest (E)</td>
<td></td>
</tr>
<tr>
<td>Foster enjoyment/ teacher enjoyment</td>
<td>Enjoyment (E)</td>
<td></td>
</tr>
<tr>
<td>Encourage belongingness/collaboration/co-operation/social interactions</td>
<td>Needs, Interest (E)</td>
<td></td>
</tr>
<tr>
<td>Decreased expectancy of participation/task involvement</td>
<td>Lack of Persistence (B)</td>
<td></td>
</tr>
<tr>
<td>Provide low level tasks/decreased challenge</td>
<td>Lack of Valuing and Self-efficacy (C)</td>
<td></td>
</tr>
<tr>
<td>Use ineffective extrinsic rewards</td>
<td>Lack of Mastery (C)</td>
<td></td>
</tr>
<tr>
<td>Low levels of monitoring/scaffolding learning</td>
<td>Uncertain Control (C)</td>
<td></td>
</tr>
<tr>
<td>Use a controlling style/undermine students</td>
<td>Anxiety/Shame (E)</td>
<td></td>
</tr>
<tr>
<td>Display a lack of interest</td>
<td>Disinterest (E)</td>
<td></td>
</tr>
<tr>
<td>Allow a negative classroom atmosphere</td>
<td>Negative Emotions (E)</td>
<td></td>
</tr>
</tbody>
</table>

The teaching practices identified in the literature and summarised in Table 3.1 importantly connect teacher instruction and emotional support that is pivotal to initiating and sustaining student engagement in learning mathematics. However, the teacher practices discussed and links to motivational factors are by no means comprehensive. Mechanisms of teacher practices and how these influence student motivation and engagement in mathematics classrooms need to be examined more extensively. A fundamental aim of the present study is to investigate teachers’ cognitive and emotional beliefs related to learning mathematics in conjunction with their practices used in mathematics classrooms. The purpose of this is to gain a clearer understanding of the practices teachers use to motivationally support their students’ mathematics learning. The majority of the research reviewed in this chapter draws on studies that are generalised across all student groups and learning contexts. The present study aims to extend the research field by examining teacher practices for students with varying characteristics. It investigates teacher practices for students with
both high and low achievement levels. The aim is to discern whether teacher beliefs and practices for teaching and engaging students differ according to variations in student achievement levels.

As student motivation and engagement are highly individualistic and closely linked to achievement outcomes, further investigation is necessary to reveal how teachers perceive student engagement in conjunction with achievement, their beliefs about its importance for learning and the practices they use to promote student engagement in mathematics. The present study seeks to address questions such as the following: Do teachers perceive a student’s achievement level as an indication of their engagement or are they perceived independent of each other? Do teachers alter their teaching practices for low and achieving students? If so, what alterations are made and how are they determined? Are teachers who alter practices and respond to students’ needs more effective at promoting engagement in mathematics?

**Practices Influencing Mathematics Engagement and Achievement**

Lutz, Guthrie and Davis (2010) identify a range of teacher practices and link them to corresponding increases, decreases and sustainment of student engagement. Lutz et al. (2010) also determine additional aspects of engagement relating to levels of achievement. For example, engagement of high achieving students increases when they are cognitively challenged, whereas engagement of low achieving students increases with sharing their understandings and being supported to continue with learning.

A number of practices are associated with sustaining engagement for all students including: setting clear content goals for tasks; matching task material to the content goals; strategy instruction such as reviewing and recommending use; scaffolding student knowledge; choices of material; and promoting collaborative support. The research of Lutz et al. (2010) not only highlights that students of varying achievement levels respond to different emphases of teacher practices but raises the “possibility that the task type in which students are engaged may be crucial for producing engagement that leads to achievement gains” (p. 14). Lutz et al. (2010) also suggests that the patterning of scaffolds that teachers use influence the facilitation of student engagement in complex tasks. The notion of different scaffolding or instructional practices for enhancing student engagement in tasks of different or varying complexities should be pursued. Together with the knowledge that students of
varying levels of achievement respond to differing teacher practices, the design, management and delivery of instruction for various tasks (depending on complexity and purpose) is another consideration for meeting specific student needs to enhance engagement and achieve better outcomes.

Stephan, Caudroit, Boiche, and Sarrazin (2011) explore students’ perceptions of their competency finding that in certain situations, such as receiving poor grades, students tend to discount feedback or evaluations to preserve their self esteem. Stephen et al. (2011) explain the reasons that students need to self-protect by discounting the grades they receive “is not elicited by the grade itself, but by the resulting low perceived competence” (p. 451). Nussbaum and Steele (2007) suggest that discounting negative feedback is a self protection response in particular situations that allows students to maintain their persistence with learning in the longer term. Their study reveals that low achieving students maintain levels of engagement despite poor grades, therefore highlighting that engagement and achievement levels are not always aligned.

These findings are significant for the present research as it is concerned with investigating factors influencing students with different engagement and achievement levels. It raises questions such as: Why is it that some low achieving students remain engaged and others not? Does the presence or absence of certain factors influence low achieving students to engage and others to disengage?

Conclusion

The importance of teachers clearly identifying and articulating their beliefs about student engagement has been emphasised. Through reviewing what is meant by teacher beliefs and how these relate to their practices for teaching and engaging students in mathematics, the main purpose of this chapter is realised. Teacher beliefs about student cognition and emotions are equally relevant in the context of teaching and engaging students in mathematics. The teacher practices reviewed reflect a greater awareness and articulation of elements of motivation and engagement within mathematics instruction, indicating that there is merit in investigating “a set of instructional practices for achieving instructional objectives related to both motivation and learning” (Stipek et al., 1998, p. 485).
The present study is important because it aims to comprehensively examine the beliefs and practices of teachers effective at promoting student engagement in mathematics. Crucially, it aims to consider the intricate relationship between motivational factors and how these influence student engagement. This study also investigates how teacher beliefs and practices for teaching and engaging students vary for students with both high and low achievement levels in mathematics. This investigation will have significant implications for teachers as it is shown that it is teachers’ mathematical beliefs and practices that bring about cognitive and emotional shifts in student engagement in mathematics.
Chapter 4
Methodology Study 1

This thesis reports on research composed of two interdependent qualitative studies: an Interview Study referred to as Study 1; and a Case Study referred to as Study 2. This chapter focuses on Study 1 and establishes the context and methodological approach in which the current research sits including an overview of the MYTEAM Project. First, the research questions for Study 1 are presented and their contribution to the overall project is explained. This is followed by an introduction to the use of qualitative research methods and a justification for the choice of methodology used. Next, the process for selecting participants is outlined. In particular, how student and teacher participants for this qualitative study were selected using data collected in the initial quantitative data phases of the larger MYTEAM Project is explained. The final section explains the methods used for analysing the data including the approach to coding and the identification of emerging themes. Reliability and validity for qualitative research method and the treatment of associated issues are also discussed.

Setting the Context:

Using Data from the Quantitative Phase of the MYTEAM Project

The MYTEAM Project consisted of three phases: the quantitative study phase; the qualitative study phase; and an intervention study. Each phase and the studies within them were interdependent and contributed to the overall aim of the project, being to better understand academic engagement in mathematics. This section outlines the data collection process used during the quantitative stage of the MYTEAM Project and its purpose in identifying and establishing participants in the present study.

The quantitative component of the MYTEAM Project used an extensive and purposively designed survey, called the Mathematics Motivation, Engagement, and Attitude Survey (explained in detail by Martin (2003, 2007)), and a mathematics
achievement assessment instrument (Appendix A) to establish shifts in students’
engagement, motivation and achievement levels both over time and academic year.
The survey combined a number of instruments tailored for mathematics that were
validated by previous research (Martin, 2007). The resulting instrument (MYTEAM
Survey) contained 108 items against which the students rated themselves from a scale
of 1 (strongly disagree) to 7 (strongly agree).

The questions in the MYTEAM Survey included 44 items from the MES
developed by Martin (2003). The MES is an instrument that measures student
motivation and engagement through questions relating to 11 first-order factors (under
the umbrella of four higher order dimensions) each representing various constructs of
motivation and engagement. The 11 factors relate to Martin’s Motivation and
Engagement Wheel, (2007) discussed in depth in Chapter 2. Table 4.1 lists the factors
and dimensions measured by the MES.

Table 4.1
*Factors and Dimensions Measured by the MES Survey*

<table>
<thead>
<tr>
<th>Higher Order Dimensions</th>
<th>First Order Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Cognition</td>
<td>Self-efficacy</td>
</tr>
<tr>
<td></td>
<td>Mastery Orientation</td>
</tr>
<tr>
<td></td>
<td>Valuing</td>
</tr>
<tr>
<td>Adaptive Behaviour</td>
<td>Persistence</td>
</tr>
<tr>
<td></td>
<td>Planning</td>
</tr>
<tr>
<td></td>
<td>Task Management</td>
</tr>
<tr>
<td>Maladaptive Cognition</td>
<td>Anxiety</td>
</tr>
<tr>
<td></td>
<td>Failure avoidance</td>
</tr>
<tr>
<td></td>
<td>Uncertain control</td>
</tr>
<tr>
<td>Maladaptive Behaviour</td>
<td>Self-handicapping</td>
</tr>
<tr>
<td></td>
<td>Disengagement</td>
</tr>
</tbody>
</table>

As Table 4.1 illustrates, there are six adaptive factors (self-efficacy, mastery
orientation, valuing, persistence, planning and task management) and five
maladaptive dimensions (anxiety, failure avoidance, uncertain control, self-
handicapping and disengagement) forming part of Martin’s Wheel. Each of the eleven
factors is assessed through four items on the MES. From completed surveys, a measure for each dimension can be obtained and adaptive and maladaptive measures can be calculated. These adaptive and maladaptive measures of each student participant were used for the present study.

A mathematics assessment instrument adapted from the Wide Range Achievement Test 3 (WRAT) (Wilkinson, 1983) was included with the MYTEAM survey to measure student achievement. This adapted assessment was implemented by the MYTEAM researchers (comprising three mathematics educators with experience developing curriculum and assessment material at school and government levels) to obtain an ‘external’ mathematics score for each student. The scores were ‘external’ in that they were independent from assessments undertaken internally by the school. This external score was then used as a measure of achievement for the purposes of the MYTEAM Project and the present study. The assessment was designed so that it could be administered to all participants in the study (Years 5 to 8) and the results demonstrated graduated mean level differences for each year level, $F(3,4375) = 269.96, p < 0.001$ (Grade 8 > Grade 7 > Grade 6 > Grade 5) (Martin et al., 2012).

The initial MYTEAM Survey (called Time 1) was undertaken in May 2008 by 33 primary and 14 secondary schools that distributed the survey to a total of 4516 students in Years 5, 6, 7 and 8. The results of Time 1 generated key findings regarding students’ engagement and achievement in mathematics (Martin et al., 2011) and established a baseline for monitoring shifts in student engagement and achievement in future years.

In May 2009, the MYTEAM Survey was distributed to the same primary and secondary schools and was again completed by students in Years 5, 6, 7, and 8 (called Time 2). There was a new Year 5 cohort and as the Year 8 cohort from 2008 had progressed to Year 9 this cohort was not surveyed in Time 2. The number of students who completed the survey in both 2008 and 2009 totalled 1596. As each student used an individual code for completing the surveys, it was possible to track students from Years 5 to 6 ($n = 546$), Years 6 to 7 ($n = 378$) and Years 7 to 8 ($n = 672$) who had completed the MYTEAM Survey in both 2008 and 2009.

Data collected from students who completed the MYTEAM Survey meant that the MYTEAM researchers could examine transitions across all year groups and for

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4 May is in the second term in NSW schools, almost mid-way through the school year.
individual students. This was important for establishing student (and, by implication, teacher) participants for Study 1. The data also allowed researchers to find the mean scores of student engagement by year and by individual classes within each year to establish ‘engaged’ classrooms. This was important for establishing teacher participants for Study 2, and the process for this selection is discussed in detail in subsequent chapters.

The quantitative components of the MYTEAM Project therefore provided a considerable amount of rich and detailed data about individual students who evinced changes (both upwards and downwards) in their mathematics engagement and achievement and about classrooms that maintained engagement in mathematics. The design of Study 1 seeks to complement the MYTEAM data by investigating the circumstances and factors that influenced these changes in depth. It was therefore important to use the data collected in the quantitative phase of the MYTEAM Project to identify appropriate participants for Study 1. How the participants for Study 1 were selected is discussed later in this chapter.

The research questions for Study 1 were:

1. What individual and classroom level factors do students perceive as influencing their engagement, motivation and achievement in mathematics?
2. How do teachers perceive students’ levels of engagement and motivation in mathematics and how is this reflected in their teaching practices?

The Purpose of Qualitative Research

Qualitative research provides researchers with opportunities to study the perspective of participants toward various events, beliefs and practices as well as answer questions and explore issues that may not be apparent using other research methods (Gay & Airasian, 2003). The underlying philosophy of qualitative research guides the methodologies and methods adopted as there are various approaches and types of data collection available. To capture valid, reliable and useful data, choosing methodologies and instruments for data collection appropriate to the research is crucial.
Although the number of participants in qualitative research tends to be relatively small compared to quantitative research, the data sought are intensive in nature, often revealing rich and detailed information. Analysis of data is mostly interpretive and great care is taken to bring together collections of relevant data—to organise, classify, categorise and draw meaning from it. The nature of qualitative research methods and data collection often necessitates the researcher operating within the field—where and when the research takes place. In these circumstances, it is usual for the researcher to acknowledge his or her role within the research process itself, noting the potential pitfalls and simultaneously recognising the advantages of being accepted in or even observing within the field (Gay & Airasian, 2003).

In qualitative research, collection of data usually occurs within the ‘naturalistic’ research setting, that is, within the participants’ environment and context. Choices about which data should be collected and in what manner are made by researchers according to the purpose of the research (Cohen, Manion, & Morrison, 2002). Qualitative research will often utilise multiple data collection methods at different stages, gathering extensive evidence that converges to establish a deep understanding of the focus of the research.

Interviewing has become a main tool for the collection of qualitative data in mathematics education research, particularly as a way of unravelling the ‘how’ and ‘why’ of student thinking. The purpose of the research guides the construction of interview questions and tasks. For example, if the researcher’s aim is to discover a student’s level of understanding of mathematical concepts, the interview would be methodical and orientated towards determining the student’s mathematical knowledge (Zazkis & Hazzan, 1999). Conversely, if the purpose is to understand how a student perceives their learning experiences in mathematics (as was the case for Study 1) the style of interview would be more conducive to eliciting personal views, beliefs and emotions.

Accordingly, different styles of interview fulfil different purposes in qualitative research. Interviews can take various forms: some are unstructured, some are semi-structured and others are structured (Yin, 2003). This implies either using no guiding questions (unstructured), using a set of questions to guide the interview discussion but providing scope to ask additional questions as required (semi-structured), or using a pre-determined question format (structured). The characteristics of the interviewee are also an important consideration when selecting
an interview style. For example, establishing an appropriate atmosphere and the approach taken to questioning is worthy of particular consideration to elicit informed and reliable responses when interviewing students (Cohen et al., 2002).

Using field notes in qualitative research is common. Such notes are recorded by the researcher at the time of interview or observation (or soon after) as a way of capturing additional information about the setting, demeanours and other relevant factors that occurred at the time of data collection. In addition to the researcher’s notes, other artefacts may be sourced such as samples of work, copies of material used in observation sessions, sketches, photographs, video and audio recordings.

In Study 1, the main source of data was obtained through in-depth, semi-structured interviews with students and their teachers. Field notes recorded at the time and immediately following the interviews supplemented the interview data obtained during the interview. The following section outlines and details the design and purpose of Study 1.

Research Design

The overarching design for this inquiry was qualitative in nature, predominantly employing interview approaches. Study 1 focused on understanding individual, classroom, pedagogical and school level factors that influence engagement and achievement through in-depth interviews with students and their teachers. A key aim was to understand the influence of salient factors on levels of engagement distinct from students’ achievement levels in mathematics. The selection process of the student participants (and therefore teacher participants) was central to determine participants with different levels of achievement and engagement and guide the design of the study.

The first research question considers the students’ perceptions of how individual and classroom-level factors influence levels of engagement, motivation and achievement in mathematics. This involved eliciting their feelings towards mathematics, their views on their mathematical capabilities, their thoughts on what takes place in mathematics classrooms—and how this affects their engagement and achievement in mathematics.
The second research question dealt with teachers’ perceptions of students’ engagement in mathematics, the relationship of engagement and levels of achievement and the extent to which teachers use strategies to engage students as part of their teaching practice for mathematics. Information from interviews with the teachers provided considerable data about their perceptions, beliefs, experiences and practice. Eliciting perceptions from both the students and the teachers allowed for a deeper understanding of the issues and processes that influence student engagement and achievement in mathematics and enabled a comparison of perceptions of engagement.

Selection of Participants for Study 1

Student Participants

It was essential to consider engagement and achievement separate from each other given the aim of this study to examine factors that influence student engagement and achievement in mathematics. Data collected during the quantitative study phase of the MYTEAM Project provided information about students’ shifting engagement and achievement levels that subsequently ascertained engagement and achievement profiles of each student. These data had a direct bearing on the selection of the appropriate participants for Study 1. A detailed explanation of this process follows.

Participants for Study 1 were selected using data collected from the quantitative phase in Time 1 (May 2008) and Time 2 (May 2009), using the MYTEAM Survey. The foci of the interview study were students who made the transition from Year 6 (the last year of primary school) to Year 7 (the first year of secondary school) and completed the survey on both occasions. This transition group was of particular interest as previous research (Russell et al., 2003; Siemon, 2001) highlighted concerns about students disengaging from school as they made the transition into secondary school. Additionally, some studies have found that the rate of student achievement slows or plateaus during this time (Hill et al., 1993). Conversely, other research in Australia has contradicted this (Cooney, 2006) indicating that rates of achievement continue to rise in Year 7, resulting in some ambiguity about student achievement patterns in early secondary years.

Examining student motivation, engagement and achievement during the transition into secondary school was a key aim of this study in order to shed light on
this ambiguity in the research. The overall results of the Year 6 to 7 cohort \( (n = 378) \) during the quantitative phase confirmed concerns about student engagement in mathematics with declines noted in most of the adaptive factors as measured by the MES. This identified the need to examine in depth the factors that influence students as they enter secondary school.

An overall analysis of the results of the MES component of the MYTEAM Survey, provided evidence to support significant \( (p < 0.001) \) declines in adaptive factors (such as self-efficacy, valuing, mastery orientation, planning, and task management) and a significant \( (p < 0.001) \) increase in disengagement for the cohort transitioning from Year 6 in 2008 to Year 7 in 2009 (Martin et al., 2011). Results of the mathematics assessment component showed significant \( (p < 0.001) \) increases in average scores for the Year 6 to Year 7 cohort from 14.45 to 16.12 out of 30—though it was expected that students’ achievement levels would be higher after an additional year of schooling. It was from this group of 378 students that parameters were determined for selecting students to be interviewed for Study 1.

First, the adaptive and maladaptive scores for each student in the Year 6 to Year 7 cohort captured in Time 1 and Time 2 were used to determine students who had shifted upwards (becoming more engaged) and downwards (becoming less engaged). The adaptive motivation levels were determined by calculating the sum of each student’s measures on the adaptive items of the MES separately for Time 1 and 2. As illustrated in Table 4.1, the six adaptive factors are self-efficacy; mastery orientation; valuing of school; persistence; planning; and task management.

The maladaptive motivation levels were determined using the same process. The maladaptive behavioural dimensions were represented by two factors: disengagement and self-handicapping. Students could obtain a maximum score of seven for each adaptive and maladaptive factor each time the survey was completed. Adaptive and maladaptive factor scores were averaged to obtain adaptive and maladaptive scores for individual students.

Differences in the adaptive and maladaptive scores between Time 1 to Time 2 could reveal shifts for each student over the one–year period. The researcher was able to identify increases, decreases or no change in the 378 students’ engagement and disengagement levels in mathematics that had occurred during the transition from primary to secondary school. Students could then be categorised as either ‘engaging’
or ‘disengaging’ in mathematics based on the upward and downward shifts of the adaptive and maladaptive measures.

The following example illustrates how students were categorised as engaging and disengaging using a combination of their shifting adaptive and maladaptive scores. Student LAD2 whose maladaptive score shifted from 3.25 (Time 1) to 5.75 (Time 2) displayed a significant downward shift over one year (2.5 points) that is, shifted towards disengagement. At the same time the adaptive score of the same student decreased from 5.50 (Time 1) to 3.46 (Time 2) a decrease of 2.04 points, a shift away from engagement. The overall shift for this student is calculated by the 2.5 increase in their maladaptive score and the 2.04 decrease in their adaptive score. The students combined shift is calculated as 4.54 points towards disengagement and therefore this student was categorised as belonging to the ‘disengaging’ group.

To better understand the complex factors that influence an individual student’s motivation and engagement to learn mathematics, Study 1 sought participants who would represent a variety of student types including those who demonstrated significant shifts in their motivation and engagement and exhibited varied levels of achievement. A further refinement of the Year 6 to Year 7 cohort ‘engaging’ and ‘disengaging’ categories also took into account each student’s mathematical achievement indicated by their scores in the mathematics assessment at Time 2.

Mathematics assessment scores of the 378 students ranged between 3 and 26 out of a possible 30. Aiming to understand the influences of engagement and motivation on achievement levels, Study 1 focused on students who fell in the lowest and highest achievement bands. Tripartite splits were set at score 13 and score 18 of the mathematics assessment. This set score bands for high, middle and low mathematical achievement and ensured sufficient numbers of students were captured to represent the engaging and disengaging categories. Students who scored between 3 (being the lowest score) and 13 out of 30 were deemed as low achievers on the mathematics assessment. Students who scored between 18 and 26 (being the highest score) out of 30 were considered as high achievers on the mathematics assessment. Students who scored between 14 and 17 out of 30 were viewed as medium achievers and this group were not considered for inclusion in Study 1.

To illustrate how achievement scores were applied for the purposes of categorising students the results for student LAD 2 are again drawn upon. Student LAD2 scored thirteen out of thirty on the mathematics assessment in Time 2 and was
considered as a low achieving student for this study. Therefore this student was categorised as ‘low achieving disengaging’ (LAD). The achievement parameters of 13 and 18 were applied to all of the students in the engaging and disengaging groups. This refinement process resulted in the identification of 93 Year 7 students as potential participants for Study 1. All of these students had demonstrated significant upward or downward shifts in both adaptive and maladaptive scores and were either low or high achievers in mathematics.

**Establishment of Specific and Purposeful Groupings**

With knowledge of their engagement/disengagement and high/low achievement characteristics, the 93 students were placed into one of the following four categories: low achieving + disengaging (LAD); low achieving + engaging (LAE); high achieving + disengaging (HAD); and high achieving + engaging (HAE).

The students in each of the four categories were listed, showing details of their school and class, their mathematics assessment score (in Time 2), their adaptive and maladaptive measures (in Time 1 and Time 2) and the shift in adaptive measures and maladaptive measures (between Time 1 and Time 2). As students with the largest shifts in adaptive and maladaptive measures between Time 1 and Time 2 were preferred, ascertaining the shift measures was important as this enabled the researcher to determine the size of student shifts.

It was possible to calculate the overall net shifts in disengagement (i.e., where adaptive shifts decreased and maladaptive increased) and in engagement (i.e., where adaptive shifts increased and maladaptive decreased). Cross-referencing the net shifts against absolute adaptive scores (for the two engaged groups) and absolute maladaptive scores (for the two disengaged groups) provided a check for any anomalies. Subsequently, samples of students from each of the four categories were invited to participate in interviews, based on the size of their shifts.

**Identifying Specific Students for Interview in Study 1**

Within each of the four categories, overall shifts were calculated and ranked from the greatest to the least overall shift. The net shifts of some students in each grouping were minimal (less than 1.0 point) indicating that there was less value in pursuing them for interview. Fourteen students from each group being those who displayed the greatest net shifts, were identified and invited to interview. These
students experienced shifts between 1.00 and 5.09 points and therefore were the most significant for the purposes of Study 1. Overall, 54 Year 7 students representing 11 secondary schools were invited for interview. The 36 teachers of these students were also invited for interview. There were less teacher participants than student participants because some teachers \((n = 9)\) taught more than one student identified through the student selection process. Figure 4.1 depicts a summary of the process, for selecting the 54 students (and therefore the 36 teachers) for interview. The direction of the process for selecting students and their teachers for interviews is depicted in Figure 4.1 as flowing from outside to inside.

![Figure 4.1 Summary of student participation selection process for Study 1](image)

Several teachers identified were not available for interview because they were on leave or had left the school. In a case where the teacher was not available, the student(s) of that teacher were not pursued for interview, as Study 1 aimed to capture
the views about mathematics from both the students and their corresponding teacher to enable comparisons to be made. In some instances, the parents of students did not provide consent for interview and these students were not pursued.

The research had anticipated capturing around 40 students and their respective teachers from at least 4 different schools as this would represent a broad spectrum of students, teachers and schools. The final cohort of participants for Study 1 comprised 37 Year 7 students and 31 mathematics teachers (being the teachers of the 37 students) drawn from 10 secondary schools, therefore meeting the breadth and depth anticipated by the research objectives. The number of student interviewees for each of the four categories is presented in Table 4.2.

Table 4.2

<table>
<thead>
<tr>
<th>Student Category</th>
<th>Category Label</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Achieving + Engaging</td>
<td>LAE</td>
<td>10</td>
</tr>
<tr>
<td>Low Achieving + Disengaging</td>
<td>LAD</td>
<td>10</td>
</tr>
<tr>
<td>High Achieving + Engaging</td>
<td>HAE</td>
<td>9</td>
</tr>
<tr>
<td>High Achieving + Disengaging</td>
<td>HAD</td>
<td>8</td>
</tr>
</tbody>
</table>

Each student in the four categories listed in Table 4.2 was assigned a code. For example, the ten students in the ‘low achieving engaging’ category were coded LAE1 to LAE10, the ten students in the ‘low achieving disengaging’ category were coded LAD1 to LAD10, the nine students in the ‘high achieving engaging’ category were coded HAE1 to HAE9 and the eight students in the ‘high achieving disengaging’ category were coded HAD1 to HAD8.

The participants were drawn from schools operating in a large school system in a Metropolitan region of NSW, Australia. All of the schools were comprehensive schools of mixed ability. The 10 schools are identified as A-J in Table 4.3 and represent a range of social and economic levels and genders. There were 4 female–only schools, 3 male–only schools and 3 mixed–gender schools.

Establishing Teacher Participants for Study 1

It was deemed important to not only understand the students’ perception of individual, class and school level factors that influence engagement and motivation to learn mathematics, but to compare and contrast this to teachers’ perceptions. Importantly the inclusion of teacher perceptions of student engagement provides
another valuable source of information by offering a separate but contextually related perspective than that sourced from the students (Reschly & Christenson, 2012). Interviewing both the students and their teachers meant that responses from both could be categorised and compared. By examining responses, it was possible to determine aspects of mathematics teaching and learning which were considered important to students and teachers, including those that were common to both, and reasons why each was important.

The teachers at each school were assigned a code that included the letter representing the school and a number representing each teacher at that school. For example at school A, five teachers were interviewed and these teachers were coded, A1, A2, A3, A4 and A5. A similar coding system was applied to the teachers interviewed in the ten schools involved in the study. Table 4.3 summarises the final number of student and teacher participants for Study 1 and the schools from which they were drawn.

Table 4.3

<table>
<thead>
<tr>
<th>School Code</th>
<th>School Gender</th>
<th>School Year Groups</th>
<th>Number of Students Interviewed</th>
<th>Number of Teachers Interviewed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Female Only</td>
<td>7-12</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>Female Only</td>
<td>7-10</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Female Only</td>
<td>7-12</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Female Only</td>
<td>7-12</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>Male and Female</td>
<td>7-12</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>Male and Female</td>
<td>7-10</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>G</td>
<td>Male and female</td>
<td>7-12</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>H</td>
<td>Male Only</td>
<td>7-10</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>I</td>
<td>Male Only</td>
<td>7-12</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>J</td>
<td>Male Only</td>
<td>7-12</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>37</td>
<td>31</td>
</tr>
</tbody>
</table>

Data Collection, Procedures and Instruments

Collection of Data for Study 1

For Study 1, both the students and teachers took part in interviews that were semi-structured. The semi-structured interview format proved appropriate as it allowed for a list of prepared questions to guide the interview and capture similar and
comparable information while providing flexibility to include other information depending on the responses from the participants. Initial questions established student background information such as current class, teacher and the like. The semi-structured interview questions for students (Appendix B) aimed to elicit student thoughts about the learning environment, student-teacher relationships, syllabus content, use of tools for learning mathematics (including technology) and homework in mathematics.

One set of questions asked about students’ likes, dislikes and feelings towards mathematics. Another set of questions asked students to discuss their achievement in mathematics and to provide reasons for their judgement. Students were also asked about aspects of their mathematics lessons, for example, to describe what happened in a ‘typical’ lesson, to describe their behaviour in mathematics lessons, how they interacted with other students and the teacher, comments on homework completion, whether or not they sought help at home or school for mathematics learning and whether textbooks and technology were used. Students were also asked to comment about differences between mathematics in primary years of schooling compared to their current experiences in secondary school.

Interviews with teachers were also semi-structured with a list of prepared questions that were used to guide the interview (Appendix C) made available to the teachers prior to the interviews. The interview questions aimed to elicit teacher conceptions of mathematics including their approach to teaching mathematics, experiences of working with other practitioners, perceptions of their students understanding and engagement, their views about and attention paid to engaging students in mathematics and the use of key pedagogical tools such as textbooks, technology, assessments and the like.

Initial questions to teachers established background information such as classes taught and length of service. Approximately half of the questions asked teachers about student engagement including what teachers noticed when identifying student engagement, descriptions of what student engagement looked like in their classrooms, their views on the importance of engagement for mathematics, how they promoted engagement in mathematics lessons and how they perceived student engagement in the context of student achievement in mathematics. The following set of questions asked teachers about interaction with colleagues and regarding sharing
information on teaching and programming. The final set of questions asked about use of technology and other tools for teaching mathematics.

The interviews with students and teachers for Study 1 were recorded on an audio device and later transcribed. Field notes recorded information about the students’ favourite subject at school, who they sat next to in mathematics classes, homework habits, and possible career choices. Notes were also recorded about student demeanour during the interview as this was relevant in context of the measures that had determined the student as ‘engaging’ and ‘disengaging’. At the time of teacher interviews, field notes recorded biographical information such as teachers’ qualifications, years of service, years of teaching Year 7 mathematics, as well as noting aspects of demeanour and unusual occurrences. Interruptions or noteworthy events that occurred during the interviews were also recorded.

Study 1 sought to interview both the students and their teachers who had been identified from the latest quantitative data collection phase being at Time 2. It was crucial that the interviews took place in the same school year so that the perceptions of the students and teachers who shared a classroom context and setting were examined within the same context and setting. Previous research notes that perceptions of learning and engagement are context specific and therefore the perceptions of the participants should not be considered in isolation but in consideration of classroom variables such as the classroom environment teacher pedagogy and peer interactions (Deed, 2008). The importance of interviewing the students and teachers within the same school year is reflected in the aims and design of Study 1.

In Australia, there are four school terms that run from the end of January to the middle of December. The interviews and observations were arranged to take place at the start of Term 4, 2009 in the months of October and November. Term 4 is the final term of the school year in NSW schools, which meant that the teachers and students had spent the majority of the school year together and it was expected they would be able to reflect on their experiences in mathematics classes throughout the year.

The interviews took place at the relevant school that the student attended in a room and at a time organised by a school representative (usually the Head of Mathematics or the Deputy Head of the school). The school administration arranged for the teachers to be released from class in order to take part in the interviews. At the beginning of each interview, the researcher confirmed with the students and teachers
that they understood the reasons for interview and that their participation was voluntary. The semi-structured interview format allowed for some flexibility as to the order of questioning which could fluctuate according to the responses by the interviewees. The student interviews each took approximately 20 minutes depending on the length and depth of the students’ responses. The teacher interviews took between 40 and 60 minutes, again depending on the length and depth of responses.

Data Analysis

Analysis of Student Interviews

The approach to data analysis was inductive. Initially, several student transcripts were read to gain some perspective of the types of responses students provided prior to commencing the data analysis. There was a wide variation in the depth of responses to the interview questions from the students. A computer software programme called NVivo (QSR-International, 2008) was used to assist in coding data. With large and extensive data sets, as in Study 1, the NVivo software assists by helping to manage data and ideas, run queries and draw reports (Bazeley, 2007) as well as developing a process for the development of categories that could be clearly understood and scrutinised (Constas, 1992).

The researcher was able to start coding comments that were essentially descriptive of an aspect about mathematics learning, for example, liking mathematics, homework completion and views about mathematics ability. As the reading and coding of transcripts continued, some aspects arose repeatedly and these were identified as key ideas and subsequently established as categories (referred to as nodes in the NVivo programme). It became apparent that several nodes were about similar phenomenon and belonged together. These nodes were attributed to themes and the themes were given descriptive labels representing key aspects influencing student engagement and motivation towards mathematics learning. The interview transcripts were checked again to ensure the appropriateness and consistency of coding (Rogers & Goodrick, 2010). For example, one interview question asked students about their recollection of a typical Year 7 mathematics lesson and coded as ‘Typical Lesson’, however this node was one of seven that contributed to the theme about ‘Students’ Perceptions of Mathematics Teaching’.
The four themes that emerged from the coding of the data were: ‘Students’ Beliefs about their Mathematics Achievement’; ‘Students’ Emotional Responses Towards Mathematics’; ‘Students’ Perceptions of Mathematics Teaching’; and ‘Students’ Behaviours while Learning Mathematics’. Three of the themes broadly echoed the three types of engagement identified by the Frederick Framework (2004): Students’ Emotional Responses Towards Mathematics reflect emotional types of engagement; Students’ Behaviours while Learning Mathematics reflect behavioural engagement; and Students’ Beliefs about their Mathematics Achievement incorporates cognitive aspects of student engagement. The fourth theme, Students’ Perceptions of Mathematics Teaching included not only students’ perceptions of what took place and how they were taught in mathematics lessons (i.e., their perceptions of mathematics pedagogy), it also overlapped with their feelings and their mathematics understandings. Therefore, the coding process documented the origins and nominations of the categories decided on (Constas, 1992).

The process of coding the students’ responses using the four themes was undertaken by the researcher and validated by an additional researcher associated with the MYTEAM Project. The coding for some students was relatively straightforward as appropriate categorisation was clear however some student responses were complex providing greater detail and nuance. The following is an example of the coding process that provides some insight to the decisions made about how the student responses were categorised. When asked “What is your opinion of how you go in mathematics?” one student (who had previously been categorised in the HAD group) responded “I’m pretty good. I go very well in tests. I study with maths. It’s not my best subject but I go really good in tests when I try hard” (HAD3). This response elicited much broader information than just a view of ability. It allowed the researcher to compare the accuracy of the student’s actual achievement level (which in this case was ‘high’ based on the results of the MES) with perceptions of her achievement. It also revealed that the student gauged her achievement level based on her test results. In addition, the student disclosed that mathematics was not her best subject (implying that this student perceived she performed well in other subjects), although she applied herself and studied for maths tests to better her chances of doing well. Information from responses like these was relevant to more than one category and, in this example, certain information was coded to the theme ‘Students Beliefs about their
Mathematics Achievement’ in mathematics and also to ‘Students’ Behaviour while Learning Mathematics’.

Apart from analysing the responses of individual students, the responses were further considered in the context of ‘engaging’ and ‘disengaging’ students and by levels of achievement (in keeping with the categories established when selecting participants for the study being HAD, LAD, HAE and LAE). Again referring to the example given above, “What is your opinion of how you go in mathematics?” the response from the student HAD3 was read in context of all students in the ‘disengaging’ groups (HAD and LAD) and then read in context of all students in the HAD group. In this way, individual student responses were explored, and then considered in the context of other ‘engaging’ or ‘disengaging’ students and finally compared to students who were of a similar achievement level. This resulted in establishing a thorough and rich identification of factors influencing shifts in students’ engagement and disengagement and their relationship to achievement in mathematics relevant to each grouping. This approach presented an alternative method used in previous research (Lutz et al., 2010) and provided specific insights into features of achievement in conjunction with engagement in the context of mathematics classrooms. This process of refinement occurred for each student response coded to the four themes. For each of the themes, factors relevant at individual, classroom and school-level were identified. A summary of the factors identified in each of the student groups for each theme can be found in Chapter 5.

**Analysis of Teacher Interviews**

Interviews with teachers elicited their perceptions of student engagement, motivation and achievement in mathematics, their pedagogical approach to teaching mathematics, their beliefs and views about learning mathematics and the like. The teachers also reflected on and surmised reasons why students started to lose interest in mathematics.

Each of the teacher interviews was transcribed and read several times to gain an understanding of the key themes emerging from the data before the commencement of coding. As with the student responses, the qualitative analysis software programme, NVivo (QSR-International, 2008) assisted in organising the interview data throughout the coding process. As with the approach to the analysis of the student interviews an inductive approach was taken. In keeping with the research
questions for Study 1, the focus was on responses relating to teachers’ perceptions of
(a) student engagement and disengagement and (b) pedagogy and practices for
engaging students in mathematics. The researcher established provisional codes for
major themes as each transcript was attended to, developing and refining like codes as
required until saturation was reached. The following outlines the approach taken to
analyse teachers’ responses including how they described student engagement or
disengagement, the ways teachers identified engaged and disengaged students in their
mathematics classrooms and the strategies used to engage students’ in mathematics.

The analysis of teacher perceptions of engagement and disengagement in
mathematics was approached in two stages. First, teacher comments were identified
and organised by type—behavioural, emotional and cognitive. Drawing on literature
reviewed for the present research that espouses the current conceptualisation of three
types of engagement (Bryson & Hand 2007; Fredricks et al., 2005; Fredricks et al.,
2004; Hughes et al., 2008; Wang & Holcombe, 2010), teachers’ perceptions of
students’ engagement and disengagement were examined with the view to specifically
identifying behaviours, feelings and cognitive components of engagement and
disengagement.

It became clear during this first stage that the range of comments within each
type was broad and required an additional means of differentiation. For example,
considering comments identified as behavioural included “refusing to talk to the
teacher”, “fiddling and chatting to friends” and “keen to ask and answer questions”
thus representing quite different levels or shades of behavioural engagement. A
similar range of comments was also evident for emotional and cognitive types of
engagement.

The second stage of analysis introduced another aspect by considering levels
of engagement within each type. Consideration of the varying levels of engagement
was particularly relevant for: (a) gaining a clearer understanding of what is meant by
student disengagement and (b) contributing to theorising about the unidimensional
relationship between engagement and disengagement.

Research into disengagement (Bryson & Hand 2007; Deed, 2008), disaffection
(Nardi & Steward, 2003), ‘switching off’ (Hockings et al., 2008; Martin et al., 2012)
and alienation towards learning mathematics in academic settings is well documented,
although variations in definitions and descriptions require further investigation.
Attention from researchers to understand what is meant by student disengagement,
how and why it begins, and how it is different from low engagement has become increasingly significant as student interest and retention in mathematics courses declines.

The two-stage approach of teacher perceptions considered two important dimensions of engagement—types and levels. The two dimensions were presented as a framework to help organise and make sense of the teachers’ comments about student engagement and disengagement. At the conclusion of the analysis, it was evident that the framework not only helped in organising and describing engagement/disengagement by type and level, it could also be used as a framework for further application. The framework, named as ‘The Engagement Spectrum’, is used to report and discuss the results of the teacher interviews in Chapter 6.

The analysis of teacher interviews focused on determining the types of strategies teachers reported using and how they were perceived as engaging students in mathematics learning. The teaching strategies used were classified as meeting different students’ needs such as relevance, future value and applying and connecting mathematics. Other strategies that nurtured student internal characteristics such as autonomy and interest as well as those that identified teacher enthusiasm and interpersonal relationships were also perceived. A full discussion of the results of teacher interviews is found in Chapter 6.

Reliability and Validity

Reliability and validity in qualitative research are viewed differently than reliability and validity in quantitative research. As qualitative research is concerned with understanding phenomena from a naturalistic approach—mostly in context-specific settings—researchers are more interested in examination, illumination and understanding rather than measurement. They seek to explain ‘why’ rather than ‘what’. Qualitative research is more concerned about credibility and this is realised through the design of the research, the approach to analysis and the quality of the study.

Reliability and validity are both overarching concepts of the qualitative design of a study and each has different connotations for qualitative research. For example, reliability centres on achieving faithful explanations of enigmatic situations.
Therefore, the need for replication of results is replaced by concerns for “…precision, credibility and transferability…when evaluating findings” (Golafshani, 2003, p. 600). It is relevant to consider reliability regarding a number of aspects of the research such as choice of participants, methods of data collection and approaches to data analysis.

As interviews and observation are common methods for qualitative inquiry, one way of controlling reliability in interviews is to use highly structured interview formats (Silverman, 2005). Structured formats suggest elements of control and consistency—aspects sought after for quantitative research. Restricting the type of interviews used to achieve reliability in this way may not be helpful, however, for the aims of the research. There are other alternatives for achieving reliability including inter-rater reliability. One way of assessing inter-rater reliability is when another researcher uses the same theoretical framework to observe material to establish if they would interpret it in the same way (Cohen et al., 2002), providing credibility and demonstrating levels of precision and evidence of transferability.

For Study 1, inter-rater reliability was established according to the recommendations provided by Krippendorf (2004), who notes the need for those involved in qualitative research to be mindful and careful of using reliability measures and issues several recommendations for achieving reliability. One of the recommendations includes the use of additional coders as a way of ensuring greater reliability of data. Krippendorf (2004) also recommends that the agreed coefficient should measure agreements among multiple descriptions of units of analysis. He suggests that an acceptable level of agreement between two or more scholars should require $\alpha \geq 0.80$.

In Study 1, an additional researcher from the MYTEAM Project independently undertook a coding sample of 13.5% of the student interviews. The second researcher randomly coded six items from the interview transcripts. The coding reliability ranged from 92-100% accuracy with an average of 95.8%. Similarly, 12.9% of the teacher interviews were randomly chosen and coded for five items from the interview transcripts. The coding reliability overall ranged from 87% to 93%. For both the student and teacher interviews, the additional researcher’s results represent a high level of reliability and therefore satisfy the recommendations suggested by Krippendorf (2004).

In terms of presenting a form of qualifying measure, research that demonstrates validity is generally trustworthy. That is, where the means of sourcing
data to support the research are defensible and establish confidence that the design and methods were constructed and carried out in the search for ‘truth’. The design of the present research incorporated two qualitative studies (Study 1 and Study 2) nested within the larger MYTEAM Project (blending two quantitative, two qualitative and an intervention study). Validity is relevant to the design of Study 1 and Study 2, across these two studies and within the MYTEAM Project as a whole.

The design of the MYTEAM Project was purposeful, being longitudinal in nature and employing a mixed method approach where the data gathered from the quantitative phase provided explicit data sets, drawn upon for the qualitative phase. Further, the analysis of data from both the quantitative and qualitative phases informed the design of the intervention study. In effect, the design of the MYTEAM Project itself provides triangulation where the data collected in the quantitative phase were used in other ways for the qualitative study phases, demonstrating its reliability and validity from two research paradigms (quantitative and qualitative), therefore adding strength to the research.

Conclusion

The designs of each Study 1 and Study 2 were interdependent and complementary. Study 1, an Interview Study, used interviews with students and their teachers and focused on identifying and exploring reasons and perceptions for shifts in student engagement in the middle years. Study 1 sought to capture beliefs and perceptions about engagement from two perspectives. Details of the student’s self-report, teacher reports of their students and the themes emerging from the interviews substantiated the key issues arising from the findings.

To complement this, Study 2, using a case study approach, focused on teachers who were effective at maintaining high levels of student engagement in mathematics. Study 2 is described more fully in subsequent chapters of this thesis. Themes for each study were established during analysis of data using qualitative methods, permitting the researcher to examine and identify connections between themes and helping to understand the influences on student engagement and related phenomenon. Overall, the researcher is confident that the design of Study 1, the use of data from the quantitative phase, the varied and purposeful data collection in the
qualitative phase, the instruments used for collection and the approach to analysis is in keeping with the fundamental paradigms of qualitative research.
Chapter 5
Student Results and Discussion: Study 1

The aim of Study 1 was to provide a deep understanding of the precise nature of the factors that have contributed toward shifts in levels of student engagement. In-depth interviews with the students and their teachers resulted in obtaining rich and detailed data from the perspectives of both students and teachers in a range of factors influencing student engagement and learning outcomes. This chapter reports on the results of the interviews with students. Results of interviews with the teachers will be reported in Chapter 6.

This chapter is organised into two sections. The first section discusses the results of the disengaging student groups and the second discusses the engaging student groups. The chapter concludes with a summary of the characteristics of the ‘disengaging’ and ‘engaging’ student groups, directing attention to the range of factors that are both shared and unique amongst students.

It will be recalled from Chapter 4, that students from each of the four groups (low achieving + disengaging (LAD); low achieving + engaging (LAE); high achieving + disengaging (HAD); and high achieving + engaging (HAE)) were invited to interview based on the size of the shifts in engagement and disengagement as determined by their results in the MES component of the MYTEAM Survey at Time 1 and Time 2. Although the students’ overall shifts in engagement were calculated as upwards or downwards, this did not mean that the students recorded all adaptive or all maladaptive scores. In fact, each student displayed a combination of adaptive and maladaptive scores, but overall their net scores shifted either upwards or downwards. The terms ‘engaging’ and ‘disengaging’ are used to depict the overall direction of students shifts in engagement between Time 1 and Time 2. In total, 37 students were interviewed: ten from the low achieving disengaging (LAD) and low achieving engaging (LAE) groups, eight from the high achieving disengaging (HAD) and nine from the high achieving engaging (HAE) group as depicted in Table 5.1.
Table 5.1
Disengaging and Engaging Student Groups

<table>
<thead>
<tr>
<th>Disengaging Students</th>
<th>Engaging Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Achieving (LAD)</td>
<td>n=10</td>
</tr>
<tr>
<td>High Achieving (HAD)</td>
<td>n=8</td>
</tr>
<tr>
<td>Low Achieving (LAE)</td>
<td>n=10</td>
</tr>
<tr>
<td>High Achieving (HAE)</td>
<td>n=9</td>
</tr>
</tbody>
</table>

Note: ‘Disengaging’ students were those whose net scores shifted downwards between Time 1 and Time 2; ‘Engaging’ students were those whose net scores shifted upwards between Time 1 and Time 2.

The sample of students enabled the researcher to understand if both low and high achieving students expressed similar reasons for their current level or recent shift in engagement or disengagement in mathematics. The analysis of interview data helped uncover factors contributing to the shifts towards engagement and disengagement for individual students and identified commonalities across students within like groupings (i.e., LAD, HAD, LAE and HAE). The results and discussion of student interviews begin with the ‘disengaging’ students with attention drawn to features that are shared and different between the low and high achieving disengaging students.

**Disengaging Students: LAD and HAD**

After analysing the interview data, four major themes emerged. The four themes were used to explore reasons for students disengaging from mathematics and included: (a) students’ beliefs about their mathematical achievement; (b) students’ emotional responses towards mathematics; (c) students’ perceptions of mathematics teaching; and (d) students’ behaviours while learning mathematics. Table 5.2 summarises the disengaging students’ beliefs, feelings and perceptions according to the four themes. A full discussion of each theme follows.

**Disengaging Students’ Beliefs about their Mathematical Achievement**

Beliefs about achievement in mathematics were a major theme to emerge from student interviews. Beliefs are defined as “psychologically held understandings, premises, or propositions about the world that are thought to be true” and are linked to powerful emotional events (Philipp, 2007, p. 259). Disengaging students (both high and low achieving) focused on two aspects of achievement: grades and understanding.
<table>
<thead>
<tr>
<th>Student Groups</th>
<th>Students’ beliefs about their mathematical achievement</th>
<th>Students’ emotional responses towards mathematics</th>
<th>Students’ perceptions of mathematics teaching</th>
<th>Students’ behaviours while learning mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LAD</strong></td>
<td>Pass/fail mentality equates with good/bad at mathematics</td>
<td>Feelings of dislike, anger and frustration</td>
<td>Should be fun, include activities involve interactions and talk</td>
<td>Rarely complete homework or do revision</td>
</tr>
<tr>
<td></td>
<td>Overall lack of understanding – strongly linked to negative feelings about the subject</td>
<td>Students try but forget methods and feel ‘confused’ and ‘lost’</td>
<td>Teachers who know how they learn.</td>
<td>Not clear about study strategies</td>
</tr>
<tr>
<td></td>
<td>Know they don’t ‘get it’</td>
<td>Enjoy fun activities/helpful teachers</td>
<td>Extra practices/repeat explanations</td>
<td>Do not seek help at home</td>
</tr>
<tr>
<td></td>
<td>Believe mathematics is important for the future/careers</td>
<td>Feelings of ‘boredom and then ’switch off’</td>
<td>Appreciate teachers’ efforts who explain/simplify</td>
<td>Like to work with friends</td>
</tr>
<tr>
<td></td>
<td>Know they don’t ‘get it’</td>
<td>Enjoy fun activities/helpful teachers</td>
<td>Extra practices/repeat explanations</td>
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<td>Appreciate teachers’ efforts who explain/simplify</td>
<td>Like to work with friends</td>
</tr>
</tbody>
</table>

| **HAD**       | Mostly specific about rank in class | Challenging work requires more effort than before and is less enjoyable. | Quick revision gets their minds in gear. | Seek help from parent/siblings or tutor |
|               | Know they perform well but modest | Do not feel as confident as in primary school | Activities, quizzes, using mini white boards. | Don’t seek help from the teacher often |
|               | Aware of not achieving as well as in primary school but unsure why | Repetition of content is boring | Group work – share dialogue and meaning/builds confidence | Like to help others |
|               | Some attribute errors to rushing or as being insignificant | Some indifference – just has to be learnt | Use computer games for revision |

Competence equates with enjoyment
Most students commented on their grades/scores obtained in class mathematics assessments or their performance ranking in class as a way to explain their achievement level in mathematics. For example, a high achieving student commented: “I’m pretty good. I go very well in tests” (HAD3). By contrast, a low achieving student responded “I don’t really think I do [well]. I get bad marks in it [mathematics]. I get 10 out of 30 for a quiz or something” (LAD2). When asked where she would place herself in the class, she replied “Low, at the bottom”.

There are several possible reasons why students attributed beliefs about their achievement level to assessment scores and test marks. First, some students may have been unaccustomed to making judgements about their achievement in other ways, such as by reflecting on their ability to complete homework or monitoring their learning and understanding during lessons. Alternatively, test scores may have been viewed as the most important measure of achievement and presented a ‘benchmark’ by which students measured their achievement compared to their classmates. In some cases, instead of gauging their achievement by comparing how well they performed to others, some students set their own personal measures of achievement such as when they “just miss a pass by a little bit” (LAD7). Again, the focus was on grades rather than on mastering mathematics concepts.

It is also possible that test scores were the only form of feedback students received about their achievement level or that students placed greater importance on written information communicated by the teachers than oral comments made in the classroom. In the absence of formative feedback, where evidence about student achievement is elicited, interpreted and used to inform subsequent instruction, (Wiliam, 2009), students may come to rely on test scores as the key measure of their mathematical performance rather than their understanding. There was little mention by the students of their teachers providing specific feedback on their work unless they sought further explanations during or after class, which was rare according to the students. It is possible that formative feedback and appraisals about achievement gains (other than those measured by test scores) are either not made explicit to the students or that students pay more attention to test scores as a measure of their achievement.

Apart from these shared characteristics of the LAD and HAD groups, some differences between their beliefs were noted. Low achieving students’ beliefs about their ability in mathematics were strongly linked to their lack of understanding of
mathematical concepts. High achieving disengaging students’ beliefs were influenced by achievement and performance results that were unstable and fluctuated. These differences are discussed below.

LAD students and lack of understanding

Low achieving students reported on their general lack of understanding in mathematics despite teacher and textbook explanations (LAD1, 2) and consequently they usually did not perform well in class assessments. This often led to low achieving disengaging students struggling to understand and to “hope for the best” (LAD9). Many of the LAD students indicated they were aware of their lack of understanding but were reluctant to ask or answer questions in class and even less likely to seek help or feedback from the teacher. Although the students recognised their lack of mathematical content knowledge required to correctly complete tasks they did not know how to access the skills and knowledge they required or what next steps they needed to take to rectify the problems.

Black and Wiliams (2009) note that one of the key benefits of formative assessment is the recognition that there are aspects of mathematics that students fail to understand. Formative feedback about assessment is seen as most effective when the information provided focuses on aspects of performance or understanding. However, in order to be useful to the student, the feedback needs to be related to the task and needs to fill the gap between what is understood and what is aimed for (Hattie, 2009). Not receiving or recognising formative feedback is problematic as many of the low achieving students also reported few strategies that would allow them to monitor and regulate their own learning in a systematic and useful way. Therefore, they may not have been aware of or able to use successful strategies for thinking about or studying to improve their achievement in mathematics. The concern expressed by low achieving students about not understanding mathematics—about not ‘getting it’—not only influenced how they considered their potential achievement in mathematics but was strongly associated with other affective factors such as their feelings, interests and attitudes (Grootenboer & Hemmings, 2007).

Several low achieving students commented about their lack of achievement and competence and this was reflected by negative perceptions of themselves as mathematicians: Examples of responses include: “I don’t think I am very good at it” and “I get bad marks in it” (LAD3): “Yes [I am] sort of at the bottom [of the class]”
...and “Last year I felt oh yeah I am doing alright yeah but then this year oh my God I am doing badly” (LAD5). These responses illustrate how students’ lack of understanding and low achievement in mathematics is associated with beliefs about their ability. Students’ beliefs about their mathematical achievement involve beliefs in their ability to understand and master concepts. It is therefore relevant how student self-beliefs are developed. According to Bandura (1997), a student’s self-efficacy is formed from four sources: previous performance and mastery experience; observing others in action; feedback and judgement from others in the students social network (such as teachers and parents); and through emotional and physiological states such as arousal, mood, fatigue and anxiety.

Many of the students in the LAD groups experienced repeated poor performance, a lack of mastery skills, a perceived absence of formative feedback and feelings of incompetence and anxiety. As a result, these students may find it difficult to build and maintain a strong sense of self-efficacy because of numerous negative factors. In addition, these students may not feel they can attain valued outcomes (such as completing tasks) and therefore their need for competency is not being fulfilled. The need for competence is one of the three psychological needs proposed by Self Determination Theory (SDT) (Deci & Ryan, 2000). If the need for competence in conjunction with other needs such as autonomy and relatedness is not met, the students self-determining behaviours may be weakened, so that their goal orientations are more extrinsic in nature than intrinsic. This may be one explanation for the focus on marks and grades as a measure of achievement by this group of students rather than on the merits of inherent understanding of mathematics concepts.

HAD students and variable achievement

In contrast to low achieving students, high achieving disengaging students credited different reasons for their performances in mathematics. High achieving students often attributed poor marks to factors external to their ability. For example, one student commented: “Sometimes I make mistakes if I run out of time in a test and I am rushing” (HAD1). Students from the high achieving group were also able to be quite specific (and a little modest) in assessing their mathematical achievement. For example: “I do alright, I usually get in the high 80s or low 90s” (HAD4); and “In the exams I normally come third or second” (HAD5). These responses indicate that the students had positive and accurate perceptions about their position in the class,
indicating that they were better able to monitor their progress than low achieving students.

In Study 1, some of the high achieving students perceived that their performance in mathematics had fallen during the first year of secondary school. Student HAD6 commented on his position in class as being “maybe a bit higher than middle”, adding that prior to secondary school “I used to be higher”. When asked for reasons, he responded, “I was one of the smarter kids in primary school but in high school, I don’t know, I just lost it I guess”. This comment is an example of a number of students in the HAD group who were unsure why their level of achievement was changing, which led to an element of uncertainty and insecurity. As one student reported: “I am not as confident as last year” (HAD4).

Watson (2010) notes that dealing with difficulties and unfamiliar mathematical concepts is likely to influence student engagement levels as they enter secondary school and suggests that students require appropriate guidance from their teachers to support their cognitive and emotional needs. Similarly, Martin (2003, 2007) identifies uncertain control as an impediment to learning that may lead to a risk of helplessness or disengagement in mathematics. Given the HAD students had previously experienced high achievement in mathematics in primary school, uncertain control about their mathematics achievement in secondary school may cause them to question their competence—recognised as an important need and necessary for any type of motivation (Deci & Ryan, 2000).

The effect of falling competence in mathematics also influenced students’ beliefs about their achievement potential, as several students indicated they were unsure if they would continue to study mathematics beyond compulsory requirements (Year 10 in NSW). However, not all high achieving disengaging students indicated that they were concerned about their results and some seemed more resilient to setbacks or making errors. Several students were better able to explain reasons for their errors and indicated they knew how to overcome these problems. Examples include: “If I make a mistake it is probably because I don’t know it” (HAD1); and “Just silly mistakes, like just say in algebra, if there was a negative, I might forget to put in the negative sign. Not anything big really” (HAD 4).

In summary, low achieving students’ beliefs about their achievement levels and lack of understanding was associated with negative feelings about their competence and low self-efficacy, which are factors identified by Martin (2003) as
significant for motivation and engagement. By contrast, high achieving students were not concerned with a lack of understanding, however some had experienced weaker performances in assessments than in the past and this was associated with confusion and uncertainty about their future competence in mathematics. Therefore, although both high and low achieving students indicated low levels of self-efficacy they attributed different reasons for this, which demonstrates the individual nature of learning and highlights the need for different responses to address the causes of low self-efficacy.

**Disengaging Students’ Emotional Responses towards Mathematics**

Students’ emotions towards mathematics emerged as another major theme from the interview data. Comments made by students about their overall enjoyment, motivation, interests, attitudes, likes and dislikes about mathematics were included in this theme and the emotional aspects of engagement were therefore captured (Fredricks et al., 2005; Fredricks et al., 2004; Grootenboer & Hemmings, 2007; Wang & Holcombe, 2010). Emotions are seen to influence motivation patterns and therefore provide clues regarding student behaviour. Emotions are central to social interactions, cognitive processing and engagement and so are highly relevant in the context of learning mathematics in academic settings (Linnenbrink-Garcia & Pekrun, 2011). It was clear from the student responses that all of the students interviewed experienced feelings of dislike or frustration when they did not understand some aspects of mathematics. However, for students in the LAD group—where there was much about mathematics that they did not understand—the association between their degree of understanding and their negative feelings about mathematics was strong. In particular, feelings of confusion, anger and frustration were evoked.

**Emotional responses of LAD students**

The feelings of several low achieving students reflected strong emotional responses towards mathematics, with LAD2 reporting:

I don’t understand it…I’m not getting it. Yes, it gets confusing. It makes me feel annoyed and angry. Well I’m angry at it because I want to get it

Other students reported difficulties recalling steps to solve problems resulting in them feeling “confused” and “lost”. One student cited her reasons for disliking mathematics as:
When I can’t seem to figure out some answers…and I can’t remember…and that even if [the teachers] help … I forget how I did it or I just keep getting lost in it (LAD7)

These are some examples of students who reported a lack of success at mathematics citing emotional and physiological states such as anger, anxiety, and fatigue during their interviews. These emotions were reported at various intensities by the students and may well reflect intensities peculiar to mathematics. To elaborate, McLeod (1992) notes that feelings such as anxiety are viewed as intense when expressed as fear but less intense when expressed as worry or dislike. Anxiety is one of the factors identified on Martin’s Wheel (2003) as impeding engagement and was a factor evident for many students in the ‘disengaging’ groups. In Study 1, although no students reported feelings of ‘fear’, several low achieving students expressed feelings of frustration, hate, and dislike. A student who did not feel motivated or engaged by mathematics and wanted to discontinue learning the subject explained:

I don’t really want to do it [mathematics] because I don’t understand it and I don’t really like it…I just think it is boring and not fun…I switch off…and realise that after half an hour I haven’t been listening (LAD2)

Comments such as these were typical of students reporting a downward shift in their engagement in mathematics and appeared most at risk of becoming isolated and disengaged from mathematics. Although previous research has identified characteristics of students who are disengaged or who show signs of being ‘disaffected’ with mathematics (Nardi & Steward, 2003), to date there has been little research considering how or why individual students’ characteristics actually shift from being engaged to poorly engaged and to disengagement.

Some students who reported that they had to struggle to understand mathematics also reported that they felt frustrated and had developed a dislike and anger towards mathematics. As noted by Brown, Brown and Bibby (2008), it is reasonable to speculate that students’ negative feelings about mathematics are bound up with their perceptions of the difficulties they encounter. Midgley, Feldlaufer and Eccles (1989) considered student perceptions of teacher support to be a strong indicator of the quality of the relationships between students and teachers. Further, the perceived level of teacher supportiveness is seen to influence students’ perceived intrinsic value for mathematics—increasing when support is perceived to be high and decreasing when support is perceived to be low. In the student interviews, many students reported that their difficulties with understanding were to some degree
alleviated by the teacher, specifically, what teachers did and how they influenced the students’ understanding and enjoyment of mathematics.

Several of the disengaging students, both high and low achieving, commented that their teacher made it fun by using the smart board, activities, games and working in groups, saying that it helped them to understand the concepts (LAD1, LAD4, LAD7, HAD1 and HAD2). One low achieving student reported that “sometimes if there are games I find it interesting to do maths because we work as a group and it’s easier to solve things” (LAD1). LAD3 explained that the teacher helped her understand because “[the teacher] knows how I learn…I put my hand up and say, what does this mean? How do you get that?” This indicates two important influences operating for this student. First, understanding what she learnt in mathematics influenced how much she enjoyed it. Second, the efforts of the teacher to attend to her needs and ways of learning influenced her feelings about mathematics. Despite the fact that LAD3 did not like mathematics in general, she enjoyed some lessons because her teacher helped her understand the mathematics, which in turn encouraged her to ask questions and persist with learning.

**Emotional responses of HAD students**

The high achieving disengaging students revealed a somewhat different story, generally falling into one of two categories. First, competent students (HAD4, HAD6, HAD8) who found repetition of concepts and lack of challenge in mathematics as “kind of boring” particularly when the “teacher explains stuff about what we already know” (HAD4) and are asked questions to which they already know the answers (HAD8).

The second category of student were those who experienced success at mathematics in primary school but who were now encountering challenges and found mathematics more difficult in secondary school. These students explained that they had to apply more effort to master new concepts. For example, one student reported, “It has gotten a bit harder so I haven’t really enjoyed it that much, as much as I used to” (HAD7). Another student commented that mathematics in Year 7 was not boring as such, “but you have to put a lot of effort into it” (HAD6). Students reported mixed feelings about the challenging mathematics work, liking the challenges of new material but not liking feeling confused by it. For example: “I like it more because we get to learn new stuff but I like it less because it is hard sometimes” (HAD2).
Other students were indifferent as to whether they enjoyed mathematics. For example: “It doesn’t really matter if you enjoy it. You are just there to learn…It would be nicer if it was fun” (HAD1). This view is indicative of an ambivalent perception towards mathematics and is noted by Nardi and Steward (2003) as a possible sign of a lack of engagement. In sum, HAD students reported varying reasons for their feelings such as linked to their desire to meet academic goals, the lack of challenge (leading to boredom) and being able to cope with challenge (requiring more effort). The students also acknowledged the role of their teacher in making mathematics fun and trying to help them understand the content. Students’ perceptions of mathematics teaching are discussed in the next section.

Disengaging Students’ Perceptions of Mathematics Teaching

Students’ perceptions about the teaching of mathematics were another theme to emerge from analysis of the interview data. In a learning context, students’ perceptions are defined as how students interpret factors and respond to the environment subject to their personal ‘filters’ and therefore is selective in nature (Broadbent, 1958; Dart et al., 2000; Spudich & Spudich, 2009). Study 1 was concerned with investigating the students’ perceptions of the teaching practices that shaped their own learning. Such perceptions can influence levels of ‘disaffection’ (Nardi & Steward, 2003) and plans for studying mathematics in the future (Brown et al., 2008).

First, students reported their perceptions of a ‘typical’ mathematics lesson and referred to related aspects such as the use of a textbook, technology, activities and their perceptions of teacher encouragement and/or indifference. Second, the students commented on how teachers attended to students’ understanding of mathematics concepts. In this way, the extent of student engagement is revealed in terms of how the students perceived their needs were met by the teachers’ practices (Skinner & Belmont, 1993).

Students’ perceptions of a typical lesson

When students were asked to describe a typical mathematics lesson, the majority explained lessons that followed a similar format. They reported that the typical lesson often started with some revision or checking of homework or used homework as a starting point for revision. The main part of the lesson was either a continuation of concepts from the previous lesson or the introduction of a new ‘topic’
or ‘chapter’ from their textbook. Reports from the students indicated this always began with the teacher explaining a concept to the whole class. This was often supported with examples on the blackboard or an electronic interactive whiteboard (‘IWB’) and, in some cases, students were asked to come up and complete examples for the rest of the class. Students recounted that they made notes and recorded examples in their note or ‘rule’ books for future reference. The teacher then set exercises from the textbook for students to work through or provided worksheets for further practice of examples. Students encountering difficulties were encouraged to refer to their notes or ask the teacher for help. If they needed teacher support, the teacher would come to them or they could go and see the teacher at their desk for further explanations. Any uncompleted class work tended to be set for homework.

Several students reported finding the nature of lessons repetitive, with significant lengths of time spent listening to the teacher. Some students found the lack of interaction as ‘boring’, causing them to ‘switch off’ and stop listening. LAD2 reported:

Well we just go in and he turns on the smart board and he explains things like for fifty minutes and the rest of the five minutes he says do a chapter and by then you are already bored and you don’t really understand it

Previous research has found that students tend to find repetitions of instruction and rote learning as tedious (Nardi & Steward, 2003) and boring (Marks, 2000). These teaching practices were also cited as reasons why secondary students find mathematics dull and a cause of reduced participation in mathematics classes (Brown et al., 2008).

Despite student reports of a ‘typical lesson’ as generally lacking any variety, further probing during interviews revealed that a number of teachers did offer variety in their approach to instruction, which proved to be more effective for engaging students. For example, where teachers asked students to come to the front and solve questions on the board, the students perceived this as being more interesting and fun than waiting while the teacher explained the work again for others. Some students reported that some teachers used activities requiring them to work with partners, taking turns to ask and answer questions of each other and this form of collaboration was viewed positively (HAD5). A few students described using mathematics websites that were accessed online in their classrooms, where they could take part in games (LAD7) and others reported that activities involving using dice and manipulative
objects were enjoyable (HAD1). One student reported that when starting a new topic, they were asked to brainstorm their ideas about possible lesson content (LAD1) and this too was perceived as a positive activity. Lessons perceived by the students as being interesting and enjoyable often involved activities requiring students to participate, interact and allowed discussion or sharing of information (LAD4, LAD7, LAD10, HAD1, HAD2, HAD3, HAD4 and HAD5). For example:

[The teacher] explains it in a fun way and he lets us do activities...because we actually do interact. It makes it more fun and it makes you want to listen...sometimes we are allowed to go and put our answers on the board (HAD2)

Some students commented on the use of warm-up activities such as oral lesson starters that “help you get into the lesson faster” (LAD10). Several students referred to their teachers’ use of mini-whiteboards (where each student had their own A4 size laminated board) in class (HAD1, HAD3, and HAD4) as being interesting and useful, by involving the whole class at the same time. Not only was using the mini-whiteboards perceived as collaborative, when all the students simultaneously displayed their answer to the teacher it removed pressure from any one student to provide the solution (HAD3). Mini-whiteboards were also reported as providing different ways of working and used for “revision and just doing things quickly” (HAD3) and offered variety by altering the pace of the lesson and the way students could record their mathematical thinking.

Several students reported that working in groups was more appealing than working alone and that they learned better when “everyone gets to talk and then we all understand each other so we know what we’re doing” (LAD6). Another student said the lessons he found most interesting were “the ones where the whole class does something together, not where you just work as individuals” (LAD9), however, he noted that he usually had to work independently for most lessons. Feelings of being isolated within the mathematics classrooms have been cited in other studies as being associated with negative feelings towards mathematics (Nardi & Steward, 2003).

In summary, students from the disengaging group revealed aspects indicating their likes and dislikes as well as what motivated and engaged them in mathematics. It was not unexpected that some of the ‘disengaging’ students reported experiencing episodes of engagement. Williams and Ivey (2001) noted the idiosyncratic nature of some students’ feelings (likes and dislikes) about mathematics and what they attributed to their lack of engagement in mathematics. It is helpful to understand the
episodes of engagement that students experience because it indicates that there are types of activities and forms of teaching practices that are appealing and can be utilised to arrest further student disengagement in mathematics.

Students’ perceptions of teachers attending to their understanding

Earlier in this chapter it was reported that a lack of ‘understanding’ and confusion about mathematics content was bound up with students’ negative feelings towards mathematics. This was particularly prevalent for students in the disengaging groups, whose perceptions of teacher assistance influenced their engagement in mathematics. In some instances, the teacher asked students to come to them individually for help or they walked around the room answering questions and re-explaining material as required. In other cases, teachers were described as being more passive, staying at their desk, waiting for students to seek them out. For LAD2 this was perceived as the teacher being indifferent to her needs:

[He] just gives you a chapter to do in the textbook. We have to do a certain amount. If you put your hand up he really doesn’t pick you. You will have your hand up for 15 minutes and he still won’t pick you. So you just put it down and ask someone else

In this situation, the students’ need for understanding mathematical concepts were not being adequately addressed by the teacher, leading to frustration and resulting in her seeking help from classmates. Not having her questions answered reduced her access to completing the required mathematics tasks and left the student feeling what she described as alienated from the learning experience. This feeling of alienation is similar to a characteristic Nardi and Steward (2004) call depersonalisation that contributes to disaffection.

Receiving timely and effective support that attends to the understanding of material, personal mastery and self-improvement has been found to contribute to student confidence and self-regulation strategies (Wang & Holcombe, 2010). In terms of helping with understanding mathematics, reports from several students suggested that they appreciated teachers’ efforts to address their needs. Some LAD students referred to receiving help from their teacher who made mathematics fun, exciting, and made jokes. Students perceived their teachers were “nice and friendly” (LAD4), and assisted them individually, reporting that for “every single thing that I ask him, he [the teacher] always helps” (LAD10). Students also perceived that their teachers’
explanations tapped into their way of thinking and learning about mathematics seeming to “always know what I have to do” (LAD10).

Despite the reports of teacher assistance, these students were identified as disengaging. One possible explanation for this is that, although making lessons fun and being perceived as friendly meant students were more inclined to take part in their lessons, it did not necessarily ensure that the teachers’ practices were effective for obtaining cognitive or academic engagement. While encouraging student participation in school work is important for behavioural engagement, cognitive engagement in academic work is viewed as a necessary condition for learning and most likely to lead to increased achievement outcomes and is therefore crucial in learning settings (Skinner & Pitzer, 2012; Usher & Kober, 2012). It is also possible that the teachers of low achieving students could be too helpful. If activities are perceived as too easy, they may provide little meaning for students as needs for competency may not be satisfied. Continually reducing challenge levels for students to achieve a level of success could send a message to students that they are not capable of successfully completing the activities or tasks themselves (Ross & Bergin, 2011).

Conversely, HAD students reported that the intent of the teacher was directed toward ensuring whole class understanding. Students reported that “the teacher makes sure we know it” (HAD4) and “explains in-depth” (HAD1), checking everyone knows what they are doing before moving on. HAD6 said that if he has a problem, his teacher would “help me understand it and then usually give me another exercise to practice it”. Some teachers helped their students scaffold their learning, for example: “he explains it and if we need help he simplifies it and makes it easy to understand” (HAD2). Given that teachers were perceived by HAD students to focus on understanding, it is a little puzzling why these students were disengaging. A likely explanation is that the students’ uncertainties about particular mathematical concepts and wavering achievement levels had influenced their feelings of competence and confidence in achieving future success in mathematics, emphasising the importance for teachers to attend to factors underpinning student engagement as well as supporting student achievement.

In summary, although students of different achievement levels reported similar feelings of enjoyment when able to take part in activities and tasks that required active participation and discussion with their classmates, their reasons for enjoyment varied. LAD students reported instances or episodes during lessons that they perceived as
engaging suggesting there are activities and forms of teaching practice that appeal to them. By contrast, HAD students found the same activities interesting because of the opportunity to share their thinking (and possibly confirm they were on the right track) with their peers. This suggests that high achieving students were receptive to ways of working in mathematics that appealed to affective dimensions such as their interests and for activities that built confidence, not solely determined by their success in mathematics but influenced by a combination of factors.

**Disengaging Students’ Behaviours While Learning Mathematics**

Students’ reports about their behaviours while learning mathematics included accounts about how they perceived they conducted themselves in and out of the classroom. Behaviours referred to included: the frequency that they asked and responded to questions; how regularly they listened in class or requested help with mathematics; their level of perseverance; approach to homework; application of study strategies; and whether they talked about mathematics with their parents and friends.

**Behaviours of LAD students**

The LAD students generally agreed that they often preferred to ask their friends for help rather than the teacher because their friends “…usually help me to understand things” (LAD4). Most of the students from the LAD group mentioned that working with friends gave them the opportunity to give and ask for help, clarify their understandings and that talking to and working with others was more enjoyable. The role of friend as a support for learning is identified by Arnot and Reay (2004) who noted that friends can point out if work is right or wrong, and at times shield each other from humiliation. Despite the preference of students to seek help from their friends (and teachers not always being immediately available to help students) students acknowledged that many teachers did not allow them to sit with their friends in mathematics classes. In terms of getting help with mathematics at school (apart from their friends), some disengaged students reported that they asked the teacher in class but none reported seeking their teacher’s help outside of class time. Only one student mentioned that she sometimes attended homework club after school where she received help with mathematics work (LAD6).

When preparing for tests and assessments, several LAD students reported that they were not proactive or did not use specific strategies. One student reported that “Sometimes I’ve got a plan” (LAD10) and another stated “I don’t go so well cause I
barely study. I don’t like studies” (LAD7). LAD1 reported that she made an effort to study but her strategy was limited: “I just keep trying going over it and try to understand it more clearly”. There were also instances where students seemed to sabotage their chances of being more successful, knowing that studying would help but they either “forgot” to do it or found themselves “too busy” to study. Martin (2003) identifies self-handicapping as a maladaptive behavioural factor which is evidenced by students who reduce their chances of success in mathematics by putting off work, not trying or wasting time instead of attending to the work that needs to be done.

It was interesting to record that although the LAD students acknowledged their lack of enjoyment, understanding and proactive behaviours in mathematics lessons, they did not perceive themselves as ‘disengaged’. One student categorised as ‘disengaging’ said she could tell disengaged mathematics students as those who “don’t really look interested in it. They just do it because they have to and they get bad marks” (LAD2). Similarly another student considered that ‘disengaged’ students “don’t usually pay attention. Get mostly in trouble. Don’t answer the questions. Just sit there with their books closed” (LAD1). Disengaged students were described by students as those who did not participate, ask questions or record notes in their books and also ‘mucked around’ and did not listen. The students making these observations saw themselves differently—while they had shifted towards disengaging they were not disengaged. They were still ‘trying’ in mathematics, they were not disruptive nor entirely ‘switched off’.

Behaviours of HAD students

Several high achieving students mentioned that they did not ask the teacher for help as often as they should (HAD7 and HAD8). Sometimes students liked to sit with friends, not to ask for help but to supply it. As one high achieving student commented: “They [other students] sometimes need my help, they’re not really good at maths and I like to help them” (HAD3). It appeared that working with peers was beneficial to some extent by enhancing affective factors as some students felt ‘good’ about being able to help and support their friends to overcome difficulties (Boaler, 2008).

High achieving students did not make many specific comments about study strategies; however, several talked about asking their parents (mostly fathers) for help
with mathematics at home (HAD3, HAD4, HAD5, HAD6 and HAD8). By contrast, none of the low achieving students reported talking to their parents about mathematics. Several of the high achieving students reported completing extra work at home, using interactive computer programs (commercial products) for help and revision (HAD3, HAD4 and HAD7), and indicated that they planned to study for tests.

**Summary of Disengaging Students**

LAD students reported mixed feelings about mathematics, with some indifferent to it and some liking it. Despite this, all of these students believed that they were not very good at mathematics. Several of the maladaptive components identified on Martin’s Motivation and Engagement Wheel (2003, 2007) were evident amongst low achieving students such as self-handicapping when students failed to study in a timely manner, thereby reducing their chances of success. Uncertain control was also evident when LAD students were confused about how to do well or avoid doing poorly. Many of the students attributed their continued efforts with mathematics to their teachers’ encouragement and several students reported that their teachers made mathematics enjoyable, particularly when they included activities that allowed them to actively participate in class or work in groups with their friends.

However, the students in the LAD group remained ‘disengaging’ in respect of mathematics, indicating that encouragement and amenable learning environments were not always enough to cultivate the students’ belief of success and need for competence. This may be because their mathematical capabilities were so underdeveloped that they had limited opportunities for attainment, which may have acted to confirm beliefs about their inadequacies (Usher, 2009). Additionally, Midgely, Feldlaufer and Eccles (1989) suggest that, because performance does not provide incentive, low achieving students may be “particularly sensitive to the characteristics of their teachers” (p. 982) and levels of support provided by them. A deficit of adaptive factors was also evident in the low achieving disengaging students. In particular, a lack of self-efficacy and confidence were noticeable. Factors reflecting cognitive engagement, such as mastery orientation, planning of work and task management were also low or absent for the majority of these students.

HAD students believed that they achieved reasonably well at mathematics, often citing their marks in tests and place in the class as evidence. Most reported that
they liked mathematics although several were indifferent. In common with LAD students, they were concerned about any lack of understanding. However, unlike the low achieving students, they were more likely to be proactive in seeking help from teachers, parents or via other resources such as computer programmes.

The main concern for many HAD students related to either coping with new and challenging material or the lack of stimulation or being ‘bored’. Several of the high achieving disengaging students reported some confusion about their apparent decline in performance and this resulted in uncertainty about their competence. Declines in performance could be due to a lack of mastery of mathematical concepts and skills that only became apparent once the students encountered the secondary school mathematics curriculum. The combination of uncertainty and wavering performance indicated possible changes to their goal orientations. A focus on performance is consistent with findings that suggest that orientations towards performance-approach goals increase during the middle years of schooling (Middleton & Midgley, 2002). Unfortunately, this is also consistent with findings demonstrating that performance-approach orientations can develop into performance-avoidance orientations, particularly when the students’ perceptions of their competence wavers (Linnenbrink-Garcia & Fredricks, 2008). In the following section, attention is directed toward the perceptions of students who were identified as ‘engaging’, both high and low achieving.

**Engaging Students: HAE and LAE**

Engaging students evinced upward shifts in adaptive measures and downward shifts in maladaptive measures on the MES component of the MYTEAM Survey between Time 1 and Time 2. Generally, the engaged students from both the high and low achievement groups presented a positive approach to mathematics and were the students who most clearly indicated that they liked mathematics. The four themes were again used to explore reasons for students engaging in mathematics. Table 5.3 summarises the engaging students’ beliefs, feelings, perceptions and behaviours according to the four themes and a discussion of each theme follows.
Table 5.3
Summary of Engaging Students’ Reports by Themes

<table>
<thead>
<tr>
<th>Student Groups</th>
<th>Students’ beliefs about mathematical achievement</th>
<th>Students’ emotions toward mathematics</th>
<th>Students’ perceptions of engaging mathematics teaching</th>
<th>Students’ behaviours while learning mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAE</td>
<td>Okay at some mathematics</td>
<td>Like learning even though it requires more effort</td>
<td>Like to hear as well as write explanations</td>
<td>Will ask for help from the teacher in class</td>
</tr>
<tr>
<td></td>
<td>View themselves as about average in the class but not on tests</td>
<td>Like being challenged – enjoy when they ‘get it’</td>
<td>Teachers always try to help them understand</td>
<td>Will seek help at home. Complete homework</td>
</tr>
<tr>
<td></td>
<td>Non specific about place in class</td>
<td>Like a variety of activities</td>
<td>Teachers offer more than one method – students choose which helps them</td>
<td>Revise for exams even if only have a vague plan.</td>
</tr>
<tr>
<td></td>
<td>Prepared to try first and then ask for help</td>
<td>Difficult but has to be done</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAE</td>
<td>Make accurate assessments of their ability</td>
<td>Like being competent and find it easy</td>
<td>Teacher goes over examples until all students understand.</td>
<td>Know they need to listen and ask questions/clarify meanings</td>
</tr>
<tr>
<td></td>
<td>Know they achieve well and confident of their ability</td>
<td>Like learning new things, with more steps</td>
<td>Class asked to brainstorm concepts at the start of the topic to help orientate their thinking</td>
<td>Sit at the front of the room or close to teacher</td>
</tr>
<tr>
<td></td>
<td>Know when they do and don’t understand</td>
<td>Know it is important for later in life/future</td>
<td>Build understanding of certain concepts within the topic.</td>
<td>Seek out ‘smart’ friends</td>
</tr>
<tr>
<td></td>
<td>If confused, they seek help</td>
<td>Like and enjoy the subject</td>
<td>Like short cuts and ‘tricks’ provided by the teacher</td>
<td>Complete homework and revise work</td>
</tr>
</tbody>
</table>
Engaging Student’ Beliefs about their Mathematical Achievement

Similar to students in the HAD and LAD groups, students who were identified as engaging in mathematics also gauged their mathematics achievement mostly by their ranking in the class or results of recent assessments. However, their comments tended to be more specific and were accompanied by clearly articulated reasons for their beliefs.

LAE students’ beliefs

Low achieving engaging students tended to be less specific about their place in the class, describing their ability as “average” or “around the middle of the class”. Several LAE students such as LAE8 mentioned that they usually “got things right” when marking their mathematics answers in class. LAE7 commented that: “I tend to get it, but when it comes to tests, I don’t get it that [well]”. Despite performing poorly in test situations, low achieving students felt confident of their achievements when working in class and this knowledge was adequate to maintain their belief that they would achieve understanding if they persisted.

Some LAE students also indicated awareness of their lack of understanding and actively sought help if they needed it. For example, LAE4 reported:

I go pretty good, but sometimes like if I don’t understand something I won’t go really good because I find if I don’t understand something and I don’t ask and then I don’t get the work right

To overcome difficulties, LAE4 explained his approach for seeking understanding as follows: “I’ll start whatever it is and then I’ll find it difficult” so I will “ask the teacher to explain it again” and then “I know when I’ve got it because I find it easier to do and I get the hang of doing it”. Another low achieving engaging student explained that he was aware he needed the teacher’s help when he could not resolve difficult questions on his own but otherwise could manage independently (LAE7).

Several LAE students mentioned particular concepts in mathematics were “hard to understand” and that they did not feel like they knew what was going on “some of the time” depending on “the topic” (LAE2). Other students mentioned some mathematics concepts were more difficult than others (LAE6) and “I think I’m okay in some parts” (LAE5). These students also demonstrated a desire to understand, recognising they were having difficulties and trying to overcome on their own or by seeking help. This usually resulted in these students being able to resolve difficulties and they were able to assess their progress or understanding and could then continue with their work independently.
HAE students’ beliefs

By contrast, high achieving engaging students provided specific reasons for their beliefs about their ability. One HAE student considered that he was “pretty smart and pretty good at maths…on tests and stuff I get good marks… [I am] one of the higher people in the class” (HAE8). Most students in the HAE group felt they were in the middle to high range in the class. When asked how they determined this the students referred to marks on assessment tasks (ranging from 66% to 90%) or by referring to their rank in a test. For example, HAE1 reported: “I’d say I am pretty high, I normally come third. In my last test I came first”. Another student who placed himself near the top of the class thought that he obtained “good grades and I work hard for it” (HAE9). High achieving engaging students also reported that they intended to study mathematics throughout their school years and mentioned they were interested in careers that relied upon a mathematics base such as an actuary (HAE2), engineer or architect (HAE9), accountant (HAE1), mathematics teacher (HAE4) or forensic scientist (HAE7).

HAE students were generally self-assured when describing their performances in mathematics, referring to occasions where application and effort had helped them, further reinforcing the value they placed on studying. Previous success with mathematics appeared to give them confidence and surety about their capacity for future achievement, resulting in a confirmation of their competence and developing a strong sense of self-efficacy. For example, when asked during interviews why she might take mathematics later in secondary school, HAE2 replied “I’m pretty good at it and I enjoy it and I think it can really help in doing other stuff”.

Several of the high achieving engaging students described a metacognitive approach to learning mathematics, demonstrating they were monitoring their learning and were aware of what they did and did not know. For example, one student explained: “When I understand something, I know, because it makes sense to me and if someone asks me I can just tell them. If I don’t know when they ask me I will be unsure (HAE1). Such students were strategic, seeking help if needed it and others they got confused, they sought help by asking the teacher or someone around them. These students portrayed an intrinsic approach to learning. For example, HAE1 used her initiative, working on aspects of mathematics she had difficulties with as illustrated by this comment: “Sometimes if I don’t get things in class I go home and practice them. Like we learnt long division yesterday and I just practice it”. These traits are indicative of several adaptive cognitive and behavioural factors including valuing, mastery
orientations, self-efficacy and persistence, identified by Martin (2003) as being important for enhancing motivation and engagement.

In summary, students from the ‘engaging’ groups typically believed they were either good at mathematics (high achieving) or capable of becoming good (low achieving) and were focused on spending time and energy to invest in mathematics learning (Fredricks et al., 2005). Despite finding some work difficult at times, these students persevered with trying to understand mathematical material. They also utilised strategies for learning to overcome setbacks and difficulties or checked with the teacher to clarify their learning. Underlying factors such as persistence and intrinsic orientations to learning are adaptive behavioural factors on Martin’s Motivation and Engagement Wheel (2003).

Engaging Students’ Emotions Responses towards Mathematics

Generally, engaged students reported positive feelings towards mathematics, although the intensity of feelings between low and high achieving students was different. Student reports also revealed that the reasons for enjoying mathematics varied between individual students even amongst those in the same group.

Emotional responses of LAE students

Several of the LAE students said mathematics was their favourite subject and they enjoyed “the learning part” (LAE10) and “learning new things” (LAE8). As LAE4 commented: “It’s a little harder than primary school, but I’m learning more”. Some students also liked the challenge of “solving different problems” (LAE9) and enjoyed “hard things where you can do it by yourself” (LAE7). Such responses indicate that despite their low achievement level, these students were enjoying learning and mastering new concepts in mathematics. This was quite a contrast to the LAD students who were much more concerned about their lack of understanding than seeking new challenges. Even when faced with difficulties in mathematics, LAE students reported a positive response. For example:

Mostly I think it is difficult but I don’t really have feelings that I hate it…I know it is all difficult but I have to get on with it… I know I have to do it. So I sit down and have a positive feeling about it and I do it (LAE7)

Emotional responses of HAE students

Most of the HAE students, reported that they enjoyed and liked mathematics but not always for the same reason. Four students linked their ongoing enjoyment of mathematics to their level of competency because they found it “easy” to understand (HAE2, HAE3, HAE4
and HAE9). Three mentioned that they liked learning new things and work that required several steps like problem solving (HAE1, HAE2 and HAE6), since “there’s a lot more interesting and more challenging work” (HAE2). Four HAE students reported that maths was their favourite subject with two of these students reporting effusively that they loved maths and always had, recalling previous successful experiences with mathematics during primary school. Their love of the subject endured even when they were bored at times, such as when the teacher was explaining something they already understood. HAE1 reported that on these occasions “…[I] try and make it challenging...if he [the teacher] sets a question I do it and then I try to explore other ways to do it to see if there is an easier way than I already know”, thus setting herself challenges to alleviate boredom.

In summary, although both high and low achieving students enjoyed mathematics when it was presented as fun games, LAE students mentioned more often that the activities by which they learn mathematics, and the degree to which they understand it, played a role in their enjoyment of mathematics. The HAE students portrayed a high level of confidence in their mathematical abilities, reported their enjoyment of learning mathematics, acknowledged that they found it useful and understood its importance for the future. HAE students also enjoyed the challenges that mathematics offered them, gaining satisfaction from understanding and mastering new mathematics concepts and tasks that involved greater levels of complexity. Some students indicated that they made efforts to stay engaged during lessons and endured repetition even when they already understood concepts.

Engaging Students’ Perceptions of Mathematics Teaching

Reports from engaging students identified some effective teacher practices that sought to develop their understanding of mathematics. Some students recognised that a particular activity or explanation made sense to them and assisted their understanding of an aspect of mathematics.

Perceptions of LAE students

One LAE student found the way his teacher provided information in multiple ways and offered alternative pathways to understanding as helpful:

The information she gives us is she goes over it more than once so then it gets stuck in your head…she explains it three ways…I choose the easiest way to do it and then if it’s not right I just do the other ones (LAE9).

Another LAE student observed the overarching pattern of mathematics lessons, noting how his teacher focused on a series of lessons on one topic and that these were connected:
Usually we stay on the same thing for about three days—the same topic. Then my teacher for one day she will tell us all about it and then for homework we have to do it. I just like learning when she writes it down so I can learn all about it (LAE8).

The predominant focus of LAE students was achieving a level of understanding of mathematical concepts in contrast to the LAD students whose perceptions of mathematics teaching reflected a desire for more interesting and enjoyable activities. A likely explanation for this difference is that students in the LAE group were already engaged behaviourally, emotionally and cognitively and endeavoured to develop strategies to enhance their learning and understanding in mathematics.

Perceptions of HAE students

Several HAE students mentioned that their teacher checked that the students understood concepts before they continued with further work, affirming to students the importance teachers placed on a thorough understanding and their preparedness to provide the best opportunities for their students to experience success. One student reported that her teacher “goes step by step and he does it over and over again”, but if she was not sure of something she would tell the teacher and he would do more examples until everyone understood (HAE6). Another HAE student reported on the approach her teacher took for each mathematics topic to consolidate learning when completing “summaries at the end of each topic…of all the things we did”, which she considered helpful for looking over her work and revising (HAE3). HAE9 reported that her teacher “…just explains it well…lots of examples…she’d always ask if you’re understanding it which is good” and that if she did not understand the teacher would go through it again or come and see the student personally to help with the working out process. The teacher would also “give us lots of shortcuts to understand things and kind of tricks and stuff so we’d understand”.

A number of HAE students described the approach of their teachers as being supportive of their understanding. This sometimes involved activities and worksheets tailored to mathematical concepts taught, and at other times involved activities were used for a specific purpose. For example, when starting a new topic one student reported:

We start with the title page and then we do definitions for the title of the subject…we would write [the title] and we draw pictures and wrap words around it and we brainstorm it…and she writes words on the board and we would write down what it means and we would check it together as a class (HAE5)

Other HAE students reported that they enjoyed having the opportunity to go to the front and solve questions on the board. The students found this fun and challenging as they were able to try and figure out the answer by themselves before anyone else (HAE2, HAE3, and
HAE4). High achieving engaging students perceived teachers who wrote notes on the board for students to copy and who went through homework for most of the lesson as less effective motivationally.

Teacher behaviour and involvement reflects the quality of the interpersonal relationship between teachers and students (Skinner & Belmont, 1993). HAE3 reported that she found connections with teachers important for her understanding and motivation to learn. Students’ perceptions of teacher behaviours and their feelings of connectedness influence motivational factors. Teachers who worked at developing interrelationships with their students not only facilitated student engagement they helped develop students’ identities of being mathematically competent (Anthony & Walshaw, 2009).

*Engaging Students’ Behaviours While Learning Mathematics*

Students reported their behaviours towards learning mathematics both during lessons and at other times. Overall, engaging students reported that they listened to instructions and explanations by their teachers and enjoyed learning new things and challenging work. The engaging students also tended to revise work ahead of assessments, reflecting planning and management of their study. This is indicative of adaptive behavioural factors included on Martin’s Wheel (Martin, 2003).

Behaviours of LAE students

Despite LAE students struggling to perform well in mathematics, they employed many adaptive characteristics for learning including behaviours that were conducive to enhancing their learning. For example, LAE students appreciated the value of paying attention in class: “You have to listen so you can understand…Don’t muck around when she [the teacher] is speaking” (LAE10).

Approaches to exam study varied between LAE students, with some knowing what they needed to study and planning for it. In preparation for an exam, LAE7 commented:

Yes. I have to study more…Probably going to study everything that I have in my test like data, graphs, numeracy, fractions and algebra and going to study all that …each day something else

Another student reported that he goes “over the work that I’ve learned, I memorise it and I keep doing it…I do practice questions” (LAE3). Other students revealed that their teachers helped them prepare for the exams by, for example: telling them “what to study. I go to Maths Online [commercial product]” (LAE8).
Although LAE students may not all be aware of sophisticated study strategies it is evident from these reports that they undertake forms of study and listen to their teachers’ advice. This reinforces characteristics of effort and persistence to overcome their lack of understanding and reflects a goal orientation for mastering performance traits (Middleton & Midgley, 2002), which is reflective of engaging behaviours.

Behaviours of HAE students

HAE students also reported proactive study behaviours such as asking questions and independently finding information required to enhance their learning. One student stated: “I normally sit right in front of the teacher’s desk. It is easier when I have a question, he’s right there” (HAE1). Some HAE students mentioned that asking questions of the teacher was useful and their teachers “prefers it as well” (HAE6) and are “more open to questions” (HAE3). Although HAE students did not always get a choice about sitting with their friends, if they had problems they would take action themselves and ask a “smart” friend in class if the teacher “was going to be a while” (HAE8).

Students in the HAE and LAE groups all reported that they completed their homework. The amount of homework varied considerably from ad hoc pieces: “stuff I don’t finish in class” (HAE9) to regular requests, “every time we have maths – 4 to 5 times a week (HAE8)”. Some did extra homework to satisfy their desire to thoroughly understand the concepts. For example, “if I don’t get things in class I go home and practice them” (HAE1). Other students sometimes “went online” and did revision or games once they had completed homework (HAE9) and HAE8 refers to his notes when unsure.

The behaviours of engaging students reflected an active approach towards learning mathematics. These behaviours included listening in class, attempting and persevering with class work, asking for help in class and at home, completing homework and studying for tests. Although LAE students may not have used the most effective study strategies and encountered greater difficulties with understanding concepts than the HAE students, their levels of perseverance and desire to master content was still high.

Summary of Engaging Students

High achieving engaging students tended to express beliefs that they were competent at mathematics, while low achieving students indicated that they believed with effort and persistence that they could be “good” at mathematics. Therefore, both groups portrayed robust levels of self-efficacy in terms of their mathematics potential. Many of the LAE students demonstrated a strong desire to “keep trying” in mathematics which implied they
believed that effort and application through specific strategies such as completing homework, revising, and asking questions would improve their results. In addition, low achieving students aimed to master concepts and this was evidenced by reported factors underpinning emotional, cognitive and behavioural engagement in their quest to persevere and overcome difficulties. However, despite interest and effort to improve their mathematics achievement, students in the LAE group did not consistently use specific strategies to address learning deficits. Although most LAE students did report that they made study plans for tests, the plans tended to be all encompassing such as ‘studying more’ or ‘studying all’ of the concepts rather than identifying specific areas that needed to be mastered. Additionally, there was little mention by these students that they monitored their study progress or adjusted their study plans. The limited use of self-regulation and metacognitive process such as planning, monitoring and control of learning by LAE students is important to note. The paucity of appropriate and effective cognitive engagement strategies may be one reason why these students continue to underachieve in mathematics despite their efforts and interest to improve.

Engaging students perceived that their teachers helped them learn through a number of practices including: the planning of activities and materials; brainstorming activities, discussion; summarising topics; tailoring activities to topics; variable instruction modes such as partner work; showing ‘tricks’ or short cuts and emphasising understanding. The activities described by the students indicated a degree of sophistication and purpose beyond arousing the student’s interest. This signifies a clearer focus on cognitive engagement and an emphasis on learning strategies to master mathematics content, although the level of sophisticated strategies and how they are used by individual students can vary widely and lead to very different outcomes.

Engaging students were aware of aspects of mathematics that they were “good at” and when they needed to seek help. This exhibited planning, control and management of their learning and demonstrated their ability to self-reflect and self-regulate their learning, albeit to different degrees. By definition, all of the HAE students enjoyed success at mathematics. They felt confident, enjoyed mathematics and cited previous positive mathematics experiences. Engaging students also showed the following characteristics: a tendency to use learning strategies to clarify and rehearse mathematics work; resilience to set backs such as not understanding new work immediately; pro-active in seeking help; enjoyment in helping others; sharing their mathematics ideas with peers and teachers; and seeking out challenging mathematics work.
Developing a Student Engagement ‘Profile’

As previously set out, the aim of Study 1 is to provide a deep understanding of the factors that have contributed toward shifts in students’ levels of engagement. This central aim has been addressed by considering the first research question:

What individual and classroom level factors do students perceive as influencing their engagement, motivation and achievement in mathematics?

In this chapter, factors identified as influencing students’ engagement were reported by reference to four major themes and examined via four unique clusters of students: low achieving disengaging (LAD); high achieving disengaging (HAD); low achieving engaging (LAE); and high achieving engaging (HAE). Examining and reporting the results according to these groups has been critical in observing factors of motivation and engagement for students at a point in time (in this case the transition to secondary school). This allowed for comparisons to be made, which highlighted both shared and unique features of the four groups. Identification of traits within each group was helpful for profiling the way particular groups of students, behave, think and feel about mathematics.

In addition to investigating unique features of the LAD, HAD, LAE and HAE groups, the groups could also be considered in other ways. For example, by similar levels of engagement: LAD + HAD; and LAE + HAE, or similar levels of achievement: LAD + LAE; and HAD + HAE. Either of these perspectives may be useful in providing detailed information for targeting factors specific to groups of students to help maintain or enhance student engagement.

The two theoretical frameworks selected for research (discussed in Chapter 2) are drawn upon and links between underlying student motivation and engagement in mathematics are made by considering the relative presence and absence of motivational factors for both the disengaging student groups and the engaging student groups investigated in Study 1. The results are summarised in Table 5.4 for disengaging students (both LAD and HAD students) and Table 5.5 for engaging students (both LAE and HAE students) and a ‘profile’ of the motivational patterns reported by the four student groups is revealed.

Disengaging Students

As summarised in Table 5.4, the disengaging students generally reported an overall lack of adaptive factors. Although nearly all students were deemed to value mathematics and
reported they believed it was important for use in the future and their potential careers, there was a lack of specific behaviours to reinforce these beliefs. For example, their involvement in class was passive, being limited to what was being asked of them rather than self-driven. There was also an absence of mastery approaches to learning and they evidenced low levels of persistence when solving mathematical problems. Although planning and study management strategies were acknowledged as important by both LAD and HAD students, they were only used by some students and at unsophisticated levels. A recent study also identified that Year 7 students’ planning and management factors regarding mathematics as very low (Plenty & Heubeck, 2013).

LAD students’ levels of self-efficacy were found to be low and fragile due to a history of low achievement and a lack of understanding in numerous areas of mathematics. This was
Table 5.4
Motivational and Engagement Profiles of ‘Disengaging’ Students

<table>
<thead>
<tr>
<th>Types of Engagement</th>
<th>Behavioural Engagement</th>
<th>Cognitive Engagement</th>
<th>Emotional Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Behavioural Engagement</td>
<td>Cognitive Engagement</td>
<td>Emotional Engagement</td>
</tr>
<tr>
<td>Strong Presence</td>
<td>n/a</td>
<td>LAD</td>
<td>LAD</td>
</tr>
<tr>
<td></td>
<td>HAD</td>
<td>HAD</td>
<td>LAD</td>
</tr>
<tr>
<td>Relative Absence</td>
<td>n/a</td>
<td>HAD</td>
<td>LAD</td>
</tr>
<tr>
<td></td>
<td>LAD</td>
<td>LAD</td>
<td>HAD</td>
</tr>
</tbody>
</table>

Factors
- Disengagement
- Self-Handicapping
- Persistence
- Planning
- Task Management
- Uncertain Control
- Failure Avoidance
- Mastery Orientation
- Self-Efficacy
- Valuing
- Anxiety
- Interest
- Positive Attitude
- Positive Feelings

Table 5.5
Motivational and Engagement Profiles of ‘Engaging’ Students

<table>
<thead>
<tr>
<th>Types of Engagement</th>
<th>Behavioural Engagement</th>
<th>Cognitive Engagement</th>
<th>Emotional Engagement</th>
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<tbody>
<tr>
<td></td>
<td>Behavioural Engagement</td>
<td>Cognitive Engagement</td>
<td>Emotional Engagement</td>
</tr>
<tr>
<td>Strong Presence</td>
<td>n/a</td>
<td>LAE</td>
<td>LAE</td>
</tr>
<tr>
<td></td>
<td>HAE</td>
<td>HAE</td>
<td>HAE</td>
</tr>
<tr>
<td>Relative Absence</td>
<td>n/a</td>
<td>HAE</td>
<td>HAE</td>
</tr>
</tbody>
</table>

Factors
- Disengagement
- Self-Handicapping
- Persistence
- Planning
- Task Management
- Uncertain Control
- Failure Avoidance
- Mastery Orientation
- Self-Efficacy
- Valuing
- Anxiety
- Interest
- Positive Attitude
- Positive Feelings
compounded by the presence of maladaptive motivational factors on learning such as high levels of anxiety, failure avoidance behaviours and feelings of uncertain control leading to, in some cases, self-handicapping behaviour. Students reported their lack of understanding and achievement was associated with their feelings of frustration and dislike. Despite these reports none of the students in the LAD group had ‘given up’ or were completely disengaged from mathematics, however some did exhibit self-handicapping factors such as knowingly not completing homework or not studying for assessments. Student reports revealed that most in this group still perceived that mathematics was important and they would like to do better however, lacked the skills and methods for changing achievement outcomes. The concerns of LAD students about their lack of understanding coupled with poor perceptions of themselves as mathematicians make for a challenging group. Teaching strategies that include interesting and enjoyable activities that encourage participation with classmates to build understanding and competence are likely to provide these students with opportunities to experience success in ways that foster positive and engaging experiences.

Based on the interview responses, high achievers and those who sought challenge had strong measures of self-efficacy, while students who were struggling with the challenge of new content tended to have low levels of self-efficacy. Therefore, some HAD students required challenge and interesting activities, and others who were uncertain about their competency required support and reinforcement as their self-efficacy was wavering.

**Engaging Students**

As summarised in Table 5.5, engaging students exhibited many adaptive factors such as self-efficacy, value and mastery and adaptive behaviours such as persistence, planning, and task management. The HAE students exhibited confidence and competency in their mathematical ability. Therefore, challenging work and stimulating approaches would likely enhance their learning opportunities. In contrast to LAD students, LAE students displayed robust self-efficacy, with a desire and willingness to persist with learning, despite difficulties with understanding concepts and low achievement levels.

Student engagement in learning is viewed as an important predictor of general academic achievement and positive academic outcomes (2004; Lutz et al., 2010) and even necessary for constructive educational beliefs and behaviours (Middleton & Midgley, 2002). However, this research revealed that not all students who were highly engaged experienced
high achievement. This is apparent in students in the LAE group, who were identified as engaging in mathematics but experienced low levels of mathematics achievement. It is clear that there are many individual level factors (emotional, cognitive and behavioural in various combinations and degrees) (Fredricks et al., 2004) and classroom level factors (school, teachers and peers) (Attard, 2011; Hardré, 2011) influencing students’ levels of engagement in mathematics other than successful or unsuccessful levels of achievement (Martin, 2007; Martin et al., 2012). Understanding the reasons why students remain engaged in learning mathematics despite low achievement is important information for mathematics teachers. For teachers, knowing how to promote student efforts, interest, attitudes, values and self-efficacy beliefs when achievement performance levels are low, would be advantageous.

**Shared and Unique Characteristics**

When considering the overall characteristics of the four student groups it emerged that there were shared characteristics between students in the ‘disengaging’ and ‘engaging’ groups but differences between high and low achieving students within those groups. This indicates that the students in Study 1 were more alike in terms of their levels of disengagement or engagement than by their levels of achievement. In particular, the engaging students (HAE and LAE) were more alike in terms of emotional factors such as attitudes and interest, and behavioural factors such as persistence, planning and task management in mathematics. For example both HAE and LAE students shared beliefs about effort and persistence as being key factors for ensuring achievement and this helped them overcome setbacks such as poor grades or not immediately understanding concepts. Engaging students were also proactive in helping themselves by asking for assistance, completing homework and using study strategies.

Cognitive engagement factors were also evident for both HAE and LAE students. However the HAE students reported using more sophisticated learning strategies, reported greater control of their learning and they were keen to explore more complex and challenging work than the LAE students. The needs of high achieving engaging students were distinct from those of high achieving disengaging students. Students in the HAE group were proactive about their learning, enjoyed mastering concepts and employed a range of strategies (such as completing homework, studying for tests and asking questions) to enhance their understanding.

The interview results draw attention to the complex relationship between engagement and achievement, where high levels of student achievement were not necessarily indicative of
high levels of engagement as evidenced by the HAD group of students. Despite their relative success in mathematics, HAD students were identified as disengaging, signifying that factors other than achievement need investigating as influencing levels of engagement. Increases in student disengagement in secondary school as indicated by disinterest and lack of participation in mathematics (beyond compulsory requirements) during secondary school are of concern in Australia and, while achievement in mathematics is related to these increases, it is only one of the influencing factors (Forgasz et al., 2008; McPhan et al., 2008). Uncovering reasons behind students’ disengaging characteristics when their achievement in mathematics is high in mathematics is central to understanding the underlying needs of those students.

Although many HAD and LAD students shared characteristics such as believing that mathematics was important for their future and persistence with learning, they were not particularly interested or did not like mathematics as a subject. Despite believing that mathematics was important and required effort, many of the low and high achieving students did not actively seek ways to improve their achievement in mathematics as they often did not complete homework, ask for help from their teachers or study effectively for assessments. Both HAD and LAD students reported feeling a lack of control over their achievement performance, a focus on performance over mastery and low levels of confidence. The low achieving disengaging students showed a marked presence of anxiety and this appeared to stem from a general lack of certainty of mathematical concepts. Therefore, while both groups of disengaging students generally portrayed low levels of behavioural, cognitive and emotional engagement, some students in the HAD group reported different reasons for their lack of engagement. Consequently, different teaching approaches for students with certain engagement ‘profiles’ are required to effectively halt the shift towards disengagement or to re-engage students in mathematics.

Conclusion

The findings of Study 1 student interviews reveal a range of individual and classroom factors influencing the students’ engagement, motivation and achievement in mathematics. The students reported a variety of factors relating to their behaviours, feelings and thinking about mathematics. They also commented on classroom factors such as interpersonal relationships and teaching practices that influenced their engagement. The participants were
drawn from a diverse student group, seeking the perceptions, views and beliefs of students who achieved at varying levels in mathematics.

The presence of different factors underscores the multidimensional nature of different types of engagement and highlights the complexity of engagement and the difficulties for teachers to understand how to interpret it. The findings also identify that the presence or absence of adaptive factors and maladaptive factors are important for considering the degree of student engagement and its effect on achievement outcomes.

In sum, the differing needs of students with varying engagement and achievement levels indicate that they would benefit from different approaches to teaching mathematics. Students’ motivational needs could be more accurately targeted if specific factors were identified as needing support. In particular, supporting adaptive factors and reducing maladaptive factors with a view to arrest further declines in student engagement would be beneficial.

The next chapter reports on the interviews with teachers, completing the second part Study 1. The teachers’ perceptions of student engagement complements the students’ self-reports discussed in this chapter. Together, the student and teacher perceptions provide a rich and detailed account of the factors influencing student engagement in mathematics.
Chapter 6
Teacher Results and Discussion: Study 1

Concerns about falling student engagement and participation in mathematics are well documented (Thomson et al., 2012; Tytler et al., 2008). Effectively addressing these concerns requires a deeper understanding of the factors influencing student engagement in mathematics. The previous chapter reported students’ perceptions of their mathematical ability, their feelings about and behaviours towards mathematics and classroom teaching of mathematics. Information from the students was elicited to form a deeper understanding of the range of factors and how they interact to influence student engagement in mathematics. Students’ perceptions of their engagement present one vital perspective on student engagement. To gain a comprehensive understanding of student engagement in mathematics classrooms it is also important to investigate teachers’ perceptions of student engagement and instruction that is effective for engagement.

The chapter reports on the levels of student engagement teachers perceive during mathematics lessons and the practices teachers indicate using to promote student engagement. To gain a deeper understanding of how teachers perceive student engagement, it is important to investigate what they report noticing when discussing how their students operate in mathematics classrooms. Specifically, the study aims to elicit teachers’ perceptions of levels and types of student engagement in mathematics. Next, details of the Engagement Spectrum, the framework that emerged during the analysis stage and used to organise the types and levels of engagement reported by the teachers, is outlined. The three levels of student engagement used in the Engagement Spectrum, being Disengagement, Variable Engagement and Substantial Engagement, are explained. The remainder of the first section reports the findings from the teacher interviews.

The chapter also presents the practices that teachers report using to engage and motivate their students in mathematics. Teacher practices are investigated to understand the importance teachers place on engaging students in mathematics: how practices support or hinder student engagement are also explored. Given the aims of Study 1, attention is given to whether or not teachers alter their teaching strategies for engaging students with varying levels of achievement.
Teachers’ Perceptions of Student Engagement

Although several important themes emerged during the coding process, this part of Study 1 focused on teachers’ perceptions of student engagement in mathematics. In Chapter 2, ‘perceptions’ were defined as an individual’s interpretation of or response to a situation. Interpretations are filtered by one’s personal experiences and characteristics, knowledge and skills. Teachers’ perceptions of student engagement in mathematics reflect individual teacher interpretations of student behaviours, cognitive approaches, and emotional responses towards mathematics learning and teaching.

In this part of Study 1, teacher perceptions were sought about student engagement in mathematics at the class and individual student level over the school year from February to November. Therefore, teachers had spent considerable time with their students and had adequate exposure to enable them to observe patterns over time and specific instances of student engagement in mathematics classes. As previously explained the 31 teacher participants for the Interview Study were selected on the basis that they taught the purposively chosen student participants.

Development of the Engagement Spectrum

This section describes the three-step approach taken to develop the Engagement Spectrum. In the first instance, in-depth questioning of individual teachers elicited indicators of student engagement and disengagement. The teachers’ perceptions were initially grouped according to key words and phrases relating to students’ engagement and disengagement. The overlapping phrases and descriptions used by the teachers indicated that there were numerous shared meanings or understandings amongst teachers for how they determined if students were engaged or not in mathematics.

The teachers’ perceptions of engagement also reflected the multidimensional view of engagement where different types of engagement are seen to operate simultaneously and dynamically (Fredricks et al., 2004; Lutz et al., 2010; Wang & Holcombe, 2010). For example, one Year 7 teacher commented that she gauged engagement by a range of different things:

Their level of interest, their level of concentration. Through observation; watching them too, talking to their friend about the work, you can basically lip-read … whether they’re on task. The questions that they fire, the conversation that comes out of things. They’re the types of things which you know whether the children are on task or not, and whether they’re enjoying it or engaging. (G3)
This teacher’s comment and similar comments reflect a ‘fusion’ of different types of student engagement. However, for the purposes of this investigation, the teachers’ perceptions of student engagement were teased apart to identify specific indicators of behavioural, emotional and cognitive engagement, thereby categorising the descriptions using the Fredricks et al (2004) engagement framework. For example, in the quote given by teacher G3, “level of concentration” was identified as behavioural engagement, “questions they fire” was classified as cognitive engagement and “level of interest” was categorised as emotional engagement (Fredricks et al., 2004; Wang & Holcombe, 2010). For the teachers’ perceptions of student disengagement, similar overlaps were evident and these comments were also categorised as behavioural, cognitive or emotional. This was the second step in development of the Engagement Spectrum.

It is important to note that the teachers’ perceptions were categorised according to the researcher’s assessment of ‘best fit’ according to the definitions used by Fredricks et al. (2004), however it is recognised that categorisations could be different in other circumstances. Additionally, although the teachers did not articulate or label types of engagement and disengagement specifically as behavioural, emotional and cognitive, their responses indicated that they were able to distinguish between them and were able to describe a wide range of perceptions of student engagement and disengagement in detail.

The final step in the categorisation process distinguished between the teachers’ perceptions of varying levels within each type of engagement and disengagement. Some teachers reported students who indicated different types of engagement that could not be categorised as substantially engaged in or disengaged from mathematics. For example, “always asking and answering questions” was determined to be more intense (and engaging) than “answering questions when asked”. Furthermore, “hating maths” was viewed as more acute than “losing interest in it”. The variations in the descriptions given by the teachers meant the researcher was able to differentiate between the degree or level of engagement or disengagement based on the ‘strength’ of the words, phrases and cues used. In this way, the Engagement Spectrum was developed to categorise the intensity of student engagement reflected in the teachers’ perceptions into three levels ranging from ‘disengagement’ to ‘variable engagement’ and to ‘substantial engagement’.

In summary, the process for organising the teachers’ perceptions of student engagement acknowledged the diversity of the teachers’ responses but looked to identify consistencies with the terms and descriptions used in the engagement literature. The Engagement Spectrum, a framework, unique to this research, was developed as a functional
way to classify and discuss the range of teachers’ perceptions of student engagement, reflecting the three types of engagement (behavioural, emotional and cognitive) and the three levels of perceived student engagement (disengagement, variable engagement, substantial engagement) for mathematics.

**Justification of the Engagement Spectrum**

The Engagement Spectrum connects ‘types’ of engagement with different ‘levels’ of engagement and is subsequently used as a guide to report the results of the teacher interviews. The structure of the Engagement Spectrum includes two dimensions of engagement and is shown in Figure 6.1. Types of engagement (behavioural, emotional and cognitive) are represented on the x-axis and levels of engagement (disengagement, variable engagement and substantial engagement) are distinguished on the y-axis, see Figure 6.1.

<table>
<thead>
<tr>
<th>Levels of Engagement</th>
<th>Types of Engagement</th>
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<tr>
<td></td>
<td>Behavioural</td>
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<tr>
<td>Disengagement</td>
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<tr>
<td>Variable Engagement</td>
<td></td>
</tr>
<tr>
<td>Substantial Engagement</td>
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</table>

*Figure 6.1 Structure of the Engagement Spectrum.*

Three levels of engagement ranging from disengagement to full engagement reflect participating teachers’ perceptions that student engagement exists in varying degrees. Literature arguing that engagement and disengagement lie on a continuum was discussed in Chapter 2 and is further reflected upon throughout this chapter. In general terms, there is support that engagement occurs at varying levels (Fredricks et al., 2004) and that graduations from engagement to disengagement can occur over time (Appleton et al., 2006). Newmann (1992) also regarded engagement as lying on a “continuum from more or less…not as a state of being engaged or unengaged” (1992, p. 13), reflecting a gradual process of disconnection (Appleton et al., 2006).
In keeping with findings from previous research, the teachers in Study 1 reported similar graduations in their perceptions of the degrees of student engagement. Potentially, at an individual student level, the range of types and levels of student engagement and the way they operate together are infinite. However, for Study 1, the levels and types of engagement have been categorised into three discrete levels to unravel details of student engagement. Using categories to analyse the teachers’ perceptions of student engagement made it possible to separate types and levels of engagement from each other. Accordingly, a range of indicators for each type and level of engagement were identified which is expected to be useful to teachers interested in understanding student engagement in greater depth.

Decisions about how to determine the three levels were guided by the indicators teachers drew on to describe the students’ engagement. Students categorised as ‘disengaged’ were described by their teachers as: resisting learning by refusing to work or by interfering with other students’ participation in class; verbalising their dislike or strong feelings of anger and frustrations in relation to mathematics; and lacking cognitive strategies. ‘Substantially engaged’ students were described as positive and evidenced robust and substantial levels of all types of engagement including: being eager to participate; stimulated by and enjoying mathematics; and using cognitive strategies to enhance their learning. Students who were neither disengaged nor substantially engaged were categorised as ‘variably engaged’ and perceived by the teachers as displaying irregular levels of engagement or displaying varying degrees of different types of engagement, for example: higher behavioural engagement but low affective and cognitive engagement.

To date it is variable engagement that has received the least attention in the field of engagement and motivation. This is possibly because indicators of disengaged and substantially engaged students are more obvious or definable, whereas it is more difficult to clearly explain and define the engagement levels of students who show signs of both engagement and disengagement or whose engagement levels fluctuate from lesson to lesson. Therefore, one of the aims of this research is to explore the range of engagement levels teachers perceive in their mathematics classrooms and the reasons they suggest underlie variations in levels of engagement. The results of the teacher interviews aim to detail indicators of different levels of engagement and add clarity about students whose engagement is variable.
Results of Teacher Interviews

A summary of the teachers’ perceptions of student engagement in mathematics is detailed using the Engagement Spectrum and tabled as 6.1. The Engagement Spectrum was drawn from the teacher interview transcripts and it can be referred to throughout this chapter to illustrate and support interpretations. The Engagement Spectrum reports on behavioural, emotional and cognitive types of engagement found at each of the three levels of engagement identified in the Engagement Spectrum as follows:

1. Disengaged (also referred to as resistance to engagement)
2. Variably engaged; and
3. Substantially Engaged

**Disengaged (Resistance to Engagement)**

When teachers were asked about student engagement, behavioural indicators were often mentioned before emotional and cognitive indicators. Perhaps this is not surprising as the notion of ‘on task’ or ‘off task’, is often used as a descriptor by teachers and in teaching documents, such as ‘Quality Teaching in New South Wales Public Schools’ (NSWDET, 2003). Additionally, behavioural characteristics are the most observable aspects that teachers notice reflecting the nature of students’ participation and involvement in the mathematics classroom. In the following interview excerpt, the teacher (H2) noted several behavioural characteristics indicating a lack of willingness by students to participate and involve themselves in mathematics lessons.

**Teacher:** Firstly it is their body language, how they walk into class. The fact that they are not prepared they don’t have their textbook, they don’t have their diary, they just sit. Sometimes they don’t have a pencil or pen, so lack of organisation, their general demeanour. They might come into class and sit in a chair and not interrupt but they will just sit and they won’t talk or when you pull them in, draw them in and you are waiting for a response they will just sit there.

**Interviewer:** Do they make eye contact?

**Teacher:** They’ll avoid eye contact and which says don’t ask me. But I will deliberately go out of my way and say what you think. I did not hear the question [says students *sic*]
Table 6.1  The Engagement Spectrum

<table>
<thead>
<tr>
<th>Levels of Engagement</th>
<th>Behavioural (actions, participation and involvement)</th>
<th>Emotional (feelings, attitudes, values and interest)</th>
<th>Cognitive (regulation of learning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disengagement (Resistance)</td>
<td>Will not talk to the teacher or respond to questions/ Refuse to do work (resistant)</td>
<td>Say “I don’t like maths” and some won’t even try (given up)</td>
<td>Lack of organisation/ lack of bookwork/ no attention paid to keep notes tidy (aimless)</td>
</tr>
<tr>
<td></td>
<td>How they walk into class/sit in a chair. Sit at the back/corner–keep a low profile (passivity)</td>
<td>Say ‘I don’t like maths’ and want justification for why they need to learn it and how they will use it</td>
<td>Resistance to homework – not getting anywhere with the subject of mathematics</td>
</tr>
<tr>
<td></td>
<td>Avoid eye contact/eyes wander around the room (unfocused)</td>
<td>Disinterested/not absorbing (this sometimes only applies to a particular concept)</td>
<td>I don’t know if they know what ‘to study’ means (i.e., how to study effectively)</td>
</tr>
<tr>
<td></td>
<td>Repeat incorrect answers when asked a question or pretend they didn’t hear (defiant)</td>
<td>Self esteem for maths is low and have such a poor self image (self-blame)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of effort and drive</td>
<td>No desire to better themselves in maths (lack of self image)</td>
<td></td>
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<tr>
<td></td>
<td>Do not bring equipment – pens, rulers, calculators (unprepared)</td>
<td>Say “I’m going to fail” before tests (anxiety)</td>
<td></td>
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<tr>
<td></td>
<td>Do not bring books so homework cannot be checked (avoidance)</td>
<td>Immediate ‘I can’t do it’ or ‘Miss, this is hard’ response (resigned) Not prepared to see if they can apply new skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Off task/or not on task enough/distract others and try and distract the teacher (distracted)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable Engagement</td>
<td>Use diversion tactics - ‘lesson stopper questions’ such as “Why are we doing this?”</td>
<td>See them switching off/losing interest-starting to give up/disenchanted</td>
<td>Retention of information is poor</td>
</tr>
<tr>
<td></td>
<td>Give the appearance of listening but you can tell they are not/ Daydreaming (mentally withdrawn)</td>
<td>Get disappointed if don’t do well in tests and easily put off</td>
<td>Lack of or variable concentration/unable to focus for long periods</td>
</tr>
<tr>
<td></td>
<td>Procrastinate/Find reasons not to complete work</td>
<td>Anxious about getting things wrong in front of other students</td>
<td>Lack of discourse about mathematical themes</td>
</tr>
<tr>
<td></td>
<td>Chatting with friends</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fiddling with things – paper clips/cut up paper/–work avoiding (distracted)</td>
<td>Even if they know it (the answer) they are scared to explore /ask questions in front of the class/peers</td>
<td>More able students to whom maths comes easy usually don’t put in much effort – happy to be average (apathy)</td>
</tr>
<tr>
<td></td>
<td>Lack of perseverance</td>
<td>For those that have mastered skills, they don’t need or like repetition and get bored (unchallenged)</td>
<td>See them losing their enquiring minds</td>
</tr>
<tr>
<td></td>
<td>Wait and let others answer the questions</td>
<td>Compare themselves to more successful siblings</td>
<td>Some focus on getting good marks not necessarily understanding/enjoyment of subject</td>
</tr>
<tr>
<td></td>
<td>Muck around/Make jokes/Act the class clown</td>
<td>Many students don’t get supported from home and there are low expectations for doing well</td>
<td>Completes work but not thorough</td>
</tr>
<tr>
<td></td>
<td>Reluctant contributors - even when able to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levels of Engagement</td>
<td>Behavioural (actions, participation and involvement)</td>
<td>Emotional (feelings, attitudes, values and interest)</td>
<td>Cognitive (regulation of learning)</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Substantial Engagement</td>
<td>On Task/Pay attention</td>
<td>Interested/keen/switched on/enthusiastic/positive attitude</td>
<td>Listening to one another</td>
</tr>
<tr>
<td></td>
<td>Hands are up/ Frequent Participation/Want to contribute/Gives Answers/Keen to get involved</td>
<td>Enjoy it/They smile/They like maths</td>
<td>More communication – a connection between you and them</td>
</tr>
<tr>
<td></td>
<td>Want to Answer Questions/Wants to Ask Questions – Fire questions</td>
<td>Get excited and happy when they improve (satisfaction)</td>
<td>Book work thorough and complete – show working</td>
</tr>
<tr>
<td></td>
<td>Want to learn/ Gets on with work/Want to improve/Desire to do well (willingness)</td>
<td>Engaged because they thought it was fun and interesting (enjoyment)</td>
<td>Bring questions to class/stay behind after class to clarify concepts (mastery)</td>
</tr>
<tr>
<td></td>
<td>Self motivated /exceptional motivation</td>
<td>Thrive on attention and responsibility/Self esteem increases (pride)</td>
<td>Waiting for more – want more work (seek challenges)</td>
</tr>
<tr>
<td></td>
<td>Interacts in class/Does groups work well/Makes lots of suggestions</td>
<td>Say ‘I get it. I get it’ when experience success (excited about understanding)</td>
<td>Like to work ahead (goal driven)</td>
</tr>
<tr>
<td></td>
<td>Sit up the front/Focused/Listen (concentrate)</td>
<td>Confident in expressing themselves</td>
<td>Discusses where and how the maths will be used (make connections)</td>
</tr>
<tr>
<td></td>
<td>Always trying their hardest/persevere and don’t let frustration get in their way</td>
<td>Like the teacher</td>
<td>Keen to find out different ways of thinking/ask if they can solve its another way (seek alternative solutions)</td>
</tr>
<tr>
<td></td>
<td>Want to engage in conversation/Has discussions with friends about work (absorbed)</td>
<td></td>
<td>Like to help others and recognise this helps their own understandings</td>
</tr>
<tr>
<td></td>
<td>Come up to board/interactive screen to show their solutions (willingness)</td>
<td></td>
<td>Initiate their own methodology (try strategies)</td>
</tr>
<tr>
<td></td>
<td>Noise level rises because they are having a go/say ‘Shhh…I want to hear the next bit’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do and mark their homework/talk to teachers about their homework / do IT activities on portal</td>
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</table>
This excerpt is indicative of teachers’ comments about students who present as disengaged through their demeanour and actions—they came to lessons unprepared, they avoided being noticed, and were uncommunicative. In some cases the students’ disengaged behaviour was actively disruptive (E4)—“distracting others and the teacher” or “not listening when I am explaining something as they are talking and whispering…doing it constantly” (A3). In other cases, it was passive, such as “avoiding eye contact” (H2) or not responding. In every practical sense, students who resisted learning due to their lack of preparedness and involvement in the classroom, appeared to have ‘given up’ on learning mathematics.

Teachers also reported that disengaged students displayed a lack of effort during mathematics lessons, indicated by not asking or answering questions, not completing homework or maintaining tidy notes for revision and study. Teachers perceived that signs of resistance to engaging in mathematics were evident when students failed to bring all the necessary equipment to mathematics classes on a regular basis. In many cases, teachers noted that students used this as an excuse to avoid participation—wanting to leave class to go and get their books and equipment, or to avoid having their performance assessed.

One teacher reported that students who regularly “lost” books or did not bring them to class were resisting work: “If [they] don’t have a rule book, [they] can’t study and if [they] can’t study then it’s not [their] fault” (A4). A number of teachers also commented that disengaged students kept untidy books and did not set their working out properly (I2). Some of these indicators of disengagement reported by the teachers are similar to those portrayed by students with learning disabilities and behavioural disorders. At the time of reporting, the teachers did not attribute specific learning or behavioural issues as reasons for disengagement, although there were reports that some students found concentrating and understanding mathematics content difficult.

Other teachers reported that disengaged students had a “resistance to homework” and did not want to spend their time outside of school completing it (J2). One teacher reported on students’ lack of effort and drive noting:

A lot of kids these days do what they need to do in class and then they rarely do anything extra at home… even when you tell them this is homework sometimes it’s not done or the minimum is done (E1)

Teacher perceptions about disengagement also extended to students’ emotions, attitudes and interest towards learning mathematics. One teacher reported that some
students directly state their thoughts about mathematics, for example “they will tell you, I don’t like maths. I’ve never liked maths” (I3). Other teachers perceived that some students’ extreme dislike for mathematics was powerful enough for them to decide to give up participating altogether:

> They fall into two baskets either ‘I hate it but I am trying but I still don’t get it’ or ‘I hate it I am not going to bother with it’. And it doesn’t matter how you try to motivate them what you try and do, even if you give them short spurts of something different so you are not droning on the same thing. If they want to work at it they will work at it. If they don’t want to work at it they just don’t want to do it. And some kids are just like that (H2).

Although some emotions were reported as intense, such as “hate” and “anger”, others were less severe. Teachers reported that some students just did not seem interested in learning mathematics after a while (F1 and E4) or care about their work (H1). Other teachers reported that disengaged students had strong beliefs about their potential to achieve (or not achieve). For example, one teacher recalled a student repeating several times, “I am going to fail” before the start of a class test (A4). Teachers also reported that some students had an immediate negative response to new work, stating that the work was hard or they could not do it before they have even tried. These students were described by teachers as having a “high block” (A4) or a “brick wall” (H2) about mathematics. Such comments reflect high levels of student mathematics anxiety, a factor identified by Martin et al. (2012) as a strong predictor of disengagement.

Cognitive engagement is reflected by the approaches students take towards learning mathematics and is driven by extrinsic or intrinsic approaches to learning. Cognitive indicators include regulation, management and monitoring of learning such as mastering skills and comprehending complex concepts. These indicators are reflected in several of the adaptive factors identified on Martin’s Wheel (2007). The teachers reported that disengaged students lacked organisational skills and although they reminded students to study at home, they perceived that study for tests rarely occurred and therefore revision for tests took place during lessons (A4 and J2).

The teachers’ reports reflected a perceived lack of active participation and communication in the mathematics classroom, including being off task and employing disruptive behaviours for disengaged students as summarised in Table 6.1. The students were perceived as showing little interest in learning the content, or having a desire to do better. Instead, they verbalised their dislike of mathematics and predicted
failure. Reflecting on the factors identified on Martin’s Wheel (2007, 2009), there are clear links to factors identified as maladaptive behaviours such as disengagement (non-participation) and self-handicapping (establishing scenarios where achievement cannot be ascertained and reducing their chances of success). For disengaged students, the absence of adaptive factors such as persistence, valuing of mathematics, task management in addition to low levels of self-efficacy were reported. Also, there were a number of emotional factors evident from the teachers’ comments that indicated disengagement including dislike, lack of enjoyment, lack of interest, feelings of helplessness and frustration.

The teachers’ reports of disengaging students presents a worrying depiction particularly as indicators suggest disengagement becomes more severe as students progress through secondary school. However, they do provide clearer information about numerous signs indicating student disengagement in mathematics, and in doing so highlight factors that teachers can look for and address. In mathematics classrooms teachers play a significant role for addressing students levels of engagement as their perceptions influence the efforts and strategies used in the classroom and in turn influence student motivation and achievement (Hardré et al., 2008; Hardré & Sullivan, 2008).

The intended and unintended consequences of teachers’ expectations and actions for influencing levels of student engagement in mathematics classroom are revealed by the teacher’s reports in Study 1. Similar to findings by Hardré and Sullivan (2008) a number of the teachers interviewed seem to attribute student engagement levels to what the students do rather than what the teachers do. Although not explicitly stated, a few teachers implied that disengaged students were themselves the source of student disengagement. There were other teachers who although concerned about disengaged students felt quite helpless about it and perceived there was little they could do to change what they saw as an inevitable trajectory.

Further, some teachers perceived that engaging students in mathematics was optional; something they would attend to if there was time, but their priority was making sure that the mathematics content was taught. These reports indicate that teachers had different perceptions of and took different degrees of responsibility for student disengagement, confirming Hardré and Sullivan’s (2008) findings that teacher perceptions are highly “heterogeneous” (p. 2070). These differences in teachers perceptions are seen as pivotal for explaining the efforts and strategies that teachers
use for engaging student in mathematics (Hardré & Sullivan, 2008). Therefore, it is important to understand the different perceptions that teachers hold about student engagement, as these influence their beliefs and practices for motivating and promoting student engagement in mathematics. Investigating teachers’ beliefs and practice for promoting student engagement is the key purpose of Study 2.

Next, the teachers’ perceptions of variably engaged students are reported. Variably engaged students were distinguished from disengaged students, according to the categories developed for the Engagement Spectrum.

Variably Engaged

Descriptions of disengagement in the research literature do not adequately explain or accommodate the range of teachers’ perceptions of student engagement evident in Study 1. Teachers perceived subtleties in levels of student engagement—where certain types of student engagement were higher or lower than others. As seen in Table 6.1, teacher comments typically reported students who were “settled but not absorbing” (A4), complying with the teachers’ requests in class to complete work, or who sometimes showed greater interest in learning behaviourally, emotionally or cognitively. Therefore, teachers in this study reported not only variations in degrees and types of engagement, they also perceived different reasons and contexts for the variations. The variably engaged category therefore, seeks to describe students whose level of engagement is neither disengaged nor substantially engaged, thereby contributing to research in this field.

Teachers perceived that students displayed low levels of behavioural engagement when they avoided active involvement in the mathematics classroom. For example, one teacher reported students as being “quiet, and seated and they give the appearance of listening but they are not. They have switched off a long time ago” (A4). Although the students came into class and were settled, they were “not absorbing and not interested” (A4). One teacher described a sequence where she ‘saw’ students ‘switch off’ during the lesson:

When you’re explaining something you can sort of see the glazed over look. That’s the first indicator. The second is they start to chat. The answers that they give you, even if it’s incorrect and we work through, that they will still come back with an incorrect answer which I suppose that’s telling you something. Chatting and fiddling. It doesn’t really take a genius to see they’re not engaged. It’s not like they’re doing anything completely radical. It’s just that you can see them switching off (J2)
In the above description, several indicators are observed that are similar to Nardi and Steward’s (2003) description of ‘disaffected’ students. Nardi and Steward (2003) applied the term ‘quiet disaffection’ to describe students who, although compliant in the mathematics classrooms and who routinely executed tasks, presented low engagement for learning tasks, felt mathematics was not relevant to their needs and interests, and did not become substantially involved in mathematics lessons.

Teachers described students who avoided work by wasting time and procrastination, reporting that students spent: “10 minutes ruling up their page—they think that’s work but it is really work avoiding” (A3). Teachers also encountered students’ questions such as “Why do we have to do this?” (F2). Some teachers perceived such questions as a way to avoid work, while others perceived them as legitimate questions for seeking understanding (F1). Avoidance factors, such as low levels of effort and tendencies to procrastinate are identified on Martin’s Wheel (2003, 2007) as low ‘persistence’ (adaptive behaviour).

Teachers also noted that some students’ lack of engagement fluctuated. They reported students who at times were engaged but appeared reluctant or were unable to maintain their engagement and needed encouragement. Teachers reported that these students would “still have a go, at least for part of the lesson and you have to remind them” (J3), or they “would contribute occasionally and every now and then (A4). In other cases teachers reported students who would attend to their work if the teacher stood near them “but the minute you move away they have lost interest” (J1). Some teachers commented that students were less engaged when studying particular mathematics content such as algebra, factors and multiples, whereas percentages, graphs and geometry offered more opportunities for students to make connections (H1). One teacher reported that she found that changing topics was engaging for students as she could encourage them to “get their teeth into it” and showing them examples of how to master new concepts (J3).

Fluctuating engagement within and across lessons is discussed in engagement research (Bryson & Hand 2007; Smith et al., 2005), with variations in disengagement and engagement over long and short periods not unexpected. Fluctuating student engagement has implications for assessing levels of engagement. It implies that assessment of engagement should be considered over time and under varying circumstances, rather than based on a single episode or restricted to observable engagement such as participation. A more comprehensive assessment of student
engagement inclusive of emotional and cognitive factors influencing individual behaviours in the mathematics classroom would afford teachers the opportunity to more accurately assess individual student engagement levels and structure lessons more effectively to maintain student engagement throughout lessons or activities.

Regarding emotional engagement, some teachers construed the lack of student participation or involvement in mathematics lessons as a lack of interest. However, the teachers’ reports suggested that rather than a lack of motivation and engagement, student reluctance to get involved or participate in class may be due to other factors such as a lack of confidence in understanding the mathematics work. One teacher reported that it was sometimes hard to tell if a student was shy or disengaged when they did not participate actively in the classroom (E1). For example, although students might know the answer to a question often they were “scared to explore in front of the peer group” (C2). Another teacher commented: “If I ask her what did you get [as an answer] she kind of panics and she is very unsure of herself. I don’t think she likes that attention either if she feels under pressure” (E1).

Teachers also perceived that uncertainty and anxiety were factors influencing the students’ reluctance to participate, particularly “getting things wrong in front of the other students” (D1). Some indicated they were very aware of the students’ concerns about being “totally exposed” and looking “like an absolute idiot” in the classroom, so instead they would have a quiet word and suggest they seek help outside of class (H2). Teachers reported student anxiety or fear of humiliation in front of classmates affected the students’ self-image and influenced their behaviour in the classroom. Such fears can continue to plague learners well beyond Year 7 (Hockings et al., 2008) and they can have a powerful influence on whether or not some students seek help. This may be particularly important during the early years of secondary school. One teacher noted the passivity of students in her class, reporting that students would not ask questions even if they were stuck, but gladly accepted teacher intervention and help if supplied voluntarily (I1). Some students, rather than not wanting to look stupid, were concerned about being seen as “smart”. For example, another teacher commented that one of her students understood the mathematical procedure he used to solve a problem but did not “want to get involved or share it with class”, reasoning that “I don’t think he wants to be seen as smart, to be seen as capable of doing it. I think he’s happy just sitting in the corner and not be pushed or asked” (E1).
Factors that impede or hinder learning such as ‘anxiety’ and ‘failure avoidance’ are noted on Martin’s Wheel, (Martin, 2003; 2007) and also acknowledged by teachers as factors influencing students’ engagement. Teachers reported that students appeared nervous and worried, particularly when they did not have a secure understanding of the mathematics concepts or were unsure how to do well in mathematics. Understanding the reasons why students appear reluctant to take a more active and participative role in mathematics lessons is important. It is crucial that teachers do not make assumptions about a lack of student engagement in mathematics based solely on behaviours, as it possible that it is the students’ feelings of anxiety or competence that hinders their participation. Understanding more clearly what is inhibiting a student’s participation means that teachers have the opportunity to use instructional techniques and practices to support students’ needs.

Teachers perceived different underlying reasons for students’ cognitive engagement. On one hand, teachers noted the difficulties some students had with understanding content while, on the other, some students were perceived as being unchallenged during mathematics lessons. Several teachers reported that some students lost focus because they have difficulties understanding mathematics content, yet perceived that this did not necessarily mean they were disengaged:

_I think she is passive. At times you see her staring at the ceiling when you are trying to explain something because it’s gone beyond her. But she does do the work when asked and if I ask her for an answer she’ll give it to me after a struggle…but I don’t think she is disengaged. I just think she finds the content a bit difficult (E1)_

Other teachers recognised that not all students actively sought help, however were still aware that they needed support reporting that when a student is very quiet “doesn’t talk much but is struggling with work and comes to you, you still give them encouragement” (F1). This type of situation highlights the different ways teachers perceive student engagement. Whilst some teachers may perceive students’ lack of help-seeking as an indicator of disengagement, other teachers perceive different underlying reason for such behaviours. Therefore, the reasons teachers attribute to certain student behaviours can influence the strategies they use. Strategies that ignore students’ needs for support may result in further disengagement or, as in this case, addressing the students needs resulted in promoting student engagement. Research that focused on understanding why students chose not to continue with mathematics after the compulsory years noted that perceived difficulty, dislike, boredom, lack of
confidence and relevance were factors that influenced their decisions and future intent not to studying mathematics longer than necessary (Brown et al., 2008). Students who experience continual difficulties or perceive difficulty with mathematics require specific teacher intervention and support to maintain their participation and engagement in mathematics.

Teachers, who reported students as being unchallenged, included those students that were reasonably competent but not active participators in mathematics. For instance, one teacher reported, “I have a couple [of students’] who are the class clowns but incredibly bright …who possibly lack discipline and lack interest in the subject at times” (J1). Similarly, some students were identified as under-achieving, but they “don’t want to be seen as nerds and that kind of stuff” (J1). The influence of peers and classroom level factors on student effort has been noted in previous research. Sullivan, Tobias and McDonough (2006) found that a significant number of students under-contributed in mathematics classes to conform to the class culture or to “avoid the perception of trying due to threats of sanctions by peers” (p. 96)

One teacher noticed that a very capable student in his class was “performing below his ability and was not engaged and [not putting] as much care into his work” This teacher commented that it was frustrating when “you know they can do the work and they are not doing it” (H1). In these situations this teacher reports addressing the issues “honestly” with students by telling them “look, you are smart I can see you can do the work, you are just not performing, I am disappointed” and reports that in response the students “sometimes do pick up their act” (H1).

Teachers also perceive factors outside of the classroom that influence student engagement levels. One teacher commented that he perceived that the level of parent support also influences students’ level of engagement:

Lower engaged students … haven’t been given as much encouragement by their parents to really concentrate and focus whereas … low ability but highly engaged students are ones that have a lot of support from their parents. [They are] the ones who always come to the parent teacher meeting and are always interested in how their kids are doing. So I think in one way their parents encourage them to really work hard (H1).

However, teachers perceived that generally students were left to their own devices and did not receive much support from home, as the parents of many students worked unusual hours so were not at home to help them, or because the parents did not feel that they were good enough at mathematics to support their children (H2). Some teacher also reported that parents who did not enjoy mathematics when they were at
school relayed this information to their children and this negatively influenced their children’s engagement (A1, F2 and I1).

Teachers considered that some students who achieved well in mathematics were bored and this influenced their engagement levels. The teachers reported that capable students often “are just kind of standing still” and that “number crunching is really boring for girls who [want] to go further” (C3). Similarly, another teacher noted the needs of brighter students who did not need repetition, stating that this led to boredom and possible disengagement (J1). Factors such as tedium, experiences of rote learning or rule following and a sense of depersonalisation were included in descriptions of quietly disaffected students by Nardi and Steward (2003).

Understanding the needs of students who are capable of achieving highly in mathematics, yet remain bored or unchallenged in the classroom, is important because of the influence this may have on their future intentions to pursue further mathematics study.

In the present study, some teachers do recognise that repetition and lack of challenge are factors that undermine student engagement and aim to address these by making alterations in their practices. For example, one teacher reported that while adhering to key mathematical points when teaching the lesson, she makes alterations if she “feels that the students need a bit more challenge in the classroom” (F1). This teacher went on to explain that it is because she knows her students needs that “I differentiate it for the kids” and “individually plan for them”, and tries to make lessons exciting by using a variety of activities. Another teacher acknowledged the importance of including “practical lessons and lessons involving computers and smartboards”, finding this “really does engage the students as long as you choose the activities well” (H1).

Some teachers thought that high achieving students remained focused on achieving and “want to get a good mark in the exams”, but not necessarily on wanting to master their understanding (E2). Students who place greater importance on performance rather than mastery of mathematics reflect a performance orientation to learning. Students who undertake mathematics work driven by extrinsic reasons (for example, not wanting to disappoint others or to avoid doing poorly or looking like they perform poorly) rather than for intrinsic reasons (for example, working because they themselves want to do well), may do so to avoid failure (Galloway et al., 2004). ‘Failure avoidance’ is a factor highlighted by Martin (2003, 2007) as an impediment
to engagement particularly if students are susceptible to feelings of failure if their performance levels fall.

In summary, teacher perceptions of students’ variable engagement, summarised in Table 6.1, identify reasons why some students showed signs of wavering engagement in mathematics. The teachers described engagement types such as: compliant behaviour but needing coaxing and encouragement; emotional states ranging from lack of interest and boredom to anxiety; and cognitive approaches ranging from poor organisation, study and lack of understanding to underachieving and being unchallenged. Teachers reported that indicators of variable engagement were not confined to low achieving students, but were also evidenced by those students who experienced success in mathematics, therefore indicating that variable engagement exists across different achievement levels. It was also reported that teachers used various practices to promote student engagement and that the practices used depended on the teachers’ perceptions of the students’ engagement and achievement levels. In cases where students achievement was low and engagement was fragile they tended to take a more supportive approach and where achievement was more robust, teachers tended to address students effort more directly.

**Substantially Engaged**

When teachers discussed students whom they considered substantially engaged, they reported students who were “switched on [and] participating. They want to answer questions, they want to ask questions. They smile” (J2). Students were described as actively participating, wanting to answer and ask questions, regulating and organising their learning and being interested and enjoying mathematics lessons. Teachers perceived highly engaged students as displaying “interest, their level of concentration…watching them talking to their friends about the work…whether they’re on task…the questions that they fire, the conversation” (J1).

Teachers reported that students demonstrated engaging behaviours in mathematics classes: “their hands are always up… they are willing to give an answer. They want to come up to the board to show the answer…You see smiles and ‘I get it, I get it’” (E1). Other teachers noted in Table 6.1, that students considered substantially engaged, seemed willing to work with the teacher during the lesson. For example: “they are always wanting to try and answer questions, they get on with their work, with activities, they are attentive and co-operative” (A2). Another teacher
acknowledged that engaged students were interested in learning and understanding rather than just completing tasks or following procedures, stating that in her opinion ‘engaged’ means:

On task, interested in not only finishing the task but finishing it to the best of their ability, to a high standard, and wanting to know what they don’t know, wanting to go that step, rather than ticking and crossing, actually finding out why (J3)

Teachers’ responses reflect that engaged students’ behaviours in mathematics classes extended to understanding and mastering concepts. Teachers were cognisant of the amount of effort that lower-attaining students applied towards mathematics. They often realised the importance of small achievements for continued persistence and positive emotions and perceived that they contributed to their students’ achievements and engagement. One teacher reported that one of her low achieving students:

Always tries his best… perseverance would be his number one strength… the desire to do as well as he can regardless of what it is— just to even improve by three marks he gets excited and happy. He really struggles with maths, but it doesn’t stop him trying and I think without blowing my own trumpet, I think I have a lot to do with that (J2)

Interest and effort along with long-term persistence are often cited as key indicators of student motivation (Hardré et al., 2008; Martin et al., 2012). Engaged students are also reported as demonstrating positive emotions such as enthusiasm, curiosity and enjoyment (Skinner & Belmont, 1993). In Study 1, substantially engaged students, often indicated strong emotional engagement indicating that they liked and enjoyed mathematics. For example, one teacher reported of a student:

He tells me. He likes maths. He is prepared. His book is neat… and he will do the extra work or the extra questions. He just sits down and gets on with the work. He is quite focused (I2)

Some teachers reported that even if students were frustrated or unable to complete a task they did not let this “get in the way” of learning (F1) and persisted with seeking understanding. Students would ask for help after the lesson telling the teacher they “need more help” or need to improve in a particular area (F1). This teacher perceived that her teaching made a difference to students persistence stating that, “as a teacher, I try and show a lot of enthusiasm with the way I teach … I’m very positive about it and any small thing that the students do; I’ll pick up on it and I’ll say ‘good effort’” (F1).
Regarding cognitive perspectives, the teachers reported that engaged students displayed greater levels of respect for learning and sharing knowledge with others. One teacher reported a heightened ‘communication’ in the classroom, indicative of the idea of ‘flow’ (Csikszentmihalyi, 1990) where students’ interests and learning coincided and resulted in learning experiences being enhanced by satisfaction and absorption in what they were doing:

Well they’re keen and participating and hands are up. Sometimes it means the noise level’s gone up actually, because they are all having a go. You are just aware there is a communication between you and them. It’s not chatter, there’s more questioning and listening to one another (J3)

Other cognitive characteristics of engaged students, noted by teachers, included concentrating, maintaining attention in class, following up and clarifying their understandings. For example:

They are self motivated to a certain extent, their bookwork is always thorough and complete; they’re the ones who bother to…do their homework…and mark their own work. They are the students who, not necessarily in the class, but after the class would stay behind and clarify points (J3)

One teacher reported a high achieving student who “asks questions when he doesn’t understand things, so he’s keen to learn and cover things” and is focused on thoroughly mastering skills and concepts (E2). Engaged students were also perceived to be more proactive about mathematics work outside the classroom. For example: “motivated kids will go home and do ‘Hot Maths’ [on-line modules] and ‘Smartboard’ [interactive whiteboard] lessons” (A2); and “They talk about it [mathematics] outside of the class with me. They talk about their homework” (A3).

Teachers reported that engaged students were thought to value and show interest in knowing where they would apply the mathematics they were learning: “They’re usually very interested in things like discussing where it will be used and how it will be used…it’s very much ‘how do we use it in life’?” (D1). Teachers commented they “saw” that engaged students were interested in learning more, for example, “You get the ‘sshhh’, I want to hear the next question’ so they’re waiting for more, they want more” (F1) and “A lot of them want to work ahead” (J1).

Substantially engaged students, regardless of their achievement levels, indicated an interest in doing better, a willingness to persevere and to participate actively in the classroom. It was clear from the teacher reports that they perceived
signs of student engagement independent from a students’ level of achievement. In the following example, the teacher perceived the student (who was low achieving) as highly engaged because they were interested learning and understanding mathematics:

They don’t talk to other students… They are focused, they are listening, they also ask a lot of questions. Low ability kids ask a lot of questions. They are more engaged because they want to learn this and trying to get their heads around it asking for help…Any student asking for help is a student doing well in the engagement stakes (H1)

In summary, the teacher reports of substantially engaged students in Table 6.1, are associated with several adaptive cognitive and behavioural factors on Martin’s Wheel (2003, 2007). These include cognitive factors such as: ‘valuing’ of mathematics tasks and as a subject; a ‘mastery orientation’ to learning in wanting to understand the concepts; high levels of ‘self-efficacy’ with students believing they could understand with effort and help. Behavioural characteristics were also evident, such as ‘persistence’ and effort with tasks within and outside of class and in overcoming difficulties; and ‘planning’ and ‘management’ of mathematics work.

Although the Engagement Spectrum was used to tease apart and describe distinct types of engagement, the reports by the teachers demonstrate that types of engagement are interrelated and operate in a multidimensional way. This is consistent with engagement literature (Fredricks et al., 2004). Several of the teachers described a positive learning cycle where students who were interested in learning actively participated in lessons and employed strategies including asking questions, persisting with concepts and clarifying understanding in order to master concepts. It is also noteworthy that when reporting about ‘substantially engaged’ students, there were several instances of teachers perceiving ways that they themselves influenced student engagement in their mathematics lessons.

Summary of Key Findings and Links to Student Results

The qualitative results of the teacher interviews identified three significant findings about teacher perceptions of student engagement in mathematics. First, teachers perceived differences in the behaviours, cognitions and emotions between levels of student engagement. Second, teachers perceived that there were different reasons to explain fluctuations in student engagement. Third, the teachers’ perceptions
of student engagement and disengagement in mathematics were not necessarily associated with students’ levels of achievement.

**Key Differences between Levels of Student Engagement**

A major difference between students with different levels of engagement was their preparation for and involvement in mathematics learning. Disengaged students avoided eye contact, sat toward the back of the room and did not bring books, pens, calculators and other required equipment to lessons. The teachers reported that despite breaking down and re-wording questions to elicit responses, disengaging students could often not be drawn into class discussions. By contrast, substantially engaged students greeted the teacher, engaged in conversation, sat near the front of the classroom and were prepared for their lessons.

Disengaged students avoided task completion by chatting to others, procrastinated by spending time on ruling up pages, asked ‘lesson stopper’ questions and distracted others. By contrast, substantially engaged students were perceived as eager to ask and answer questions and to communicate and contribute to class discussions. These students got on with their work and sought help if they needed it. Some students demonstrated participation in other ways, such as completing work with help from a friend or seeking help after class from the teacher.

In terms of making progress with mathematics learning, disengaged students did not tend to complete or mark their homework or seek help outside the classroom if unsure about content. Substantially engaged students generally kept tidy and clear notes, completed and marked homework, sought help at school or home to clarify their understandings and at times undertook additional practice. These findings are significant as they draw teachers’ attention to a number of characteristics that are absent in disengaging students.

**Fluctuations in Student Engagement**

Students who were perceived as variably engaged displayed a combination of engaged and disengaged indicators and often at less intense levels than those found for the disengaged or substantial engaged categories. In summary teachers perceived variably engaged students as:

- Those who understood the content taught were bored and preferred challenge;
• Those whose mathematics achievement was good but participation low;
• Those who attended class, without proactively participating and were inclined to procrastinate and daydream but attended to work when prompted;
• They answered questions if asked, but tended not to volunteer, as they often felt anxious about getting things wrong or, conversely, looking too clever in front of their peers;
• They believed that mathematics was important but often felt they were not as capable as their peers and were sensitive to and disappointed with poor test results;
• Their retention of information and concentration in lessons was weak;
• They did not use sophisticated study or self-regulation strategies; and
• They tried to make sense of what they were being taught but preferred to ask for help covertly by approaching friends or the teacher after the lesson.

The teachers revealed that their perceptions of variably engaged students described two sets of characteristics. One set of characteristics pertained to students who were perceived as competent at mathematics but not highly engaged, the other depicted students who were reluctant to engage.

Competent but not highly engaged

Teachers reported of students who they perceived as ‘bright’, and who had historically achieved well in mathematics, “getting by” without too much effort. However, as the students were faced with more difficult concepts in secondary school they were required to put in greater effort which they did not enjoy and were not achieving as highly or as easily as they had in primary school. The teachers also perceived that for some high achieving students their focus in mathematics was on how well they did, their performance, rather than on mastering mathematics concepts. In such cases, falls in performance are likely to challenge students’ feelings of perceived competence and this has implications for students’ self-efficacy. Several teachers (C3, E2 and J2) also perceived that high achieving students required challenges in mathematics work both in terms of content and pace and did not need repetition of skill type work.
Comparison between the teacher and student interviews revealed significant overlaps between the perceptions of the teachers and the perceptions of the students. Specifically, many of the characteristics identified by the teachers were also reported by the students in the ‘high achieving disengaging’ (HAD) category discussed in detail in Chapter 5. HAD students reported they were aware of their ‘place’ in the class relative to others and perceived they were not achieving as well as they had in primary school. In terms of their emotions, HAD students equated enjoyment with competence, they thought that Year 7 mathematics was challenging and required more effort, which they found less enjoyable, and commented that repetition of content was boring. Students’ perceptions of their competence, emphasis on performance, coupled with needing to put in greater effort are likely to be factors influencing their decreasing interest in mathematics. This is consistent with research that has identified that perceived competence, learning goals and ‘content instrumentality/value’ strongly influenced interest and intentions to complete high school and study further (Hardré et al., 2009). The intentions of students in the HAD category were to continue studying mathematics until they completed school and had career aspirations including law, veterinary medicine, medicine, physiotherapy and police enforcement. Therefore maintaining students’ perceived competence and interest in mathematics is important, suggesting a need for teachers to be vigilant and take actions to support students who are concerned about their competency at mathematics. Importantly, HAD students provided some indications about aspects of mathematics teaching they perceived were important to them. These included quick question and answer sessions that got them thinking and put their ‘minds in gear’, quizzes and group work where they could share dialogue and their understanding with others.

Reluctant to engage

Student lack of involvement in mathematics lessons was construed by some teachers as a lack of interest or engagement, however others teachers perceived that reluctance to participate in class was due to other reasons. Such reasons included emotional factors such as anxiety and lack of confidence in mathematical understanding. The teachers reported that some students seemed anxious, unsure, scared and shy in mathematics classrooms and this hindered their level of active participation in mathematics lessons. For other students, teachers perceived their reluctance was due to difficulties with understanding the content. The teachers’
responses indicated they were hesitant to force student participation, as they were conscious of not embarrassing students in front of their peers. Some teachers indicated that they would gently probe students until they felt it was time to withdraw so as not to make them feel uncomfortable and instead preferred to speak to them individually as they walked around the classroom.

Turning again to the findings from the students interviews discussed in Chapter 5, those in the ‘low achieving disengaging’ (LAD) category reported a general lack of understanding of many mathematical concepts, knew they ‘did not get it’ and equated passing or failing mathematics as being good or bad at it. LAD students expressed anger, frustration and dislike because of their difficulties with understanding many mathematics concepts as many believe mathematics was valuable and important for their futures. LAD students often felt ‘lost’ and found homework hard to complete, were not clear about strategies to use for study and usually did not seek help at home or in lessons unless from a friend. The reluctance of some students to take a more active and participative role in the mathematics classroom therefore occur for various reasons. It is important that assumptions about lack of disengagement in mathematics are not made when it may in fact be the students’ feelings of anxiousness or competence that hinder their participation. Further, by understanding what is inhibiting a student’s participation provides information to the teacher who can use different instructional techniques and practices to support the student’s needs.

In cases where students’ feelings of competence and perceived effort are weak, it is important, as suggested by Hardré et al. (2009) that extra care is taken “to ensure that students believe they have the competence to succeed, and that they see their success as due to their own ability and effort” (p. 15). In this way, clear links between effort and grades received are made. In this study nearly all students referred to their grades (rather than their efforts) and improved understanding as a way of judging and describing their performance in mathematics. Interestingly, although many teachers referred to students’ grades or test performance as indictors of achievement levels, many also emphasised the efforts students made to overcome their learning difficulties. Despite the emphasis on formative assessment as providing an opportunity to clarify thinking (Reeve, 2009; Watson, 2010; Wiliam, 2009), based on the student reports in Study1, feedback about students’ efforts and academic progress were rarely explicitly communicated to students.
Understanding student thoughts and feelings about mathematics provides vital information for teachers to better meet students’ needs for promoting engagement. Teachers may not be able to convince students to like or enjoy mathematics, however they can use teaching strategies to reduce off-task behaviours and encourage active participation and involvement. Modelling strategies that foster understanding such as keeping organised notes and approaches to study that build students’ competencies are likely to be effective for promoting engagement. Increasing feelings of control over learning and using effective planning and task management strategies can also help students feel less anxious about mathematics.

**Relationship between Levels of Engagement and Achievement**

The results of the teacher interviews indicate that while student engagement was often associated with levels of achievement, high engagement and disengagement did not necessarily correspond to high and low levels of achievement respectively. Several teachers reported of high achieving students who showed limited interest in mathematics or achieving higher grades and, although they were quite capable, they chose not to participate actively during class. In these cases, the teachers describe specifically probing students’ mathematical thinking during lessons as a way to encourage their participation and interest. There were also reports of low achieving students who teachers perceived were substantially engaged. They commented on these students’ requests for help and their perseverance to understand what they were being taught. In both cases, the teachers perceived that the students’ levels of engagement were not highly associated with their level of achievement. In fact, the teachers perceived that motivating factors of some low and high were at odds with student achievement levels. For example, teachers perceived high levels of effort, interest and persistence by very low achieving students. By contrast, fairly low levels of effort, interest and enjoyment were perceived in very high achieving students.

These findings reflect the importance for teachers to consider student engagement and achievement in the mathematics classrooms because paying attention to student engagement and student achievement in isolation is likely to reflect only a partial understanding of the students’ learning needs and consequently limit the effectiveness of teacher support and intervention.

By contrast, there were instances where teachers reported that levels of student engagement were strongly associated with their achievement. This association was
greatest for high achieving substantially engaging and low achieving disengaged students. Of concern were disengaged students with low achievement, who struggled to understand mathematics concepts. As reported by the teachers, low achieving disengaged students also portrayed frustration and dislike for mathematics, but lacked the effort and perseverance that low achieving substantially engaged students demonstrated. Therefore, encouraging students’ efforts and implementing learning strategies in ways that will improve achievement levels are significant factors for promoting engagement for ‘disengaged’ students with low achievement levels.

One conclusion that may be drawn from these results is that attention to engagement and achievement in mathematics is important for all students, however in some cases the emphasis on maintaining engagement or attending to achievement may need to be prioritised to meet individual student needs. For example, students with low achievement but high engagement levels would benefit from different teaching strategies more than students with high achievement levels and low engagement. Reports from the students revealed that their views about their achievement, feelings about and behaviour towards mathematics learning indicated different responses and needs. High achieving engaging students felt competent, welcomed greater challenges and wanted to discuss their mathematical thinking with other students, therefore providing opportunities for mathematical discourse is important for these students. By contrast low achieving engaged students would ask questions, complete homework and revise as they strove to understand mathematics, therefore formative feedback and encouragement would be beneficial.

Establishing effective ways for teachers to diagnose student engagement levels and underlying motivational factors provides teachers with opportunities to use teaching strategies that specifically target certain types of engagement that are most likely to positively influence achievement outcomes for individual students. Links between motivational factors that influence cognitive and emotional engagement are important to pursue particularly as they are viewed as vital for student self-regulation and metalevel knowledge. Such knowledge increases student awareness for planning, monitoring and managing cognitive and emotional engagement during academic tasks and therefore important for promoting overall engagement in mathematics.
Section Conclusion

The Study 1 results confirm that student engagement is complex, involving the inter-relationship and variability between three types of engagement. The Engagement Spectrum emerged from the data and provided a way to frame the types and levels of engagement described by the teachers. This provided a clearer picture of: (a) how teachers identify student engagement; (b) the type of factors they perceive as influencing levels of student engagement; and (c) how achievement levels are associated with levels of engagement. It was discovered that although teachers’ perceptions of types of student engagement were consistent, the importance they placed on each type differed. For example, some teachers focused on overt student behaviours while others were more sensitive to the subtleties of students’ emotional responses in conjunction with their cognitive approaches for mathematics learning. Overall, despite teachers being concerned about students’ needs for understanding mathematics, teachers’ reports about cognitive engagement and practices used to support it were limited. The following section investigates in detail the strategies that teachers used for supporting and shaping student engagement in mathematics classrooms.

Teacher Practices for Engaging Students in Mathematics

The practices reported reflected the teachers’ perceived needs of the students at a classroom level. There were also instances of teachers using particular practices for students with different achievement levels. The results report six categories of practices teachers used for supporting engagement: (a) the relevance and future value of mathematics; (b) applying and connecting mathematics; (c) autonomy support and empowerment; (d) student interest; (e) teacher enthusiasm; and (f) interpersonal relationships. Teacher practices that hinder or reduce opportunities for student engagement are also reported and these include: (a) unintended negative engagement strategies; (b) engagement as an occasional practice; (c) uncertainty about how to engage students; and (d) controlling teaching styles.
Practices Used for Engaging Students

Over half of the teachers interviewed discussed using practices in their mathematics classrooms and several teachers reported drawing from models associated with developing student thinking about learning. Certain formalised programmes focused on developing thinking skills (e.g., Programme for Environmental, Experiential Learning (PEEL), ‘Habits of Mind’ and ‘Blooms Taxonomy’) were reported as useful guides for solving problems, for interpreting and analysing questions, and generally enhancing students’ understanding.

Several teachers reported using thinking and learning programmes developed for consolidating understanding of content such as making summaries at the end of a topic or brainstorming potential content material at the start of a unit of work. The teachers who reported using these practices also indicated an elevated awareness of the importance of establishing students’ understanding and were concerned with maintaining students’ interest and efforts with mathematics.

Teachers in one school reported they carried out an evaluation with their students to determine their interest towards mathematics topics, and several teachers reported talking informally with students about their interest in mathematics. In nearly all cases, the teachers reported using practices for engagement based on their previous experiences of teaching mathematics to students of the same year level (first year of secondary school), rather than based on a purposeful analysis of the class or individual student motivational needs.

Broadly, the types of practices used by teachers attended to students’ external or internal needs. Practices that focused on students’ external needs mainly reflected reasons that teachers perceived students would want to learn mathematics whereas other practices aimed at supporting students’ internal interests and psychological needs (Hardré & Sullivan, 2008). Externalised motivating practices predominately related to two aspects: relevance and future value of mathematics and; the application and connection of mathematics concepts. Internalised factors focused on student interests and supported student autonomy for learning. Other practices reported by teachers included displays of teacher enthusiasm for mathematics (both overtly and covertly) and the development of interpersonal relationships with students. Although these two practices do relate to students internal needs, they have been reported separately due to the emphasis placed on them by the teachers, particularly on their
positive influence for increasing student efforts, self-efficacy and overall engagement levels.

Practices emphasising the relevance and future value of mathematics

The majority of teachers in Study 1 drew on the practical application of mathematics as a practice for engaging their students in the classroom context. The use of mathematics in ‘real life’ was often cited, as a reason for studying mathematics because “mathematics has a place in life, in the simple things that you do. In making a cup of coffee…that ratio of how you want your drink or how you are going to make a cake” (H1).

Nearly all teachers reported they were accustomed to and even expected student demands for reasons and justification of the mathematics they were learning at school. Questions such as “Why do we have do this?” or “What are we going to use this for?” were common and, although some teachers perceived this as a form of procrastination from getting on with work (A4 and F2), others pre-empted the questions and used them as opportunities to garner students’ interest and excitement for the lesson (A1, C3 and H2). Most teachers attempted to address questions about relevance and future value of mathematics in positive ways, for example:

I chat with them about all the different things they can do with maths or things that could be helpful to know when they get out in the real world. If you point out where they can use it in the real world that tends to bring them around a lot more. For these girls relevance is really important (D1)

Some teachers aimed to justify the learning of current mathematic content as important steps in building knowledge for more complex mathematics work later on and beyond school, reporting:

The stuff we are learning now is just a building block to using high levels maths in jobs when you leave school. I usually say there is not a job you will do that uses maths exactly like this but if you cannot do this easy stuff you will not be able to do the more complex stuff in engineering, medicine etc. (A3)

Several teachers responded to questions about relevance and value in less positive ways, taking pragmatic approaches. One teacher’s response appeared to imply that persisting with mathematics knowledge and understanding is not a valuable pursuit in itself, but rather something to endure for other purposes:

I said the reason you should do it (maths) is number one, you have to do the School Certificate and it is going to be in there and number two, it is a skill and so you can show an employer… So I was honest with her. Would you use it everyday life? No you would not (B1)
Another teacher did not think there was any point in explaining to students the value of learning aspects of mathematics, viewing questions from students about the relevance of content as “lesson stoppers” saying that he preferred to “plough on and pretend the questions did not come” (F2). This teacher appeared to think it was futile trying to provide satisfactory explanations for students, reporting:

I think most teachers more often than not are challenged to come up with a good story why do I care about solids and properties of solids. But at 13 and 14 (years) sometimes we are doing it because we are doing it. I do not think you are going to come up with a satisfactory story for a 13 year old so sometimes I just think what is the point. Let’s move on with the lesson (F2)

This comment reflected that the teacher would rather avoid addressing the issue of how mathematics was relevant to the students’ understanding and implied that the students were not legitimately interested in understanding the reasons for studying mathematics. The teacher’s main concern was to stay focused on the lesson content and cover the curriculum material.

Practices emphasising mathematic applications and connections

About a third of the teachers reported instances where they provided students with examples of how mathematics was connected to the students’ “world” (H2), perceiving that mathematics “needs to be connected to their life in some way” (C2) and to help them see some personal relevance in mathematics. One teacher sourced relevant internet sites that connected specific aspects of mathematics (e.g., ratio and scale drawings) and “how mathematics is used in different work situations”, believing the students found this “interesting, motivational and relevant” (H2).

Another teacher reported that before beginning a topic on percentages she asked the students to research and source relevant material from newspapers about interest rates and so on (C3). By taking this approach, the teacher perceived she was establishing relevant background awareness of percentages and how these were used and applied outside of the mathematics classroom. Some teachers revealed that they were aware that students felt a lack of connection with mathematics. In the following example, the teacher endeavoured to link thinking processes such as logic and reasoning used in mathematics to other subjects and longer term use:

I think [the students] see [mathematics] as being isolated and non-connected and hence comments… “Why do we have to do this?” I tell them it is a way of increasing their ability to reason and to be logical and whilst it may not have a direct application outside of school the skills that they learn and by following a process are useful skills outside of mathematics (A4)
In most cases, the teachers’ comments reflected that students were interested in why they were learning mathematics. Most of the time teachers provided answers that addressed why students would want to learn mathematics—such as for their future careers, practical application and the relevance use of mathematics beyond school—rather than addressing why mathematics was relevant to their personal needs.

Practices to enhance autonomy support and empowerment

‘Autonomous teaching styles’ are described as “interpersonal sentiment and behaviours teachers provide to identify, nurture and develop students’ inner motivational resources” (Reeve, 2009, p. 159). Autonomous styles are considered important for meeting one of the basic psychological needs of students and are associated with positive classroom functioning and increased educational outcomes (Connell, 1990; Reeve, 2012; Skinner & Pitzer, 2012). Several teachers demonstrated an autonomous teaching approach, welcoming students’ questions and encouraging independent investigations. For example: “Oh we can explore that with me doing the guiding...and see if we can come up with some solutions. Or, you go home and look, then come back and let me know” (E2). Another teacher was keen for students to take control of their learning by seeking solutions for themselves:

Maths needs to be centred on the students…it should be about the kids themselves taking control of what they are doing, owning what they are doing, so it is not just me giving them the answers, they are actually finding the answers themselves...it needs to be connected to their life in some way (C2)

Teachers who supported student autonomy also tended to adopt the students’ perspective, welcomed students’ thoughts, feelings and behaviours therefore acknowledging them and their potential contributions. For example:

I see a lot of students get frustrated because they can’t do something, but I also see students that don’t let their frustration get in the way- they do try and persevere. I have a number of students who come to me and always ask me after the lesson… and I do sit down with them and we work through it and they are really, really willing to give it a go (F1)

In this example, the teacher accepted that some students felt frustrated at times but recognised their continued efforts to overcome difficulties with mathematics content. She supported their perseverance by making herself available therefore demonstrating that she valued them and the importance of mastering mathematics concepts.

Practices emphasising student interests
Teachers reported using practices that were sensitive to students’ personal interests and desires. For instance, one teacher noticed a student’s capability and interest in mathematics, and nurtured this by allowing her “to create the warm-up for the class”, commented that the student became “even more motivated. She got a buzz out of doing that, like owning what we were doing and running it” (C2).

Other teachers reported using practices to tap into students’ interests. One teacher endeavoured to “veer away from the textbooks and make the maths a little bit more meaningful and a little bit more practical... looking at a clip on ‘You Tube’ based on [content]” (H2). Another teacher reported that capturing students’ interest and stimulating thinking was a positive practice for starting lessons:

I try and start off lessons with puzzles and things to get their brains ticking. It is always good to start with these fun questions it just gets them going. I found that it doesn’t necessarily have to relate to the topic at hand, it really just intrigues them with puzzles and little games (F1)

In some instances, teachers nurtured students by encouraging them to try again and persevere with understanding (F1), suggesting that if students make mistakes or do not understand “look at it tomorrow, you might get it” (E3). Some teachers used a change of content as an opportunity to re-invigorate students’ interest and efforts (J3). Many teachers perceived that encouragement and advice motivated students, reporting that positive reinforcement such as a “well done” and telling students they did a “good job” (H2) was an important practice for maintaining student engagement. Another teacher reported he conveyed his beliefs of a student’s potential by offering specific feedback about the students’ strengths, saying “you’re a really good mathematician, you can do this, it’s going to take you a little bit more time and you need to be organised” (E2).

Several teachers perceived that one way of motivating students and maintaining their interest was to offer variety in their lessons, by making lessons fun (E1). Another teacher, (E2) reported that he perceived that his students liked a kinaesthetic approach to learning. This teacher offered hands-on approaches for engaging students in learning such as interacting with the whiteboard (IWB) by moving things around and writing solutions. Teacher E2 also regularly used mini-whiteboards (A4 size laminated boards), reporting: “Any kids that I’ve ever taught, love working on the mini-boards. I think it is safe for them, so that they can immediately erase something and correct it straight away” (E2).
One teacher reported using a more subtle way of sparking students’ interest in mathematics learning by deliberately leaving mathematics notes from previous classes (of a higher year level) on the board. The teacher would draw younger students’ attention to the work on the board so they could get an idea of where mathematics is headed as they progress through school with the view that they could be exposed to more sophisticated mathematics and not be “frightened of it” (C3).

Strategies emphasising teacher enthusiasm

Over a third of teachers reported that they informed students about their personal feelings towards mathematics and perceived that this had a flow on effect for motivating their students. One teacher reported: “I am quite excited about maths as a subject...the kids know I love maths and they kind of tease me...but that has rubbed off on several of them” (J3). Another perceived that she portrayed enthusiasm in the way she taught and this was beneficial for her students (F1), and another teacher (E3) used her own past mathematics workbook to inspire students. One teacher set herself the challenge of trying to change her students minds about maths, making it a “bit more fun and get more kids enjoying it and liking it” and to “appreciate it, why it works and how it works” (E1). She commented:

Sometimes I think it’s just because I walk in, I smile and I put on a show and sometimes I think that might be it - but a few of them seem to be picking up things a lot better, a lot quicker and they’re better achieving and they’re happy with themselves, like this is the first test I’ve passed in maths (E1)

Other teachers prepared and arranged activities that they perceived would be interesting to the class or individual students. For example: “Before the lesson I research quite a lot on a topic, so I know beforehand...so I know when the questions come to me” (F1). One teacher offered students lessons before school where he “created [mathematics] problems...and they can pick one and do it” and this provided opportunities for students to engage in mathematics work in different ways than they usually did in the classroom (C2).

Practices emphasising interpersonal relationships

Teachers engaged their students through their interpersonal styles in the mathematics classroom, reporting that interpersonal relationships with students were important. For one teacher, his main reason for entering the teaching profession was “the interaction with people, making a difference with people, the relationship” (C2).Teachers also reported that they believed it was important to make a personal
connection with their students: “I think it is important if you have, a rapport then I think you are going to get a lot more out of any student” (J2).

It was evident that initial exchanges between students and their teachers were important, and once students knew the teacher was there to help them, the relationship between them began to build and the students were more likely to seek help again in the future. One teacher reported her sensitivity to students’ feelings and perceived that establishing relationships and “building trust that you are not going to make fun of them or make them embarrassed” (I1) was very important. Teachers perceived that students needed to feel confident and unafraid of asking for help when they needed it. For example:

I figure if the kid is too scared to ask you a question then what is the point of being a teacher. They are supposed to want to ask you so you can help them. So, I always try and be as friendly – I like to think one of my strong points is my rapport with the kids because I try and relate to them as much as possible and we talk about soccer and guitars and music (E3)

Similarly, another teacher reported that it was important for her to know how to “connect” with each student believing:

It is very important to know how they work how they think and that way I can get a better idea of how I can help them how I can adjust my work. At the start of the year, I make a point of wanting to get to know them a little bit more to see how they work (H2)

Several teachers perceived students’ demeanours in the mathematics classrooms as being different (some being quiet and others more energetic) and recognised that, because of this students needed to be treated and motivated differently. For example, one teacher commented: “When you know that a student is a very quiet student, doesn’t talk much but is struggling with work and comes to you, you still give them encouragement”, they seem to recognise that you can and will help them and they will seek help later on (F1).

Strategies that Hindered Engagement

Unfortunately, not all teachers used strategies to support learning and engagement. While teachers did not report that they intentionally set out to hinder or undermine student engagement, it was the absence of practices or unintended negative practices that were identified. Unintended negative practices included those that the teachers perceived as helpful to students; however the engagement literature has identified that these practices are considered to undermine student engagement.
Practices considered to undermine student engagement include: emphasising performance; expressing negative expectation about students’ task success; expressing dismay for inappropriate answers; giving disorganised instructions; misinterpreting students’ statements; and conveying that the teacher needs to be pleased (Lutz et al., 2010). Raphael et al. (2008), noted additional practices such as: decreasing the value of the task; lack of monitoring and scaffolding; providing ineffective feedback; and using negative and inefficient classroom management. In Study 1, some of these practices that undermine engagement were reported by teachers, including negative expectations for task success, a lack of monitoring and scaffolding, and providing ineffective feedback. Apart from using unintended negative practices, some teachers in the present study also reported that they perceived engaging students in mathematics as an occasional activity and one that was considered as less of a priority than teaching the mathematics content. In these circumstances, the engaging activity usually amounted to a lesson that included doing something different or fun that the teachers perceived their students would find engaging.

There were also reports of teachers who perceived that students needed to be engaged but were unsure how to address the issue and did not believe that they were able to positively influence student engagement. Teaching styles that are controlling are also perceived as negatively influencing student engagement as they focus on behavioural compliance and do not support emotional or cognitive engagement (Reeve, 2009). Practices that hinder student engagement are described next and in each case, the teachers failed to recognise the importance of student engagement in mathematics, they did not make strong commitments for attending to student engagement and they did not take responsibility for engaging students in mathematics.

Unintended Negative Engagement Practices

Several teachers expressed low expectations of students to persevere with learning and work at revision. For example, one teacher reported that, although she would speak to the class about topics for revision and set some practice questions for each night, she did not think the students would do the revision at home (A4). Rather than support students for persisting or provide relevant and useful revision strategies, she continued the same practice, which was to put a “few revision questions on the board”. This teacher did not change her practice for her students even though she suspected that most students’ revisions for an upcoming test would include a simple
“look through their books” which she did not perceive would “make a difference to them” (A4). Rather than address reasons why students were not revising, or encourage strategic revision, the teacher’s practice did not address the students’ needs to master the concepts for the upcoming assessment. The teacher’s lack of expectation that the students were interested in revising at home and persisting with learning meant her approach did not promote behavioural, emotional or cognitive types of engagement.

Another example of an unintended negative practice was a teacher who decided that it was best to start Year 7 mathematical work at the very basic level because some students had lower mathematical skills than others. He reported that “you can’t even pitch to the middle as some miss out, that’s why it has to be pitched to the bottom, even though, yes, some kids have done it before” (A3). This teacher did not consider differentiating mathematics work for students with different mathematical needs. He treated them the same even though he was aware that the students in his class had varying levels of mathematical capability. This teacher did not perceive that repetition of content for most of the students could be considered as unnecessary, boring and non-engaging. Instead he justified his belief by saying “revision can’t hurt” (A3).

Engagement as an occasional practice

In Study 1 several teachers perceived engagement as something to be attended to occasionally or separate to the teaching of mathematics content. Such teachers perceived that teaching mathematics content and completing curriculum requirements was their main responsibility, even when they were aware that student understanding and engagement would be compromised:

You’re always finishing a topic to get onto the next one. I don’t get enough reinforcement and I sometimes have to abandon students’ understanding to make sure I get through the programme… to be covered which is the requirement to cover something in Year 7 for Year 8... I have the responsibility to cover it… that does affect all students or any student who’s not understanding...How is that supposed to help them engage? I’m not apologising. I’m just saying how I see this happen and I sometimes allow a loss of engagement they say I have to sacrifice (F3)

Comments about needing to rush to get work covered were made by several teachers, who felt that “even if you have some great ideas that could engage, there is just not the time for it” (A3). This teacher wondered how other teachers could organise their teaching better than he could, reporting: “I’m always behind trying to keep up” and “there are always interruptions at school, you lose a period here and
there and you are behind‖ (A3). The same teacher perceived that practical lessons were “a time waster”, arguing that there was “so much content to cover”, that spending a whole lesson on cutting something out, for example, was “time lost toward actual learning” (A3). The teacher went on to say that despite wasting time, these types of lessons were needed “every so often so that [students] don’t think that maths is boring every period, which a lot seem to think” A3. This teacher perceived that engaging students in a practical activity would alleviate their boredom with mathematics, rather than to consider other ways he could engage students in activities that were also effective for covering mathematical content and addressing learning needs.

Another teacher’s solution for meeting the demands for teaching content and the need to engage students was to attempt to balance both by including engaging lessons some of the time or for part of the lesson, commenting that not every lesson could be exciting (H1). Other teachers perceived that engaging lessons included those where students did not think they were working and included a “practical lesson like they have to do measurements so they measure their limbs, go out in the playground they can talk, the freedom, they don’t mind, they get engaged” (F3). This teacher thought that not only did these kinds of lessons reduce constraints on students it also allowed them to “socialise …at the same time they can talk about the weather, their girlfriend” (F3).

From these reports, it appears that some teachers perceived that a one-off interesting or different activity satisfied students’ need for engagement. Many of the comments suggested that when teachers selected an interesting activity the value of the task was not carefully considered. In some cases, the expectation that students would complete tasks was low and the monitoring and scaffolding of class work was limited.

Uncertainty about how to engage students

Uncertainty about how to engage students in mathematics was reported by several teachers, with one believing that the “ideal situation for engagement” would present itself if certain conditions were met (F3). This teacher commented that: “if we wanted to engage students you have a perfect teacher, which I’m not, and have perfect students which is hard to get. You need to have the one-to-one situation” (F3). This teacher also believed that there were many factors outside his control that influenced
students’ engagement and even though he wanted his students to “enjoy the experience of maths”, they did not and he did not know how to influence that (F3).

One of the external influences on student engagement perceived by teachers was their students’ parents. Several teachers reported that parents who voiced their own dislike of mathematics in turn influenced their child’s engagement. Conversely, one teacher perceived that too much parental interest was also negative for engagement, reporting: “I think some parents drive their students and tell them how good and important maths is. They [students] rebel against that” (F3).

Many teachers also referred to the students’ lack of basic skills such as knowing their times tables and definitions of mathematical terms, which they believed should have been mastered in primary school, were a hindrance to their learning and subsequent engagement (A2, B2, E4 and F2). One of these teachers felt that it was the curriculum topics that caused a lack of student engagement asking: “Do you look at the syllabus and have you actually spoken to a Year 7 boy or a 15 year old? Are you serious? Is this going to engage them?” (F2).

One teacher also mentioned that students in the class who were not engaged had a “negative influence on others” (F3). He went on to report that a non-engaged student “doesn’t send out good signals to everyone else”, indicating this was an additional problem when it came to engaging the class. Another teacher agreed that “it is better for [less engaged students] to be sitting close to the front and away from other similarly less engaged students and hopefully closer to engaged students” (H1). This indicated that teachers perceived that the engagement levels of different students were determined by the students around them and the teachers used strategic student placement as one way for improving engagement in lesser engaged students rather than addressing it directly themselves.

The comments of these teachers suggested that students’ lack of engagement was caused by external factors such as non-supportive parents, poor primary school preparation, curriculum demands and other non-engaged students. Teachers perceived these external factors as obstacles that would be difficult to overcome and these perceptions appeared to limit the efforts they made to engage students and lowered their expectations that they could successfully engage students in mathematics. In short, they made limited efforts and took little responsibility for engaging their students in mathematics.
Controlling Teaching Styles

Separate to practices that hinder engagement, the negative influence of controlling teaching styles has also been identified as a factor in student engagement (Reeve, 2009). Controlling teaching styles directly or indirectly intrude on students’ thoughts, feelings or actions, pressuring them into thinking, feeling and behaving in particular ways. For example displaying impatience, pressuring students and failing to explain rationales for class work are practices that are controlling. Controlling styles result in students lacking motivation for personal interest, value, task involvement, positive feelings, self initiative, perseverance, creativity and preferences for challenge (Reeve, 2009). Consequently, controlling teaching styles tend to influence aspects of behavioural engagement such as on-task attention and effort, however are not supportive of emotional and cognitive aspects of engagement.

The results of Study 1 revealed that some teachers imposed controlling teaching styles in their classrooms, despite thinking they did not. For example, one teacher reported that he liked to have “a low-stress classroom” and gave students “a bit of responsibility” (B2) but also emphasised sanctions for off-task behaviours. The same teacher also reported using other practices that pressured students into completing their work during class time by imposing penalties if not completed, such as extra homework.

Another teacher reported using a system of increasing penalties in order to have her students “co-operate, listen and focus” in the classroom (A4). The teacher initially used positive reinforcement, making comments in responses to students such as “good job, excellent, okay who else can have a go?” However, the teacher reported that this practice was “short lived—not short lived but it didn’t seem to be really making a difference”. The next step involved using student diaries to report merits and demerits for the amount of questions answered in the lesson. The teacher reported that setting consequences finally “made a difference” (A4).

The teachers’ reports indicated teaching practices that imposed consequences and sanctions for non-compliance as well as placing pressure on students to conform to the teachers’ perceptions of how best to manage the learning setting. As Reeve (2009) suggests, teachers often employ a combination of autonomous and controlling styles and this was evident as Teacher A4 praised students for their contributions at one point, but reverted to controlling practices once this was no longer successful. None of these practices fostered students’ personal interest, value, perseverance,
curiosity or challenged them mathematically. The practices used by teachers centred on maintaining on-task behaviour and offered little emotional and cognitive support.

Summary of Teacher Practices for Engaging Students

In summary, this section described a range of practices used by teachers that promoted and hindered student engagement in mathematics. These included practices with a focus external to the students’ personal needs such as emphasising the relevance and future value of mathematics and the application and connectedness of mathematics. These types of practices may placate students’ immediate queries about the purpose of learning mathematics but do not necessarily, satisfy students’ needs at an individual level. Teachers reported on other aspects of their teaching practices that influenced students’ effort and engagement particular to mathematics. These included teacher displays of enthusiasm for the subject and interpersonal relationships with students. Such practices were seen to be important for encouraging students, particularly at times when they encountered uncertainty about understanding content or when they began to doubt their success or potential success with mathematics. While all students could benefit from supportive environments and teaching practices that nurture their inner-motivational needs, the teachers in Study 1 reported that students who were less competent in mathematics, responded particularly favourably to intervention and support from their teachers.

Some teachers did not use motivational practices because they were either not aware about the importance of engaging students, or they were unsure of practices that would engage them. Other teachers indicated that, despite being conscious of the need to engage students, they viewed catering for engagement as an ‘add on’ to the real work of teaching mathematics or something to include when time allowed. Further, when engagement was considered, it was often in the form of an interesting or different activity rather than embedded within the context of the teachers approach to teaching mathematics.

What is clear from all of the practices reported is that many were not effective, or as effective as they could be, for promoting student engagement in mathematics. Reasons for using ineffective practices were proposed during the teacher interviews. One reason appeared to be that mathematics teachers know less about how to motivate and engage students than they do about the content and pedagogy of teaching
mathematics. Although some teachers reported their beliefs about the importance of promoting engagement, only a few reported using sustained motivational practices in their classrooms. These findings were similar to those of Hardré and Sullivan (2008) who found that teachers appeared to have low knowledge and efficacy for motivating students who were “seriously or chronically unmotivated” (p. 2069) in mathematics.

Similar to other research findings (Hardré & Sullivan, 2008), the results in Study 1 revealed that those teachers who placed more importance on motivation and made greater efforts to engage students, used practices that met students internal needs rather than focusing on external needs. It was also evident that practices aimed to meet students’ internal needs were more likely to address emotional and cognitive types of engagement, in contrast to practices that were directed to external sources and tended to only address behavioural engagement. A number of teachers cited examples practices were used to motivate particular students. This indicates that some teachers at least perceived that individual students’ motivational needs were distinct from the motivational needs of their class. This is encouraging because it reflects an understanding that attending to individual student motivation and engagement is essential for longer-term positive mathematical outcomes.

The findings of Study 1 are significant because they highlight that teachers have a choice about the behaviours and the practices they use in their classrooms that can influence student engagement. Study 1 therefore supports Skinner and Belmont’s (1993) findings which noted the benefits of teacher practices that aim to compensate for students with low motivations and engagement by encouraging involvement and offering greater support. This is in contrast to teachers who do not perceive that attending to students’ motivation is their responsibility. Teachers who do nothing to address students’ falling engagement levels or who show negative emotions and provide less structure may in fact magnify maladaptive motivational factors, leading to further declines in engagement.

Conclusion

This chapter sought to address how teachers perceive student engagement and motivation in mathematics and how their perceptions are reflected in their practices. Teacher descriptions of student engagement in mathematics were examined and the
Engagement Spectrum was developed as a framework to discuss the range of perceptions teachers have of student engagement. The Engagement Spectrum was used to categorise distinctions between types and levels of disengagement (Table 6.1). Using the Engagement Spectrum to organise the teachers’ perceptions of student engagement was helpful in clearly identifying specific factors underlying certain types of engagement. The identification and differentiation between types and levels of engagement exhibited by students is critical for providing teachers with opportunities to assess and subsequently address the motivations that underpin the engagement or disengagement that they observe.

Although teachers reported their perceptions of student engagement in conjunction with comments about student achievement, when probed, the teachers also revealed that they were able to make distinctions between how students engaged and how they achieved in mathematics. This finding is significant as it highlights the importance of attending to student engagement in addition to achievement. Further, for students who lack engagement, it may be necessary for teachers to prioritise attention towards promoting engagement before improvements in learning outcomes can occur.

The latter section of this chapter addressed how engagement and motivation were reflected in teachers’ practices. It was revealed that many teachers used a wide range of practices for engaging students in mathematics. What was not clear however was the extent to which the practices used by teachers were targeted to meet particular motivational needs of individual students or were used because the teachers perceived they promoted student engagement across the whole class. The focus of the practices used appeared to depend on the teacher’s knowledge of available practices for motivating students and what they perceived would be effective for promoting learning outcomes for their students. This suggests further investigation of practices teachers use for motivating students is required to determine whether or not teachers draw from their experiences, advice from colleagues or pedagogic literature when making decisions about appropriate and effective practices to use.

Following on from these findings, the next chapter moves on to Study 2, the Case Study. Study 2 specifically investigates the beliefs and practices of teachers who were identified as teaching classes of motivated students. The rationale for exploring different cases is to understand different teachers’ beliefs about student engagement
and learning in mathematics and to explore how their beliefs influence the practices they use in the classroom.
Chapter 7
Methodology Study 2

This chapter presents the methodology for Study 2, the Case Study. First, the context for Study 2 and its relationship to Study 1 are established. Next, the research design is presented and the research methods used are discussed. Following this is an explanation of the process used to select participating teachers whose classroom practice was observed. The final sections discuss the procedures and instruments for collecting the data and the approach to coding and analysis.

While Study 1 investigated students and teachers perceptions of student engagement, the focus of Study 2 was to explore what took place in mathematics classrooms, by examining teachers’ practices and underlying beliefs. Exploring the beliefs and practices of teachers considered effective at maintaining engaged classrooms with students of different achievement levels is relevant for two reasons. First, Study 2 aimed to investigate the presence of engagement in mathematics classrooms where students experienced high and low levels of achievement. Second, Study 2 explored whether teacher practices that promoted engagement were different in classrooms with students with high and low levels of achievement.

Setting the Context

A key focus of Study 2 was to understand what individual teachers do that is effective for promoting student achievement and engagement in mathematics. It specifically sought to examine motivationally supportive practices occurring in targeted Year 7 mathematics classrooms.

The need for this research arises from the lack of clarity about student achievement in mathematics during the transition from primary to secondary school. There are conflicting reports of dips in learning during Year 7 (Cooney, 2006; Siemon, 2001) and other research notes the declining rates of progress between Years 7 to 9 (Williams et al., 2007). There are also corresponding shifts towards student disengagement in mathematics during this same period (Cooney, 2006; Gibbs & Poskitt, 2010; Russell et al., 2003; Siemon, 2001). Additionally research has established that the quality of student-teacher interactions (Skinner & Pitzer, 2012)
and individual teacher differences (Hardré et al., 2008) are important for shaping student motivation and engagement in classrooms. Other research has identified that reduced levels of teacher support negatively influence the engagement levels of low achieving students more so than high achieving students (Midgley et al., 1989). Therefore it is important to understand why and how some teachers are more effective at promoting engagement during mathematics instruction and if their practices vary for students achieving at different levels.

Results from Study 1 provided detailed accounts of students’ and teachers’ perceptions about achievement and engagement in mathematics. While detailed perceptions of student engagement were revealed in Study 1, this relied upon self-reported data. The data from Study 2 seeks observations of teaching practices in mathematics classrooms and enables validation of self-report data. This provides deeper insights into teachers’ beliefs about student engagement and the practices they use to motivationally support students in their classrooms. It is expected that by observing teachers’ practices and discussing the reasons for their choices will address a key aim of the study which is to better understand how teachers can more effectively address individual students’ engagement needs.

Study 2 examined the third research question, that is, how do teachers motivate and engage middle year students in mathematics? In particular it focused on:

a. What beliefs do teachers who are effective at promoting engagement hold about students’ motivation and engagement in mathematics?

b. How do teachers differentiate their practices to motivate and engage students of varying levels of achievement?

Research Design

The case study approach is well suited to educational research as it provides for an emphasis on interpreting and understanding the views of an individual or a group of subjects. As Stake (2000) notes, “[a] case study is both a process of inquiry about the case and the product of that inquiry” (p. 436). The study of a case or collection of cases usually involves several lines of inquiry to explore, explain, describe and understand a complex social phenomenon—the process of inquiry. A case study brings about an understanding of complex issues, using contextual analysis.
of limited events or situations and the relationships people have with them in a real world setting.

Stake (2000) identifies three types of case study: intrinsic; instrumental; and collective. Which type will be suitable is dependent on the purpose of the inquiry. The collective case study was seen as most relevant for Study 2 because the inquiry was interested in investigating certain characteristics. As it was not possible to tell in advance if individual cases exhibited shared or diverse characteristics, it was important to examine a range of cases in order to better understand what was important, what was variable and what was redundant (Stake, 2000). In Study 2 investigating multiple cases was seen as essential for gaining a better understanding of what teachers believe and practice are important for motivating and engaging students in mathematics. The choice of cases was purposeful and it was important that the cases were considered individually and jointly to enable an investigation of what was common and what was particular to each case (Stake, 2000). The cases for Study 2 were located in educational settings, therefore the physical, social and learning contexts of the classrooms are vital aspects of investigation for understanding the interactions and relationships between teachers and students.

A case study relies on multiple sources of data, so that lines of inquiry converge, resulting in triangulation. This helps to clarify meaning as information is analysed from different perspectives (Stake, 2000) and, consequently the findings of the case study are more likely to be accurate and convincing (Yin, 2003). The primary sources of data collected for Study 2 were numerous lesson observations, pre-and post-lesson interviews and a teacher survey. The time spent observing and asking questions about teachers’ beliefs and practices through interviews and survey meant reflections resulted in obtaining ‘thick descriptions’ and finding meaning about how teachers engaged and motivated mathematics students with different achievement levels. Data were also collected via a teacher survey, field notes (taken during observations and interviews) and artefacts such as lesson plans and photographs of student work. It is one of the unique strengths of the case study that multiple and detailed forms of data can be properly and thoroughly dealt with (Yin, 2003).

The classroom observations provided the researcher with opportunities to view and gather data in a ‘live’ setting, capturing the context, actions and nuances that might be missed or difficult to detail accurately during interviews (Cohen et al., 2002). Observing also captures the “norms and values” which are part of the context
and culture (Simons, 2009, p. 55). In Study 2, understanding the norms of each classroom setting such as the way people communicated, the way the classroom was organised, the interactions between people and the like, were important for “digging into meanings [and] working to relate them to contexts and experiences” (Stake, 2000, p. 450).

The observation of lessons also provided a factual source of events occurring in the context of the classroom and provided a “cross-check” on related data (Simons, 2009, p. 55). For instance, claims made by teachers during the pre-lesson interviews about the motivationally supportive practices they employ in mathematics classrooms, could be verified (or not) during lesson observations. Also, where motivational support for students could be identified from the lesson observations, the post-lesson interviews acted to verify and provide stimulus for deeper explanations (Atkinson, Coffey, & Delamont, 2003). Further, deeper explanations of teacher beliefs and practices for engaging students in the purposefully chosen classrooms could be compared to the practices described by the larger data set reported in Study 1. In particular, differences in the types and extent of practice for engaging and disengaging students in mathematics in particular settings could be explored. When undertaking observations it is suggested that the degree of participation by the researcher should be considered. For Study 2, the researcher’s role was that of observer-as-participant (Cohen et al., 2002); both the teachers and students were aware of and had consented to the observation of lessons for research purposes.

Selection of Participating Teachers for Study 2

Data collected during the quantitative study phase of the MYTEAM Project was used to identify classrooms of motivated students. Like Study 1, Study 2, was preceded by the quantitative phase in which data from the MES component of the MYTEAM Survey was used to inform the qualitative research phase. The students’ responses on the MES provided meaningful information about their levels of engagement in mathematics classrooms and this information was filtered to identify students who had higher and lower levels of motivation and achievement.

Using mixed methods was helpful for revealing how different forms of data work together to establish a purposeful sample to undertake investigations that were
specifically focused on certain phenomena (Brannen, 2008). In Study 2 the quantitative data identified the teachers and classrooms (i.e., the cases) for detailed investigation. First, a new data set for each class was derived which reflected the mean adaptive level (indicating engagement) and mean maladaptive (indicating disengagement). The mean achievement level for each class was based on the mathematics assessment component of the MYTEAM Survey. Next, this data set was organised into grades (Years 5, 6, 7 and 8) allowing for comparisons within and between grades to be made. The average mathematics scores were split into high, medium and low achievement groups. The application of achievement measures resulted in identifying engaged classrooms with different achievement levels.

Although the students’ levels of motivation may have been due to other factors, the students had spent half of the school year with their class and mathematics teachers. Therefore choosing teachers on the basis of the students’ responses to the MYTEAM Survey while in Year 7 was considered to be an acceptable basis for selecting them for further investigation. The process resulted in establishing classrooms with higher averages of motivated students (those with high adaptive and low maladaptive mean scores) and with high average and low average achievement for each of the four grades (Years 5, 6, 7 and 8). Although observation of Years 5, 6 and 7 classrooms took place, Study 2 was most interested in investigating the beliefs and practices of teachers of students who were closest to making the transition from primary to secondary school—Years 6 and 7. The teachers identified in the selection process were also confirmed to be suitable participants by a second source—numeracy specialists. The school system to which the classes belonged employed numeracy specialists who worked within schools and alongside classroom teachers in a supporting pedagogic role. The specialists were able to provide formative comments about the teachers and their classes who were invited to participate in Study 2. They confirmed that, in their professional opinion, the teachers identified for observation and interviews were motivating their students in mathematics.

In keeping with the aim of Study 2 and the research questions, the focus was on teachers of classes making the transition to Year 7 (being Year 6 classes at Time 1 and Year 7 classes at Time 2) and also classes with different characteristics. For the purposes of reporting results, each Year 7 mathematics class and their teacher is considered a ‘case’ in the sense suggested by Miles and Huberman (1994) as “a unit of analysis” (p. 25). The four ‘cases’ selected offered contrasting settings: high and
low achievement levels; single and mixed gender schools; male and female teachers; and teachers with varying years of teaching experience. Three of the classrooms were identified as low achieving (referred to as ‘LM’ for the mixed gender class; ‘LB’ for the boys only class; and ‘LG’ for the girls only class). The fourth class was identified as high achieving and was mixed gender (referred to as ‘HM’).

Two lesson observations with each class were planned. However, due to circumstances at the school (e.g., teacher availability within the required time frame), only one lesson was observed in two of the classes. In total, six lesson observations with accompanying pre- and post-interviews took place—one lesson of LB and LM and two lessons of LG and HM. Relevant information about the teachers and their classes for Study 2 is presented in Table 7.1

Table 7.1
Details of the Observed Classrooms (at Time 2)

<table>
<thead>
<tr>
<th>School</th>
<th>Number of students</th>
<th>School Gender</th>
<th>Class Ability Level*</th>
<th>Teacher and Code (teacher aliases used)</th>
<th>Mean Maths Score/30 (MES) **</th>
<th>Mean Adaptive Score/7 (MES)</th>
<th>Mean Mal-adaptive Score/7 (MES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valleyside</td>
<td>26</td>
<td>Boys Only</td>
<td>Mixed Ability</td>
<td>Mrs Church (LB)</td>
<td>12.62 (low)</td>
<td>5.86 (high)</td>
<td>1.99 (low)</td>
</tr>
<tr>
<td>Ellwood</td>
<td>22</td>
<td>Mixed Gender</td>
<td>Lowest Achieving Band</td>
<td>Miss Marsh (LM)</td>
<td>12.40 (low)</td>
<td>5.92 (high)</td>
<td>1.91 (low)</td>
</tr>
<tr>
<td>Bushtown</td>
<td>26</td>
<td>Girls Only</td>
<td>Mixed Ability</td>
<td>Miss Field (LG)</td>
<td>13.76 (low)</td>
<td>5.40 (high)</td>
<td>2.38 (low)</td>
</tr>
<tr>
<td>Ellwood</td>
<td>31</td>
<td>Mixed Gender</td>
<td>Highest Achieving Band</td>
<td>Mr Tower (HM)</td>
<td>17.87 (high)</td>
<td>5.72 (high)</td>
<td>1.85 (low)</td>
</tr>
</tbody>
</table>

* Ability level determined by the schools
** Achievement determined by the mathematics assessment component of MYTEAM Survey

Data Collection, Procedures and Instruments

Collection of Data for Study 2

Multiple data gathering methods were employed in Study 2 including: interviews with teachers, video recorded lesson observations, teacher surveys, analysis of artefacts (e.g. lesson plans, photographs of student work) and researchers’ field notes. Collection of varied data sources draws on observable events and actions
and also makes inferential events explicit. This increases the researcher’s capacity for complete analysis and reduces dependence on single event interpretations (Cohen et al., 2002). The multiple sources of data from four different teachers accrued a large quantity of rich data that was sufficient to describe their beliefs and practices for mathematics instruction. In similar investigations, multiple sources of data have been found to provide significant and rich sources of information about characteristics of motivation that underlie achievement and learning outcomes (Hardré, 2011; Hardré & Sullivan, 2008; Hardré et al., 2009; Raphael et al., 2008).

The interviews and observations for Study 2 were arranged to take place in October and November, being Term 4 of the NSW school year. The researcher held discussions with the teacher participants to ascertain the best times to attend lesson observations. These preliminary discussions about organisational matters also provided an opportunity for the researcher to develop a rapport with the teachers. Given the nature of the research—examining teacher classroom practice—the researcher felt it was helpful to develop a positive and trusting relationship with the teacher participants prior to the lesson observations. The researcher could assure the teachers that the key purpose of the research was to understand the approaches different teachers took to engage students in the learning of mathematics and not to judge the quality of their practice.

**Interviews**

Interviews took place with the teachers before and after each lesson observation. Pre-lesson interviews took approximately 15 minutes and post lesson interviews about 20 minutes. The interviews were conducted in a place chosen by the teachers, usually in a staff meeting room or, on occasion, in the classroom. The pre-lesson interviews were semi-structured, following a prepared list of key questions, but allowing for additional questions to clarify and explore points arising from the interviews. For example, questions included, “What activities or learning experiences have you planned for today’s lesson?” The list of guiding questions asked in the pre-lesson interviews are found in Appendix D.

The purpose of the interview prior to the lesson observation was to elicit teachers’ beliefs and learning intentions, including: the objectives of the lesson; planned activities and learning experiences; approach to delivery; anticipation of student responses to the lesson; anticipated difficulties; appropriate challenges for the
class or individual students; expectations of student engagement; and predictions of achieving successful understanding. Post-lesson interviews occurred immediately after the lesson observations with questions focused on the events just observed. A semi-structured interview format was used to elicit teachers’ views about: whether or not the outcomes of the lesson were achieved; reflections on student learning and engagement with the mathematical ideas; changes or adjustments made from the original lesson plan; and reviewing the lesson outcomes. For example, questions included “Did the students engage with the lesson in the way that you had anticipated?” and “What tells you that they were engaged?” The list of guiding questions asked in the post-lesson interviews is in Appendix E. Additionally, the post-lesson interview provided an opportunity for the teacher to offer an interpretive perspective on events (both expected and unexpected) and student responses during the lesson. All interviews were digitally recorded and transcribed to assist subsequent analysis.

**Lesson Observations**

It was decided in advance that the lesson observations would include activities prior to, during and post the lesson including capturing: the teacher setting up and preparing the room prior to the lesson; the students as they entered the room and settling themselves; the lesson activity; and the students packing up and leaving the room. The duration of each lesson was approximately 50 minutes. Video recordings of the lessons were made using one camera. The camera was set up at the back of the classroom before the commencement of the lesson and its placement allowed for optimum capture of the students, interactions between the teacher and the students during the lesson. The video recordings were of mathematics lessons that were normally scheduled in the students’ timetable. In the case where two lessons were recorded, the lessons were consecutive but due to the school timetable there were several days delay between them.

During the lessons, a range of camera shots were utilised in order to capture actions that would be most significant for eliciting information about effective practices for promoting student engagement in mathematics. For example, at times the camera followed the action and focused on the teacher or students who were talking as well as items they referred to (e.g., the board, their workbooks, manipulatives and the like). When students worked in groups or pairs, the camera focused on this
formation, using medium close-up shots. When the class worked at their desks, the camera used tracking shots to scan the room to film the students. Lapel microphones worn by the teachers captured audio recordings of discussions with students out of range of the video camera microphone. This included instances where the teachers collected the students from the corridor and brought them into the classroom and when the teacher had conversations with individual and groups of students during the lesson.

Throughout the observations, the researcher referred to a register of potential teacher practices considered specific for supporting motivation and engagement derived from the reviewed literature. In this way, practices that motivated and engaged students were kept in the ‘foreground’ of the researcher’s mind during the observations (Simons, 2009). It was anticipated that the data gathered from the observations and field notes would illuminate the practices observed and these would be reflected in the analysis (Cohen et al., 2002).

Teacher Surveys

The teachers completed a self-report titled ‘Teacher Beliefs and Practices Survey’ adapted from a survey developed by Ross, McDougall, Hogaboam-Gray and LeSage (2003) (see Appendix F). The survey was completed by the teachers prior to or immediately after the pre-lesson interviews and took approximately five minutes. It included twenty statements about teachers’ beliefs and practices regarding reform-oriented mathematics teaching. Reform orientated practices include quality features of teaching (CCSSI, 2010) that are effective for enhancing student understanding. Elements of quality instruction include the nature of mathematical content made available to students during instruction and pedagogical aspects that influence the way students are taught. For example, encouraging discourse and questioning, strategy use and development and task design are elements of instruction that support students’ motivational needs.

The teachers were asked to rate their responses using a five-point Likert scale from strongly agree to strongly disagree. The survey incorporates both positively and negatively worded statements to ensure little response bias. The survey items were extensively reviewed and found to be reliable (Ross et al., 2003). This survey data functioned to triangulate the data captured from the observations and interviews and
helped the researcher gain a more comprehensive understanding of the teachers’ belief and practices for effectively engaging students in mathematics.

Other Data Collected

Artefacts collected from each classroom included: teacher lesson plans; worksheets handed to students; samples of student work; photographs of students’ workbooks; and photographs of the room displays. The collection of these items supported information gained from the interviews and lesson observations and informed the subsequent data analysis.

Field notes kept by the researcher included notes during and immediately after the lesson observations, recording the researcher’s immediate impressions of significant learning events or aspects that could be used as a reference point for discussion in the post-lesson interview. Noteworthy aspects of the interviews and lesson delivery were recorded on a pro-forma noting: the lesson opening; main focus of the lesson; teaching strategies; lesson conclusion; classroom atmosphere; student behaviours; diagram of the classroom and reconstructions of informal comments made to the researcher (Cohen et al., 2002). The pro-forma used for the field notes appears in Appendix G. Notes made by the researcher within 24 hours of the lesson observation served as the researcher’s reflection on each lesson experience.

Data Analysis

Overall, the approach to data analysis was inductive, with explanations inferred from the rich and varied data sets accumulated for each of the four teachers: teacher surveys; pre- and post-observation interviews; lesson observations; and artefacts. Before describing specific analytical approaches for each of the data sources, the two overarching approaches are outlined.

The first approach to analysis considered each source of the data set vertically, as depicted in Figure 7.1, so that ‘like’ pieces of data across each case could be compared (Gerring, 2007). For example, the pre- and post-lesson interview transcripts for all teachers were read to identify significant themes. Videos of individual teacher lesson observations were viewed multiple times and compared to the observational data from every other teacher.
Using this approach, attention could be paid to the beliefs and practices of individual teachers in similar settings (i.e., Year 7 mathematics classes). For example, noteworthy episodes shared between teachers or specific to a teacher could be identified and serve as illustrations of particular motivationally supportive beliefs and practices when reporting the results. The beliefs and practices identified endeavoured to go beyond mere description. They aimed to explain what was said and observed to provide finely textured and richer information about actual teachers’ practices (not just self-report as was the case in Study 1) that were effective at promoting student engagement in mathematics in the context of high and/or low achieving students.

The second approach to analysis considered the data set of each teacher, allowing the researcher to look within each case to examine how each teacher’s intentions, actions and reflections were implemented in effective engagement practices in mathematics lessons (Gerring, 2007). The four data collection points for each teacher are illustrated in Figure 7.2. By viewing the data collected from various methods holistically, teachers’ views and beliefs about engagement could be linked to their practices in the classrooms. For example, evidence reflecting stated beliefs in the pre-lesson interviews were sought during classroom observations and linked to reflections in the post-lesson interviews.

![Figure 7.1 Vertical approach to data analysis](image)

![Figure 7.2 Horizontal approach to data analysis](image)
Viewing and analysing the data in this way served several purposes. First, clear and explicit links between each teacher’s beliefs and lesson expectations were made with the events occurring in the classroom. Second, each teacher’s reactions and reflections of events during the lessons showed how they took account of students’ needs and how this informed planning for future lessons. Overall, the set of data captured a ‘profile’ of each teacher and how their reported beliefs and practices were reflected in the lessons.

Considering the data collectively draws on the relative strength of using multiple forms of data, not only as separate sources, but also because the relationships between them and their complementarities could be taken into account (Atkinson et al., 2003). Although in Study 2 only four sets of data were drawn upon, the two-stage approach to analysis allowed for investigation ‘within’ an individual teacher’s practices and ‘across’ teacher practices in similar contexts (Gerring, 2007). Further, different comparisons could also be made such as considering ‘similar’ (Gerring, 2007) cases such as the beliefs and practices of the teachers in the three low achieving classes. The beliefs and practices of the teacher in the high achieving class, the contrasting case, could then be explored. Overall, this approach to analysis aims to illustrate what is the same and what is different about the beliefs and practices of teachers for promoting student engagement in both low and high achieving classes and provides a basis for contributing to further theoretical understandings (Huberman & Miles, 2002). The following sections describe how each of the different types of data collected for the cases were analysed.

**Analysis of the Teacher Survey**

To analyse survey data, each of the 20 items was given a score of 1 (strongly disagree) to 5 (strongly agree). The negatively worded statements were rated by inverting the scoring system (Ross et al., 2003). Mean scores for each participant were calculated. The closer the mean score was to five, the more closely a teacher’s beliefs and practices were considered to be reform-orientated and found to be more effective at promoting student engagement during mathematics instruction (Skinner & Belmont, 1993; Skinner & Pitzer, 2012).
Analysis of the Interviews

Similar methods were used to analyse both the pre- and post-lesson interviews as both interviews were centred on the lessons and occurred immediately before and after the lesson observations. Additionally the teachers’ beliefs and comments about their practices were made in both the pre- and post-interviews and therefore data was coded to one of two categories: ‘Teacher Beliefs and Knowledge’ or ‘Teacher Engagement Practices’.

The process for developing categories was documented so that the decisions made could be clearly understood and scrutinised (Constas, 1992). A three-step process was used: first, understanding discrete pieces of data; second, categorising data; and finally, identifying overall patterns (Rogers & Goodrick, 2010). All interviews were transcribed and read several times so that the researcher became familiar with the content, the structure of the data, and gained a perspective of the teachers’ responses. Notes were made of key aspects contained in each of the interviews which were then read again to identify and derive key themes common across all teachers’ pre- and post-lesson interviews. Initial decisions about coding began during the first and second readings of the interview transcripts, where certain attributes were noted and kept aside until further analysis could confirm or refute their importance as patterns or themes. The next stage used descriptive coding techniques to explicitly code or tag teachers’ comments noting in the first instance particular phrases used by the participants and then assigning researcher generated codes as categories began to emerge. As there were a relatively small number of transcripts for each set of pre- and post-lesson interview, the researcher coded each set of pre-and post-interviews for each teacher. Next, all of the teachers’ pre-lesson interviews and all the post-lesson interviews were compared

During the analysis, the appropriateness and consistency of coding and coding descriptions were reviewed, returning to interview segments to check and refine codes and searching for omissions (Rogers & Goodrick, 2010). In this way each set of interview data was considered and concept mapping was used to identify patterns, similarities and differences between the teachers’ responses. The interview transcripts were read by another researcher associated with the research who was able to confirm the coding accuracy by assessing a sample of the interview transcripts.
Details of the coding procedures

The semi-structured interview questions focused on eliciting the teachers’ beliefs about mathematics teaching, engaging students in mathematics and the intentions for and results of the lessons. Initially coding was broad and the categories developed were derived from those found in relevant literature and verified by referencing categories against studies that had investigated similar elements (Constas, 1992). The teachers identified several aspects such as problematic issues with the content, concerns about class and individual student understanding, ways of assessing understanding and beliefs about engaging lesson material and activities. Once all of the transcripts were coded two overarching features emerged: (a) teacher beliefs and knowledge; and (b) teacher engagement practices.

‘Teacher beliefs’ included beliefs about: (a) learning mathematics; and (b) engagement in mathematics. Examples of how responses were coded for beliefs about learning included: “I try and get them [students] to tell me what they discovered” (LG). An example of teacher beliefs about student engagement included: “If they [students] are participating, if they are doing their work, if they are discussing with their peers” (LM). At the class level teachers reported comments such as: “They were very engaged with the resource, they loved the resource” (LM). At an individual level, an example included: “She was participating a lot more than she usually does” (LG).

‘Teacher Knowledge’ included knowledge of: (a) content and pedagogy; and (b) students. Knowledge of content and pedagogy included comments such as: “When they try and apply a procedure that they are not understanding…they are just applying a procedure” (LG). Teachers also reported anticipating content issues such as needing “to clarify the difference between mass and weight” (HM) and anticipating potential difficulties with language and meanings. Also included were reports about teachers’ understanding of the content and their preparations for teaching: “I plan the week ahead…I always try spend a lot of time marrying what I can do on the smartboard with the knowledge” (LM). The teachers also reported ways in which they prepared the students for learning by planning to use strategies and activities involving the students: “They are going to complete some worksheets as a group activity…they are going to be working as a team. It’s going to be collaborative” (LB).

Knowledge of students reflected statements the teachers made about the class or individual students, for example, “We have gone through the process of adding like
terms, subtracting, multiplication of algebraic terms, division yet they still seem to be confused” (LB) and “He needs a lot of attention because the pace and depth is a bit quick for him. His working memory is not as good as a lot of the others” (HM). Future plans included reports about how teachers planned to address future students’ needs. One teacher thought he would need to revisit the concepts of net and gross reporting, “Yes I will go back over it” (HM). Another was considering how best to encourage her students to practice the concepts: “I am sort of debating whether or not to give them questions from the textbook or worksheet” (LG).

The coding of these comments to the two designated categories was consistent with literature about teacher beliefs and knowledge (Anthony & Walshaw, 2008; Askew et al., 1997; Ross et al., 2003; Sullivan, 2011; Watson, 2010) and engagement in mathematics (Fredricks et al., 2004; Hardré et al., 2008; McPhan et al., 2008; Nardi & Steward, 2003). The documentation of the coding process aimed to satisfy the origination, verification and nomination of the categories decided upon (Constas, 1992).

Analysis of the Lesson Observations

The lesson observations were supported by field notes taken during the lesson, audio recordings and video recordings made throughout the lesson. While the field notes and audio recordings provided some additional information and assisted in clarifying activities and events during the lesson, the video recordings constituted the main source upon which the observation analysis was based.

There were several advantages of using video recordings for analysis including reviewing material repeatedly, reviewing material differently (with and without sound), reviewing material in different time frames (e.g., micro analysis or episodic analysis) and viewing by additional researchers to assist in establishing validity (Rose, 2003). Multiple viewings of the lessons from different perspectives was helpful for identifying practices of teachers who were effective at promoting student engagement during instruction in mathematics. This approach supported Study 2 as the focus was on describing particular practices rather than describing or measuring the frequency of any practice and obtaining frequency scores (Gerring, 2007). This was best obtained by identifying practices that promoted behavioural, cognitive and emotional engagement singularly and in combination, throughout the mathematics lessons.
The lesson observations were viewed in their entirety several times during which the researcher kept notes. Although there was a clear chronological order of events and activities in each lesson, a method for analysing the complexity of classroom activities, dialogue and interactions occurring simultaneously was required. Since the interactions and dialogue between the teachers and students was dense, an approach to analysis was decided upon that would focus on identifying patterns of practice and critical features that were effective for engaging students in mathematics. In the first instance, the researcher used a concept mapping approach to determine overarching or ‘global’ characteristics of teacher practices that identified three aspects for further investigation: teacher actions; teacher discourse; and teacher expression (Stake, 2000). Detailed notes of each teacher’s practices recorded how and where teachers stood, physical movement of the teachers around the room, how and when they spoke to students, and how they responded to and interacted with students verbally and non-verbally.

A second approach to coding considered the teachers’ instructional practices for mathematics and engagement. The researcher began this process by listing the instructional practices of one teacher’s lessons and then distinguishing between the mathematics instruction and pedagogic components. This process was guided by various frameworks that identified instructional practices for engagement and mathematics discussed in relevant literature (Lutz et al., 2010; Raphael et al., 2008; Reeve, 2012; Stipek et al., 1998; Sullivan, 2011). The researcher continued to analyse the lesson observations of the other three teachers and recorded their practices in the same way, adding new practices to the list until saturation was reached.

At the conclusion of this process the list of practices was consolidated and categorised as representing certain characteristics. The labels applied to describe each of the categories were drawn from relevant literature, again satisfying origination, verification and nomination requirements (Constas, 1992). The nine categories identified were:

- Promote emotional engagement;
- Create engaging classroom environments;
- Promote task importance and value;
- Promote content goals;
- Promote varied strategy use;
- Promote competency and self-regulation;
- Promote autonomy;
- Promote collaboration; and
- Promote monitoring and feedback.

As an example, comments by teachers that were coded ‘Promote content goals’ incorporated several teacher practices including:
- Makes content goals clear;
- Reminds students about the task process/overall goal of the lesson;
- Gives clear instruction/structure for tasks – rephrases if required;
- Reviews conceptual knowledge related to the current lesson;
- Connects responses to prior knowledge /experiences; and
- Elaborates meaning or gives examples showing typical use.

During the coding process the researcher noted particular instructional episodes that stood out as being shared amongst the teachers or events that signified unique practices by particular teachers and demonstrated differentiated practices in their classrooms (Gerring, 2007). These episodes were reported in the results by way of exemplars to provide illustrations of practices found in classrooms with teachers who were identified as engaging.

Reliability and Validity

The reliability and validity of the interviews and lesson observations were addressed as the researcher questioned teachers about student behaviours and events that occurred during the lessons in the post-lesson interviews to verify their status. The purpose of this was to reduce the possibility of overestimating or underestimating the complexity of particular events observed during the lessons (Cohen et al., 2002). Similarly, the researcher’s identification of shared and unique lesson episodes was justified as the events occurring during lessons were discussed and clarified by the teachers in the post-lesson interviews immediately after they occurred and explained in context of the lesson. In order to overcome potential bias and to validate the
researcher’s interpretations, multiple forms of data were sought. Triangulation between data sources was established (teacher survey, interviews and observations) where the sources served to validate teachers’ beliefs and practices. Events and practices occurring during the lesson observations were validated during the post-observation interviews where particular concepts or constructs could be discussed and clarified. In addition an audit trail was created throughout the process of identifying main themes and subthemes and was referred to regularly to check the appropriateness of coding (Gerring, 2007). Accurate recordings were made when capturing data, transcribed verbatim and checked against each other by the researcher. Therefore, the researcher made every effort to ensure that the sources of data and modes of analysis were credible (Golafshani, 2003).

Other processes used to ensure validity included the involvement of two other researchers who were present at several of the interviews and who observed the lesson videos. They were able to confirm the identification of the main themes drawn from the interviews and observational data. Additionally, the teachers who took part in the lesson observations and interviews were sent copies of video-taped material and given the opportunity to confirm the material and to make further comments to the researcher.
Chapter 8

Results and Discussion: Study 2

It will be recalled that Study 1 investigated perceptions of student engagement from both the students’ and teachers’ perspectives. It was revealed that both students and teachers perceived a range of factors that influenced levels of student engagement in mathematics classrooms irrespective of levels of achievement. The teachers also reported strategies that they used to engage students in mathematics and it was revealed that some practices were more effective at meeting students’ motivational needs than others and, consequently more effective for promoting engagement.

As this thesis was interested in investigating teacher practices that are effective at promoting engagement and dissuading disengagement, Study 2 specifically investigated the beliefs and practices of teachers with classes of motivated students. It was anticipated that classes with higher than average motivated mathematics students would be influenced by teachers whose beliefs and practices promoted student engagement. Study 2, the Case Study, was centred on Year 7 mathematics classes that were identified as being comprised of motivated students based on averaged results of the MYTEAM Survey. While all four classes were identified on average as being motivated, the average achievement levels of the classes, also determined by the MYTEAM Survey, differed. One of the classes was high achieving and three were low achieving. The rationale for investigating different cases was to understand different teachers’ beliefs about student engagement and learning in mathematics and to explore how their beliefs influence the practices they used in classrooms of students with high and low levels of mathematics achievement.

Accordingly, the research questions guiding Study 2 were:

How do teachers motivate and engage middle year students in mathematics?

a. What beliefs do teachers who are effective at promoting engagement hold about students’ motivation and engagement in mathematics?

b. How do teachers differentiate their practices to motivate and engage students of varying levels of achievement?

Study 2 drew upon multiple sources of data: teacher surveys (S), pre- and post-lesson interviews with the teachers (I) and lesson observations (O). Each data
source was considered holistically. The results of Study 2 are reported according to overarching themes identified during the analysis of data and are organised into two major categories. The first category, ‘Teacher Beliefs and Knowledge’, reported on elements that contributed to establishing conditions conducive to student learning and engagement in mathematics. The second category, ‘Teacher Engagement Practices’, reported on the range of instructional strategies identified as effective for promoting learning and engagement in mathematics.

Reporting the results of teacher beliefs and practices together is consistent with research that identifies the relationship between articulated coherent beliefs and understanding as a basis of mathematics practice (Askew et al., 1997; Forgasz & Leder, 2008; Mason & Johnston-Wilder, 2004b). Together, the results reported address the purpose of the study, that is, to identify and describe the motivationally supportive beliefs and practices of teachers in classrooms with students of both high and low achievement levels. The results begin by providing background information about each of the four teachers and their classes.

Background: The Teachers and their Classrooms

Mrs Church

Mrs Church was an experienced teacher of nearly 20 years, teaching mathematics classes from Year 7 to 10 (the first four years of secondary schooling in Australia, ages approximately 12 to 16). She taught at the current school, Valleyside, for a number of years earlier in her career then taught elsewhere before returning to Valleyside several years ago. At the time the study was conducted, Mrs Church’s class was deemed as low achieving according to the results of the mathematics assessment component of the MYTEAM Survey, with the class average score being 12.62 out of 30.

Valleyside is a male only school located in a suburban area approximately 30 km south-west of the city of Sydney and caters for students in Years 7 to 10, with a total school population of around 1000 students. At the time of Study 2, there were six Year 7 mathematics classes with approximately 170 boys in the year group. The
content focus of the observed lesson was algebra and indices and was part of a series of lessons involving operations with algebra.

**Miss Field**

This was Miss Field’s first year of teaching. Miss Field taught at Bushtown. Bushtown is a female only school catering for students from Years 7 to 10. It is located adjacent to Valleyside and shares some facilities (e.g., gymnasium and hall). At the time of observation, there were six Year 7 mathematics classes with approximately 150 girls in the year group. Miss Field’s class was a mixed ability class of 26 students. The class average mathematics score was 13.76 out of 30 and were categorised as low achieving.

The first observed lesson reviewed previous taught skills with adding, subtracting, multiplying and dividing fractions as well as finding the fractions of quantities. The second observed lesson focused on preparation for an upcoming topic assessment on fractions, decimals and algebra with the teacher going through examples so the students could self-check aspects that needed further study.

**Mr Tower**

Mr Tower had been teaching mathematics for over 30 years, during which time he taught at several schools in Australia and for eight years in England. He had been at the current school, Ellwood, for the last two years, teaching mathematics to Year 7 to Year 12. He was also involved in teaching special education (students who require support with learning) and religious education.

Prior to entry at Ellwood, the students undertook several standardised assessments. The assessments were used (in conjunction with other information from the feeder primary schools) to determine mathematics classes for the start of Year 7. The classes were grouped (banded) into three levels. At the time of Study 2, there were two higher-level classes, three middle-level classes and two lower-level classes. The mathematics class observed was one of the higher-level classes with 31 students enrolled. The class was identified as high achieving according to the results of the MYTEAM Survey, with a class average score of 17.87 out of 30.

Ellwood is a co-educational secondary school situated in the Western region of Sydney, approximately 10 kilometres west of Valleyside. The school was established
in 1999 starting with a Year 7 intake of students and has now expanded to cater for students from Year 7 to 12.

Two consecutive lessons on the topic of mass taught by Mr Tower were observed. The first lesson included discussions on what was meant by mass, units used to measure mass, the relationship between the units, converting from one unit to another and assigning units when weighing objects. In the second lesson, Mr Tower focused on students’ understanding of the concepts taught in the previous lesson before addressing gross and net weight.

**Miss Marsh**

After completing her university qualifications, Miss Marsh took up her first teaching position at Ellwood, three years ago. Miss Marsh taught mathematics classes from Year 7 to Year 12. As explained above, Ellwood established three banded levels for its mathematics classes based on an assessment of mathematics achievement on a standardised test the year prior to entry. Miss Marsh taught the lowest of the banded classes with 22 students. Despite the class grouping, Miss Marsh reported that the range of mathematical ability in the class was broad. The class was identified as low achieving based on the results of the MYTEAM Survey, with a class average score of 12.40 out of 30. The topic for the observed lesson was geometry, specifically on establishing the properties of quadrilaterals.

The findings of the case study are presented and discussed in two main sections. The first reports the teachers’ beliefs about learning and engagement in addition to teacher knowledge of content and their students. The second section reports on practices that demonstrate the enactment of the teachers’ beliefs. The practices reported were used by teachers in both high and low achieving classrooms to promote student engagement in mathematics. During the reporting of the results, where relevant the following codes will be used to denotes the teachers as, ‘LB’ for Mrs Church, ‘LM’ for Miss Marsh, ‘LG’ for Miss Field and ‘HM’ for Mr Tower.

**Teacher Beliefs and Knowledge**

The teachers’ beliefs and knowledge were elicited through the survey items and responses to interview questions. Analysis of the survey data and interviews revealed that teachers’ beliefs were centred on the importance of students’ learning
and understanding mathematics in conjunction with student engagement in learning mathematics. In Chapter 7, the process for coding interview transcripts and analysing the data was detailed. Two overarching features emerged that are reported on in this results section: (a) teacher beliefs; and (b) teacher knowledge. The teachers' beliefs and knowledge were corroborated through their responses during the interviews, the artefacts used in the lessons and their responses to items on the teacher survey.

**Teacher Beliefs**

The ‘teacher beliefs’ theme includes beliefs about: (a) learning mathematics; and (b) engagement in mathematics. An example of how interview responses were coded as beliefs about learning is: “I try and get them [students] to tell me what they discovered” (LG). An example of beliefs about student engagement is: “If they [students] are participating, if they are doing their work, if they are discussing with their peers” (LM).

Apart from discussing their beliefs about learning and engaging in mathematics during interviews, the teachers also completed a survey that incorporated items that measured teachers’ beliefs and commitment to reform-orientated practices. Such practices include dimensions of: program scope (D1); student tasks (D2); discovery (D3); teacher’s role (D4); manipulatives and tools (D5); student-student interaction (D6); student assessment (D7); teacher’s conceptions of mathematics as a discipline (D8); and student confidence (D9) (Ross et al., 2003, p. 348).

As set out in Chapter 7, ratings closer to 5.0 in the survey indicated very high reform-orientated practices. The survey results indicated that each of the four teachers identified with reform-orientated practices, with the mean average rating of each teacher being 3.8 (Mrs Church), 3.85 (Mr Tower), 3.95 (Ms Marsh) and 4.05 (Ms Field).

The beliefs of the teachers reported in the survey and interviews were consistent with many of the effective instructional practices for mathematics that were reviewed in Chapter 3. Overlaps between teacher beliefs identified from the literature and from the results of the teacher survey include:

- structuring learning to help students make connection (D9: Q7, 20);
- building higher order thinking and concept mastery (D1: Q4, 13 and 16; D3:Q14).
• providing students with time to think and discuss mathematical ideas (D2: Q 1, 2 and 11; D3: 14);
• using formative feedback during instruction as learning opportunities (D7: Q 8, 12);
• focusing on classroom environments/use of teaching styles to support interactions and co-operation for learning (D6: Q 3, 6, and 9);
• fostering engagement through active involvement, providing tasks that are personally relevant, enjoyable, and relate to other subjects (D5: Q10, 18);
• offering variable ways of working that include opportunities for students to make decisions, and foster autonomy (D4: Q5, 17);
• differentiating for students’ needs by offering support and challenge to achieve competency and opportunities for task success (D8: Q15; D9: Q 7, 20); and
• sharing responsibility for learning and, reflecting on practices (D4: Q 5, 17).

Next to each of the above instructional practices identified, the survey questions are denoted as ‘Q’ and the nine dimensions ‘D’ to show links between the survey questions and dimensions of reform-orientated practices. Although individual teacher responses to the survey items differed, the responses of the four teachers were consistent across the nine dimensions of mathematics reform practices. Differences in teacher beliefs were found in the response to question numbers 5, 14, 15 and 16. Interestingly, there were ten ‘unsure’ survey responses out of 80 responses. Nine of the ten unsure responses were by Miss Field and Miss Marsh, both of whom had the least numbers of years of teaching experience. Specifically, both Miss Field and Miss Marsh provided unsure responses to three of the survey questions (Q8, 14 and 19). Therefore, it is possible to conclude that there relatively small amount of experience dealing with learning contexts, precluded them from forming firm views about some of their beliefs for teaching and learning mathematics (Philipp, 2007).

Beliefs about learning mathematics

Although each of the observed lessons in Study 2 focused on different content areas and reflected different stages of learning (e.g., topic introductions or revision of
a concept), the teachers’ main interests were to develop their students’ understandings by helping them to make meaningful connections and appropriate applications of mathematics concepts. As evident in the teachers’ responses to the survey items, this reflected a learning rather than performance orientation towards mathematics and emphasised a desire for students to be cognitively and emotionally engaged in learning mathematics.

Teacher concerns about student understanding were also evident from the interviews. For example, two of the teachers noted that some students had failed to understand particular concepts and indicated their intentions to revisit them as they believed it was important for their mathematical development. Mrs Church noted from students’ written mathematical workings that, despite having repeated the process of adding like terms, many remained confused about when to add and subtract indices. Miss Field expressed concern during interviews that, due to a lack of time in previous lessons, the teaching of fractions and decimals was rushed and she was unconvinced that her students understood the work—hence her desire to review the topic “to get it to really sink in” before the next assessment. Miss Field also emphasised that her approach to teaching went beyond applying procedures and sought to teach students to “understand what they are looking for”. Her beliefs about how best to help students understand were based on drawing out students’ knowledge and to “try and get them [the students] to tell me what they have discovered”. Using hands-on material was also viewed as important by Miss Field, who planned to use counters for fraction work, as it not only helped her to check on student understanding, it kept the students focused, interested and motivated (I). Miss Field reported that she encouraged students who understood the work to explain it to others and see if they get it the “second time around”.

Similarly, Mr Tower focused on individual student and whole class understanding in his higher achieving class. He emphasised assessing student understanding of newly taught concepts ensuring this was secure before moving onto additional or different work:

It is a couple of days now since their last lesson and I just want to be clear that their understanding of the concept…is clear so that they can tell me what it is… to tell me the measurements in units and how they are connected (I)

Mr Tower regularly asked the students in his class to demonstrate their understanding by answering questions verbally or writing on answer on mini-whiteboards. He
explained that he also used feedback from students’ responses as a way of integrating assessment into the lesson and providing him with information about how to move the lesson forward to best meet the students’ cognitive needs.

Despite teaching high and low achieving classes, the teachers held shared beliefs towards learning that focused on helping students achieve understanding, connecting new concepts with prior learning and emphasising mastery of mathematical concepts. Practices that promote mastery and achievement through task success are seen as beneficial for influencing future achievement and intentions to study mathematics (Ainley et al., 2008; McPhan et al., 2008; Tytler et al., 2008). Embedded within practices effective for learning mathematics are practices that foster engagement (Raphael et al., 2008; Stipek et al., 1998; Turner et al., 2011). In Study 2, teachers’ beliefs about the importance of focusing on learning were accompanied by beliefs about actively engaging students in interesting and relevant activities in positive classroom environments.

Beliefs about engagement in mathematics

In addition to expressing beliefs that emphasised learning for understanding, the teachers also clearly articulated their beliefs about student engagement—its importance, how they recognised it in their students and how they adapted their teaching practices to promote it. Consistent with orientations for learning, it has been noted that teachers who press for understanding, employ practices that help students connect their knowledge and support student efforts for learning are associated with influencing positive student self-regulation and self-efficacy (Middleton & Midgley, 2002) both of which are positive factors for motivation and engagement.

Each teacher in Study 2 reported attending to behavioural and emotional types of engagement to help students reach understanding and become cognitively engaged in lessons. In addition, the teachers believed that activities in mathematics classes should encourage participation by appealing to students’ interests. The importance of maintaining student participation and interest in mathematics has been identified as relevant not only for future intentions to study mathematics (McPhan et al., 2008), but also for studying related subjects such as science and technology (Tytler et al., 2008).

Miss Marsh believed that the majority of students in her class were engaged most of the time and judged this by their level of participation, discussions between peers, asking questions (including self-questioning) and attentiveness to teacher
explanations. Miss Marsh reported during interview that she used games and activities
to both support student understandings of concepts and to encourage student
participation. Miss Marsh viewed student engagement as occurring when “the kids
want to learn and want to be there. They are engaging with the content and not just
being engaged but engaging with what they are doing” (I). Miss Marsh’s comments
emphasised sustaining student participation in the class (behavioural and emotional
engagement), with the underlying purpose of engaging students with the content
(cognitive engagement).

Mr Tower believed the students in his class were always highly engaged and
expected that they would respond particularly positively to the lesson he had planned.
Mr Tower also reported that this particular group of students was “able to self-
motivate” and that their “attention span [was] longer; their capacity to stay on task
and their interest in whatever we are doing [was] good” (I). Since the level of interest
and self-motivation in this class was high, Mr Tower reported that he could plan
lessons to appropriately challenge student thinking and believed that this was
important (S). Additionally, Mr Tower believed that students “respond much better to
hands-on situations…as more senses are involved in the learning…not just looking
and listening”. He reported that it is through touch that “there is a high degree of
engagement in the learning for [students] individually” as the students enjoy it and
“are more likely to remember it and understand it”. Mr Tower’s beliefs about his
students’ level of competence and engagement influenced his beliefs about how to
motivationally support them. He was conscious of maintaining their engagement by
not repeating material that they had already mastered, pacing and altering activities
during the lesson so that students did not become bored, and encouraged students to
regularly work autonomously (I and S).

From a different perspective, Miss Field, who taught a low achieving class,
reported beliefs about supporting students to achieve better results in mathematics.
During interview, Miss Field described one student she believed was disengaged at
the beginning of the academic year indicated by the student ‘acting out’ and being off
task in class. Miss Field believed that the student was capable of higher achievement
and discussed this with the student. The student agreed that she wanted to achieve a
better result and together with Miss Field set a target of 60% for tests. Not only did
the student subsequently surpass the target achievement level, Miss Field reported
“ever since, she has been really engaged” in the classroom. In this situation, Miss
Field promoted motivationally supportive actions in discussing student competence, offering opportunities for autonomy, encouraging persistence for mastering mathematics learning and building students’ confidence (I) and this was consistent with her responses to survey items (S). Additionally, Miss Field was conscious of engaging the class and regularly incorporated mathematics games into her lessons as she believed it was important for the students to engage in different mathematics work.

The teachers in Study 2 shared beliefs that student engagement was an important element for learning mathematics. Teachers’ beliefs concerning learning and engagement were closely bound to their knowledge of their class and individual students. It was also apparent from the data analysis that none of the four teachers held beliefs that student performance in terms of achieving high grades was more important than understanding the mathematical concepts being taught. For example, although one of Miss Field’s lessons was focused on revision of fractions and decimals for an upcoming assessment, her main interest in the lesson was for her students to “understand” the concepts. Mr Tower emphasised that he believed his student needed to see connections with their learning and although he did not anticipate problems with students understanding he would go back over work if he felt it was needed.

In terms of engagement, all four teachers believed that engaging students in learning was important and this was evident by making it a central part of the lessons. None of the teachers portrayed beliefs that engagement was “added” onto lessons, but rather engaging and interesting activities were planned for and centred on involving students in the learning through interactions and active participation. However, each of the teachers reported individual students who were not engaged in lessons at all times. In each case, the teachers talked knowingly about the particular needs of certain students in their class and this highlights a significant finding of the study. Teachers who promoted engagement in their mathematics classrooms in Study 2 not only used practices that promote student learning and engagement but also used specific strategies to dissuade disengagement including strategies particular to individual students who they perceived as being less engaged. This included students who they perceived of being at risk of becoming less engaged because of other factors such as difficulties with learning, lack of support from home or being less inclined to study or
complete homework. The following section deals with the theme ‘teacher knowledge’ and contains a fuller discussion of meeting specific student needs.

**Teacher Knowledge**

Knowledge about content and teaching (KCT) refers to “knowing about teaching and knowing about mathematics” (Ball et al., 2008, p. 401) and is related to the design of instruction for mathematics. Knowledge of content and students (KCS) refers to “knowledge that combines knowing about students and knowing about mathematics” and includes anticipating student conceptions and misconception of mathematics (Ball et al., 2008, p. 401).

In keeping with views about different types of knowledge and in the context of student engagement in mathematics, this section reports on the ‘teacher knowledge’ theme and includes knowledge of: (a) content and pedagogy; and (b) students.

Knowledge of content and pedagogy include comments that demonstrated anticipating content problems, needing “to clarify the difference between mass and weight” (HM) and anticipating potential difficulties with language and meanings. It also included reports about teachers’ understanding of the content and their preparations for teaching, for example: “I plan the week ahead...I always try to spend a lot of time marrying what I can do on the smartboard with the knowledge” (LM) and preparing the use of strategies and activities for learning.

Knowledge of students were reflected in statements the teachers made about the class or individual students, for example: “We have gone through the process of adding like terms, subtracting, multiplication of algebraic terms, division yet they still seem to be confused” (LB); and about specific students needs, for example: “He needs a lot of attention because the pace and depth is a bit quick for him. His working memory is not as good as a lot of the others” (HM).

**Knowledge of content and pedagogy**

The teachers in Study 2 demonstrated that being mindful of the content and pedagogy specific to mathematics learning was an important element when planning instruction and how it is connected to prior knowledge and cross-curricula areas. For example, Mr Tower believed his experiences of teaching the topic of mass helped him to anticipate that clarifying the “difference between mass and weight” would be a priority in his lesson (I). Mr Tower had also spoken to the students’ science teachers and knew that mass was recently covered in science lessons and he was keen to ensure
the students saw links between concepts in science classes and in the mathematics work he had prepared. Mr Tower made a point of making connections with mathematics and other subjects so the students could see a “cohesiveness about their education so things are not going on in isolation” (I) and this was also reflected in his responses to the survey.

The teachers’ experiences of teaching mathematics assisted their approaches to instruction. Mrs Church noted students’ difficulties with topics such as algebra and suggested that it is one where proficiency develops over time. Mrs Church recognised the needs of current students to master specific aspects of algebra (e.g., rules of indices) and that the students would revisit aspects related to algebra to develop a broader understanding of the topic (I). Acknowledging that reaching understanding was the key focus, Mrs Church was prepared to support learning and promote persistence for students to master concepts in mathematics. She reported that she expected difficulties to arise and that she was not concerned if all of the planned work did not get covered in the lesson as she could continue the next day. Mrs Church’s approach was consistent with reform-orientated practices referred to in the survey, emphasising her interest in students developing a secure understanding of concepts. She was cognisant of the needs her class (being a low achieving class) and took time to work through the examples. Rather than rushing through instruction, she aimed for mastery and provided a variety of support mechanisms to encourage sustained participation on tasks, task achievement and to develop students’ self-confidence in learning mathematics.

In addition to drawing on prior teaching experiences, the teachers took great care preparing lessons that would promote engagement with mathematics content by using purposeful instruction methods and activities that met their students’ needs. Miss Marsh—teaching the lowest streamed Year 7 class in the school—reported in interview, that she regularly spent time on Saturday mornings planning lessons for the week ahead. This involved consciously matching games or interactive activities that she could use on the IWB to encourage students to actively participate in the mathematics work. Miss Marsh planned to introduce the properties of quadrilaterals but was concerned that her students would find the terminology a “bit dry” (I). This influenced her plans to motivationally support the students to use appropriate terminology to describe the properties of each quadrilateral and was consistent with beliefs she reported in the survey.
Knowledge of students

Teachers’ knowledge of students’ needs were reflected in their beliefs about how to teach and engage them. All the teachers espoused beliefs that they should interact with students and create supportive learning environments. This included beliefs for attending to student interests, building confidence in learning mathematics, supporting and challenging students during their lessons. For example, before introducing the properties of quadrilaterals in the lesson, Miss Marsh anticipated difficulties that might arise with the terminology. Her knowledge of the students led her to believe that they would “have a lot of trouble deciphering the terminology” such as “parallel line, opposite and dissecting” (I). She therefore planned to spend time during the lesson to clarify the meaning of those terms in various ways. Miss Marsh was empathetic with the learning difficulties some of her students faced and she had planned to use the hands-on materials in her lesson to help the students talk about the properties of shapes they were to learn about. By anticipating and catering for her students’ learning needs, Miss Marsh demonstrated her belief in supporting their capabilities, thoughts and feelings to help them achieve learning outcomes. She also identified strongly with student engagement and reflected on her own feelings about the learning environment being positive and interesting: “You have to make it fun for yourself. If it is boring I do not want to be here either”. This level of support, such as familiarising student with relevant vocabulary, drawing attention to prior knowledge and modelling activities has been found to be effective in intervention programmes that support student learning (Sullivan & Gunningham, 2011).

However, Miss Marsh reported that two students had very low mathematics achievement levels and although she perceived that one of the students would stay engaged in the task to some degree, she reported that the other student “just totally does not want to be at school to learn maths” and commented that the student would “at least sit there quietly” during the lesson. This comment indicated that Miss Marsh, despite taking an engaging approach to teaching and planned activities to promote engagement in mathematics, was not sure how to address this student’s lack of engagement. Although the extent of the student’s achievement and circumstances was not revealed, this situation illustrates the difficulties faced by teachers when they encounter seriously disengaged students in their classes.

Previous research has identified that teachers who perceived that students were seriously or chronically unmotivated felt unable to intervene (Hardré & Sullivan,
and suggested that specific strategies were required to effectively address serious deficits in engagement. It was not evident why Miss Marsh did not address this student’s lack of engagement. It is possible that Miss Marsh lacked the experience to know what strategies to try or perhaps her strategy was to impose or encourage behavioural sanctions that kept the student from disrupting the class. Either way, it indicates that more effective strategies for addressing disengaging students are still required.

Miss Field reported in interview that students in her class had “varying low numeracy skills” and this influenced their understanding of certain concepts. She explained that she had made it clear to the students that she expected them to take responsibility for their learning and to inform her of any problems so something could be “done about it”. Miss Field also reported that she provided her students with mathematics concept checklists (A) (Appendix G), so that the students knew what was expected of them and they could “identify for themselves their area of weakness so they can focus on that when they start to study”. Miss Field believed that the checklist “gave them [students] confidence because it made studying “more manageable” as they could pinpoint where they need to start (I). Miss Field’s views of shared responsibility for learning and student self-assessment are characteristics consistent with promoting autonomy and competence—practices identified as effective for engagement (Reeve, 2012) and consistent with her responses on the survey.

Similar to Miss Marsh, Miss Field reported that several students were disengaged in mathematics. One student had been unwilling to apply effort in class but “decided to switch it on” and went and sat away from her friends so she could focus, a decision that Miss Field praised her for. Miss Field commented on another student who was quite capable, yet not highly engaged. She described how she acknowledged to the student that the work was “not as fast as you would want it” but suggested that “next year you will be top in the class” (I). Although Miss Field was mindful of motivating students who were capable, she was unsure of how successful she was at achieving this. This suggests that despite the identification of its importance, Miss Field lacked strategies for motivating all the students in her class and this was possibly due to her inexperience.

Another teacher, Mrs Church, was also mindful of promoting student engagement in her lesson by altering her practices to encourage participation, interest and persistence with learning. She believed that the boys in her lowest achieving class
lacked confidence and struggled to work independently and she adjusted her lessons to help meet the students’ needs and capabilities. For example, in the lesson observed, Mrs Church allotted time for students to work as a group to solve problems with indices. The aim was to encourage them to discuss and solve the problems collaboratively with the view that “more minds might help them out” (I). She also believed that working in groups would help build student confidence, since she considered that this particular group of students were not at a level of understanding where they could complete the tasks independently. Mrs Church believed she supported student learning in several ways including her willingness to re-explain important concepts; her preparation of supporting worksheets that the students could refer to; the preparation of problems with varying levels of challenge; and by making herself available during and after lessons if students needed help (I).

The teachers’ knowledge of their students and how they worked helped in the planning and implementation of the lessons, as they were able to anticipate students’ learning needs. For example, Mr Tower, whose class was high achieving, explained in interview that, although he had not previously taught the topic of mass to his class, he anticipated that the students would be able to connect knowledge learnt in similar measurement topics and apply their knowledge of measurement to mass. He expected this lesson to be a “one off” unless he found the students were unsure (he planned to assess students understanding during the lesson) in which case he would revisit the concepts, reiterating his belief that successful mastery of concepts was a priority.

Mr Tower believed that the students’ contributions would give him insights about what knowledge they already held about units of measurement, converting from one unit to another, assigning units to different objects and so on. Although he had prepared a skeleton of the aims of the lesson he intended that the students would actually help him “identify the aims of the lesson”, emphasising his belief that responsibility for learning should be shared and include promoting student autonomy. Mr Tower also planned to use group work with pairs of students and purposively matched a “needier student with a more able student so that they did not flounder and they get assistance”, reporting that this approach had worked well during the year. Mr Tower also planned to use personal mini-whiteboards when working with the class for two reasons. He used them to assess individual students’ responses, reporting they allowed him “to monitor progress and understanding very quickly” and they would
serve as a learning platform from which students could explain and share their mathematical thinking (I).

Summary of Teacher Beliefs and Knowledge

The teachers’ knowledge of their students and the contexts in which they were learning indicated that the teachers were aware of meeting the learning and emotional needs of the students (Park, Holloway, Arendtsz, Bempechat, & Li, 2012). While the learning needs of low and high achieving were different in the four classes each of the teachers paid attention to promoting positive motivational factors such as relevance, competency, autonomy, self-efficacy, persistence and mastery orientation and this resulted in a reduction of maladaptive factors such as anxiety and lack of control. The results revealed an emphasis on learning orientations and positive affective classroom environments both of which are linked to conceptual understanding and mastery orientations. Furthermore, a positive affective climate also predicts motivation, enjoyment, help seeking and other positive emotions. The teachers cared about their students’ progress and took a personal interest in individual students such as noticing and being concerned if students were not progressing. The teachers considered it important to include activities that they believed the students would perceive as enjoyable and interesting as well as creating positive classroom environments. Although the needs of the students varied across the four classes, the teachers’ plans for learning and engagement were applied in ways that were relevant to the needs of their students and their learning contexts. Promoting engagement was believed to be an important factor for mathematics learning in these classes irrespective of the students’ levels of achievement. However, it was also clear that the teachers were not always effective at engaging all of the students in their classes. For example, Miss Marsh did not use effective strategies for engaging seriously disengaged students in her class and Miss Field was unsure of how to motivate higher achieving students in her class. Mrs Church also seemed more concerned about addressing the engagement needs of students who were struggling with mathematics, and was not as effective at engaging students who were disinterested in group activities. Mr Tower was effective at challenging and engaging the students in his high achieving class and was aware of several students who were not achieving as
well. He reported paying attention to and using specific strategies for these students. The following section reports on teacher practices that demonstrate the enactment of the teachers’ espoused beliefs, showing how their beliefs for promoting student learning and engagement in mathematics were carried out in practice.

Teacher Engagement Practices

Teacher practices were drawn predominately from the classroom observations and were discussed by the teachers during interviews. The process for identifying patterns of practice and critical features that were effective for engaging students in mathematics is detailed in Chapter 7. The complexity of classroom activities, dialogue and interactions were all considered included the physical movement of the teachers around the room, how and when teachers responded to and interacted with students verbally and non-verbally. The teachers’ instructional practices for promoting mathematics and engagement were coded. Guided by various frameworks that identified instructional practices for engagement in mathematics (Lutz et al., 2010; Raphael et al., 2008; Reeve, 2012; Stipek et al., 1998; Sullivan, 2011), specific instructional practices were identified by particular characteristics and coded as categories. For example, the category ‘practices that promote autonomy’ included specific practices such as: minimising external control/allowing choice on tasks and ways of working; allowing time on tasks to vary for individual students; and holding students accountable for making an effort to understand/fix their work.

At the conclusion of coding, nine categories of practices that promoted mathematics and engagement were identified and labelled as follows:

- Promote emotional engagement;
- Create engaging classroom environments
- Promote task importance and value;
- Promote content goals;
- Promote varied strategy use and self-regulation;
- Promote competency;
- Promote autonomy;
- Promote collaboration; and
- Promote monitoring and feedback.
The reported results for each category include the specific teacher practices identified as belonging to each of the nine categories supported by exemplars from each class. The exemplars demonstrate how instructional practices were similar and dissimilar across the four classrooms. The exemplars are coded according to the types of class being: high achieving mixed gender (HM); low achieving mixed gender (LM); low achieving girls (LG); and low achieving boys (LB).

Although Study 2 was focused on investigating teacher beliefs and practices that promoted student engagement, during the analysis stage all teacher beliefs and practices were considered, including practices that hindered engagement. In Chapter 6, a section about ‘Teacher Practices for Engaging Students in Mathematics’ detailed ways it was perceived that teachers promoted and hindered student engagement as part of Study 1. There are overlaps between several of these practices reported by the teachers interviewed for Study 1 and the practices reported and observed by the four teachers in Study 2. These overlaps include practices pertaining to student autonomy, task importance and value and creating positive classroom environments.

The details of the observed classrooms practices were relatively consistent across the four cases in Study 2 because the classrooms had been identified as having motivated Year 7 students. By contrast, the teachers interviewed in Study 1 taught students whose achievement and engagement levels had shifted upwards and downwards during the previous year and, therefore, the range of classrooms were broader than the four classrooms in Study 2. Hence, it was expected that the practices of the four teachers of the motivated Case Study classes would more likely promote student engagement than hinder it. Despite this, all of the practices of the four Case Study teachers were investigated including any that were observed hindering student engagement. It should be noted that the practices of the teachers in Study 1 were not observed, but were reported by the teachers themselves during interviews. Importantly, the practices of teachers involved in Study 2 were not only observed during lessons, but reported on during pre- and post-lesson interviews and the teachers could provide explanations about the practices they used.

Practices that hinder or undermine engagement include practices that: convey the teacher as an audience needing to be pleased; emphasise performance goals; express negative expectation of task success; express dismay when students give inappropriate answers; forbid students to work ahead; and misinterpret students’ remarks (Lutz et al., 2010). Raphael et al. (2008) noted additional hindering practices
such as: decreasing the value of the task; lack of monitoring and scaffolding; providing ineffective feedback; and using negative and inefficient classroom management.

Reeve (2009) identified practices associated with controlling teacher styles as being negative for students by intruding on their ways of thinking, feeling and behaving both directly and indirectly. Controlling practices include: teachers relying on outer sources of motivation; neglecting to explain rationales for tasks; relying on pressure-inducing language; displaying impatience for correct answers; and asserting power over students’ negative affect such as disinterest, dislike and attitudes (Reeve, 2009).

There were few occurrences of practices undermining or hindering engagement by the teachers involved in Study 2. Moreover, the practices observed of the Study 2 teachers often countered practices that hindered engagement. For example, rather than decreasing task value, teachers who promoted engagement implemented various practices within their instruction that promoted task importance and value. For convenience and sense, practices that were identified as hindering student engagement are reported and discussed below within the nine identified categories identified as promoting engagement.

**Practices that Promote Emotional Engagement**

Students’ interest and enjoyment have been identified as important factors for continued participation in mathematics (Brown et al., 2008; Martin et al., 2012) and seen as increasingly important for sustaining other types of student engagement such as behavioural and cognitive engagement that influence overall academic outcomes (Appleton, Christenson, & Furlong, 2008; Park et al., 2012; Stipek et al., 1998). The ways that the Study 2 teachers specifically attended to students’ beliefs, values, interests, and attitudes were considered essential for promoting learning. Table 8.1 contains a summary of a range of the teacher practices observed in Study 2 that supported the development of positive emotions in students. These included encouraging students’ efforts and persistence, offering opportunities to participate and complimenting students on their work. The teachers’ enjoyment in the lessons was demonstrated by their enthusiasm. Dedication to helping their students reach understanding was reflected by the teachers’ personal interest in student achievement.
## Table 8.1

**Practices that Promote Emotional Engagement**

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourages effort and persistence</td>
<td>“We have done a lot today. You’ve worked hard. Thank you. I know you will do your best” (HM).</td>
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<tr>
<td></td>
<td>Pats on the back when student correctly solves a problem and encourages him to continue with the second part of the problem. (LB).</td>
</tr>
<tr>
<td>Offers opportunities to participate</td>
<td>“Okay, let’s see – what are some ideas? Who can volunteer?” (HM).</td>
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<tr>
<td></td>
<td>“If I wanted someone to come up to the board and write that in expanded form – who would be willing to do that? Don’t be shy?” (LB).</td>
</tr>
<tr>
<td>Alleviates frustration</td>
<td>“If you’re not sure you’re not sure – that’s okay” (HM).</td>
</tr>
<tr>
<td></td>
<td>“It’s confusing I know but that’s the whole idea – you have to work with it” (LB).</td>
</tr>
<tr>
<td></td>
<td>“If you did not understand that one don’t worry I just put this up as a challenge” (LG).</td>
</tr>
<tr>
<td>Indicates enjoyment/interest</td>
<td>“I like what I see guys. This is very good” (HM).</td>
</tr>
<tr>
<td></td>
<td>“I was glad to see there was lots of discussion and negotiation and chopping and changing. That’s all good” (LB).</td>
</tr>
<tr>
<td>Acknowledges student attentiveness</td>
<td>“Okay so I’ve been out here working for a long time. We are going to do a little bit more work with me and then we are going to get you guys to do some” (HM).</td>
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<tr>
<td></td>
<td>“This is our last example boys before I set you off on your task” (LB).</td>
</tr>
<tr>
<td></td>
<td>“Yes I promised you a game and we will get to the game. Give me ten more minutes of your attention and we will get to the game” (LG).</td>
</tr>
<tr>
<td>Acknowledges when addressing difficult concepts</td>
<td>“Here’s a hard question. This is going to challenge some of you” (HM).</td>
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<tr>
<td></td>
<td>“This one here is a bit tricky. How am I going to do it?” (LG).</td>
</tr>
<tr>
<td>Compliments students on work/efforts</td>
<td>“That’s brilliant. Well done guys” (HM).</td>
</tr>
<tr>
<td></td>
<td>“Good job. Beautiful” (LM).</td>
</tr>
<tr>
<td></td>
<td>“Thanks you so much boys” (LG)</td>
</tr>
<tr>
<td></td>
<td>“Yes. Perfect” (LG).</td>
</tr>
<tr>
<td>Shared humour</td>
<td>“So he could lift Lucas up with his ear- just imagine” (HM).</td>
</tr>
<tr>
<td></td>
<td>Shares laughter with two groups when they achieve the correct solutions (JB).</td>
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<tr>
<td></td>
<td>“The right angle is coming up David. I know you are excited about it!” (LM).</td>
</tr>
<tr>
<td>Sensitively handles mistakes and uncertainty</td>
<td>“Not sure about that one? Can you say why? Are you not real clear about it?”(HM).</td>
</tr>
<tr>
<td></td>
<td>“You did that in science? No this is bisect not dissect” (LM).</td>
</tr>
<tr>
<td></td>
<td>“Do you mind if I say it?” (checking it was okay with the student first before revealing her lack of surety to the whole class) (LG).</td>
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</table>
There were a number of similarities in the way Study 2 teachers promoted emotional engagement (whether teaching high and low achieving students). The teachers demonstrated an interest in their students beyond that of their student-teacher relationship in the context of the mathematics classroom by making inquiries about weekend activities or local sporting events. They engaged in some informal repartee with students, which served to establish a positive and friendly classroom climate. At points during the lesson all the teachers demonstrated they were enjoying themselves particularly during the group or activity section of the lesson, and occasionally shared a humorous moment or joke with the students. Opportunities to participate in learning activities were encouraged in various ways by the teachers through explicit questioning, sharing explanations verbally and on the board, working together in groups or pairs and using objects and other interactive medium. Students were not ‘put on the spot’ or forced to participate.

All Study 2 teachers made a number of one-on-one connections with the students in their classes. The teachers called students by their names and made eye-contact when talking to them, with nearly every student mentioned or called upon at some point during the lessons. During one of Mr Tower’s lessons, 19 of the students were specifically acknowledged by their names. During independent student activities, the teachers walked between groups, hovering to monitor progress, assisting when asked and encouraging students. The teachers’ effectiveness at maintaining students’ behavioural and cognitive engagement was also evidenced through acknowledgement of students’ efforts and persistence.

The Study 2 teachers not only used motivationally supportive practices to enhance student engagement, they also attempted to reduce the influence of negative factors. The teachers were sensitive to the way they dealt with students’ uncertainties, alleviated students’ frustrations, acknowledged when work was demanding and reduced opportunities for disengagement. Each of the teachers was aware of students beginning to fatigue at some point during the lessons and acknowledged this by asking the students to persevere “just a little bit longer” so the learning point could be completed. On several occasions Mr Tower told his students he was mindful of their hard work and all of the teachers reminded students of an imminent change in activity (to group work or mathematics game/activity) as they became aware of students beginning to become restless and thereby addressing potential disengagement. The teachers were mindful of reducing opportunities for the students to lose focus on
tasks. For example, when moving to group activities or a game Mrs Church organised the groups quickly before explaining the activity and Miss Field handed out cups and counters while the students completed their bookwork so that they were ready to start the next activity.

The teachers’ sensitivity towards student errors or misunderstandings was evident in various ways. In some instances, the teachers noticed a general misunderstanding amongst the class and repeated explanations or procedures. At other times, the teachers became aware of a student’s misunderstanding and dealt with this immediately with the individual student to clarify the concept. When the teachers noticed student errors they were careful not to undermine students’ motivations by emphasising their lack of understanding, but instead were sensitive to the students’ feelings and probed gently to clarify the point of misunderstanding. Though difficult to determine absolutely from observation alone, none of the students appeared anxious, frustrated or embarrassed when their teachers pursued the source of their errors. This was possibly because the students were concerned about understanding and mastering concepts and valued the efforts of their teachers to repeat explanations and probe their thinking rather how they were perceived by others for making errors or misunderstanding.

Practices that Create Engaging Classroom Environments

Another commonality among the four teachers was the establishment of engaging classroom environments. The observed practices contributing to such environments are listed in Table 8.2. These include practices that: establish and sustain a positive rapport and encourage mutual respect; establish routines and expectations for working; prepare the classroom for learning; provide appropriate materials; and establish an active presence in the classroom. These practices promoted student involvement and active participation in learning supporting students as ´agents´ and taking control of their behaviour, cognition and affect as part of the motivation and engagement process (Martin, 2012).
Table 8.2
*Practices that Create Engaging Classroom Environments*

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourages a respectful classroom environment</td>
<td>Greets and dismisses the students “Good morning everyone” and students respond. Regularly thanks the students as a class and individually for their responses (HM). “Okay, hands down girls while she is talking.” (LG).</td>
</tr>
<tr>
<td>Establishes routines/ways of working for involvement in mathematics learning</td>
<td>Requested information from a wide range of students, expected contributions, expected engagement, assessed learning from students responses (HM, LM, LB, LG).</td>
</tr>
</tbody>
</table>
| Prepares the classroom for learning                    | Checked classroom conditions for temperature and light (HM & LM) \  
Brings materials needed for the lesson, sets up computer (HM, LM & LG). \  
Writes up prepared questions on board (LG). \  
Sets up access to computer program for use in the lesson (HM, LG & LM). \  
Prepared a worksheet/revision list (HM, LM, LG & LB). \  
Brought objects/manipulative items for activities (HM, LM & LG). |
| Establishes an active and involved presence in the classroom | Directs questions to most students in the class, makes many positive and supportive comments. Constant assessment of class and individuals by asking them to show their recordings on the mini whiteboards and walking around the room (HM). \  
Directs questions to students in different parts of the room, expects full attention when talking, and later moves constantly between groups (LB). |
| Establishes expectations for taking the learning seriously | Arrives before students and readies the room. Collects students from corridor (LG & LB). \  
Closes the classroom door indicating the lesson is starting. \  
Waits for the students’ attention and greets them formally (HM, LB & LG). \  
“We are going to be doing lots of different things today…So we are going to start straight away.” (HM). \  
“Alright gentlemen, come in, unpack your bags, take out your exercise book, diary, pencil case” (LB). |
| Prompts students to stay focused                       | Asks students to put lids on markers (reduce doodling) (HM) \  
Taps desk when a student is not focused. (LB) \  
Repeats the name of/ stares at student when off task (LM) \  
Asks for whole class attention (LG) |
| Alters the pace of the lesson as required              | “We going to do this in a really snappy way [clicks fingers]” (HM) \  
Alters pace by introducing another activity (LB, LG, LM & HM). |
| Provides variations in activities                      | Whole class, paired and group work (HM). \  
Whole class and group work (LB). \  
Whole class and activity at desks in pairs (LM). \  
Whole class and activity at desk (LG). |
Mr Tower, Miss Field and Mrs Church were observed formally greeting the students once they were all seated in the classroom. The students addressed their teachers as ‘Sir’ or ‘Miss’ and showed respect to other students by listening to their explanations and queries. These observations can be contrasted to the comments made by teachers in Study 1 who perceived that students’ lack of communication, involvement and participation were indicative of students who were disengaging from mathematics. In Study 2, the observed classrooms were conducive to learning as each of the teachers prepared work for the class prior to the lesson and organised all the materials and information needed before the students arrived in the room. This indicated their readiness to begin the lesson straight away and expectation that students would also be ready to start learning, thereby reducing opportunities for students to stray off-task. Miss Field was observed writing specific fraction questions on the board that she wanted to review prior to the students entering the classroom. Mr Tower arrived before the students and checked the room conditions, set up the power point presentation and retrieved items he required from the mathematics storeroom. Students who arrived early were greeted and engaged immediately in tasks such as handing out materials in readiness for the lesson to begin.

All four teachers established an active and attentive presence in the classroom. It was observed that each teacher spent a significant part of the lesson at or near the front of the room in the first half of the lesson, usually because they were initiating work and showing examples at the board. However, once group work or other activities were introduced, the teachers tended to physically move about the room. For example, during group work Mrs Church made 13 visits amongst the student groups who were working on problem solving questions. During this time she moved amongst the groups as she attended to questions and followed up on student progress. Similarly, Mr Tower was attentive to various student needs as he managed two different activities in the second half of his lesson. Groups of students measured items at the weighing station set up at the front of the room while the rest of the class worked in pairs to complete a quiz sheet he had prepared. He was able to monitor the progress of students as they weighed and recorded assorted items as well as interact with individual students as he provided feedback on their progress.

The teachers’ class routines and ways of working varied with several differences aligned to the needs of lower or higher achieving students. Mr Tower’s
high achieving group of students covered a greater number of concepts and variety of activities throughout the lesson. He called on the students to provide him with information about content, which he would confirm by rephrasing students’ responses or he would ask the students to discuss their thoughts with each other to clarify their understandings. Mr Tower regularly asked the students to display their work as a way for him to quickly assess whole class understanding and to identify aspects that may have been misunderstood. In this way, he was able to address and clarify content throughout the lesson and move on to new concepts without unnecessary repetition. While believing that understanding was paramount, Mr Tower was mindful that spending time on work the students already understood would be risking disengagement for this group of students. He was conscious of keeping the pace of the lesson flowing and set time limits on activities to keep students challenged.

By contrast, Miss Field and Mrs Church spent considerable time during their lessons working through examples. It was during this process that students’ uncertainties and misunderstanding were revealed and provided additional opportunities to revise examples again, often requiring the teachers to break the task down into fine detailed steps. Throughout this process, Miss Field and Mrs Church regularly checked with the class that they understood each component and that they were clear about how to solve the problems before moving on to other work. Miss Marsh recognised that her students would have trouble understanding the terminology of properties of shapes and, had prepared a lesson that was predominately teacher-focused to promote active participation and involvement during the lesson. She did this by directing students’ use of correct terminology throughout the lesson using it to describe the properties as the students’ constructed different quadrilaterals. This was an effective way for Miss Marsh to model the correct terminology and emphasising that this is important for the communication of mathematical ideas (Anthony & Walshaw, 2007). Within the context of Miss Marsh’s classroom and the learning needs of her students, motivating and promoting student engagement was practiced by explicitly supporting student learning by modelling the use of terms, emphasising definitions and using these in context. Two of the students in Miss Marsh’s classroom were quite vocal, often answering questions and making additional comments during the lesson. Miss Marsh mostly acknowledged the students’ contributions with humour, saying “Did I ask you?” before turning to another student. However, on two
occasions she acted to subdue the students’ behaviour by repeating their names and making eye contact with them.

Checking on students’ understanding was a frequent practice by all Study 2 teachers and although they often asked for feedback, the teachers also actively checked that students’ uncertainties were resolved and emphasised the importance of needing to be clear about their understandings. Miss Field reminded her students she was available after the lesson and during lunch break if students wanted to ask her further questions.

Each teacher promoted positive classroom environments hallmarked by purposeful learning, preparation of suitable and interesting tasks and interest in students’ progress. Mutual respect, teacher enthusiasm, teacher interest in student learning and as individuals are clearly apparent in classrooms that promote mastery orientations which are in turn associated with motivation and engagement (Anderman & Patrick, 2012; Raphael et al., 2008; Turner et al., 2011).

Practices that Promote Task Importance and Value

The importance of tasks and their value was emphasised by Study 2 teachers in the present study both directly and indirectly throughout the lessons. Table 8.3 contains a summary of the typical practices used by the Study 2 teachers to convey importance and value. Typical practices included explicit explanations to students about the purpose of the task and why it was valuable for them to learn and understand it. Other practices reinforced importance and value of mathematics work by reminding students about mathematics conventions and process of working, establishing what the students knew and building their knowledge through questioning until the teacher was satisfied that a significant number of students clearly understood and could complete the tasks. Since mathematical proficiency develops over time, students benefit from appropriate guidance to connect mathematical components and build a hierarchical understanding of mathematical knowledge that assists in applying knowledge to solve complex problems (Higgins, 2011).
### Table 8.3

**Practices that Promote Task Importance and Value**

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probes for mathematical explanations and justifications</td>
<td>“What words do you think of when you think of mass? Who’s got three? Who’s got four? Write them in order – lightest first. Do you know their abbreviations? Write the letters next to the words” (HM). “How many shapes do I have? How many sticks? So what is the pattern? How would I know the next one? Yes, take the number of shapes and multiply by three” (LG).</td>
</tr>
<tr>
<td>Reminds about mathematic workings and conventions</td>
<td>“Be accurate; We want to be exact; Make it clear; Milligrams and in brackets mg” (HM). “Remember there is an invisible power of one” (LB). “What is it called when we flip it? Who knows the word? Yes Reciprocal” (LG).</td>
</tr>
<tr>
<td>Explicit explanations of why the mathematical task is important</td>
<td>“A really essential thing that we need to be very, very clear about” (HM). “First of all we need to get used to the terminology…the words that they use, sometimes the words they use are yuck okay so we need to make sure we understand what they mean” (LM).</td>
</tr>
<tr>
<td>Persists with the concept until completely understood</td>
<td>“Let’s just figure out what happened to people…To change it into grams multiply by one thousand. One way to understand it is to move the decimal point three places or move the digits three places to the left. Angela did you get that? Okay” (HM). “You have got two you don’t know? Okay we will learn what to do with that now” (LG).</td>
</tr>
<tr>
<td>Indicates the importance of establishing what the students know</td>
<td>“We are going to see what is the connection. I want to see how much you know about this?” (HM). “Some of you can do this in your head and that’s great but I want you to show me with your counters for now” (LG).</td>
</tr>
<tr>
<td>Challenges/supports students by offering open-ended tasks</td>
<td>“I want you to come up with a creative way of how you would show how you might change or convert grams to milligrams … let’s see if you can think of a couple of things – you might only know one” (HM). “So, on your whiteboards, this is my question to you today – what do you think we might be doing in this lesson? What are some of the things we would want to find out about today?” (HM). “What rule do you reckon we could make to help us solve this problem without having to go through that (points to expanded working on the board)?” (LB).</td>
</tr>
<tr>
<td>Challenges/supports students by probing or pushing for connections</td>
<td>“Which of those weights will be put on the scale first? Student: A kilogram Teacher: Why? Student: It’s the most accurate” (HM). “Do you remember the train tracks? Parallel lines are lines that stay the same distance apart (shows with arms). This one has two parallel sides and we know that because of the little arrows – don’t we?” (LM).</td>
</tr>
</tbody>
</table>
Overall, the cognitive demands on students thinking were elevated and occurred more often in Mr Tower’s class. Mr Tower frequently challenged his students by asking them to explain their answers. He did this by asking students to justify their understanding by independently explaining their thinking either to him or though discussions with other students. Mr Tower also regularly asked open-ended questions such as: “Give me an example of an object we could find the mass of? “What do you think we might be doing in this lesson?; and What are some of things we might want to find out about today?” Mr Tower’s questions were not limited to teaching content but also extended learning processes as students were required to apply knowledge and skills of measurement they had learnt previously such as devising a process for converting units of measurement. Increases in cognitively challenging demands on high achieving students have been associated with increases in engagement (Lutz et al., 2010).

The teachers of lower achieving students used questioning to probe students thinking and to recall particular rules or procedures in fine detail. Different kinds of questioning techniques were used by the teachers, with some questions aimed to guide students and other questions were intent on testing students understanding. Both types of questions were used in the low achieving classes as a way of supporting lower achieving students’ understanding to master concepts. By asking questions and probing for connections the teachers modelled and required the students to describe, reason and explain their thinking using mathematical language thereby supporting their cognitive engagement (Watson, 2010).

The teachers of lower achieving students were observed spending more time clarifying student understanding before moving onto new concepts. For example, Miss Field asked the class to recall how to convert improper factions to mixed numeral fractions. At times, Mrs Church asked her students to recall mathematical principles, however, at other times, Mrs Church probed her students to make deeper connection with their learning. For instance, after showing examples of how to expand a number with a power inside a bracket and a power outside of the bracket, she asked the students if they could come up with rule to help solve problems without having to go through the expanded working each time—which they did.

The extent to which teachers probed for connections varied across the different achievement levels of the classes, with the teachers emphasising recall of
mathematical conventions and procedures more often in the lower achieving classes. Although in the lower achieving classes the approaches in the observed lessons were strongly teacher directed, they aimed to support students’ learning by confirming and reinforcing prior knowledge before making connections with new knowledge. This is important for cognitive engagement.

When teachers noticed that individual students did not completely understand the explanations or examples, the teachers went through explanations again on a one-to-one basis. Miss Field often worked through further questions on the board when her students wanted to go through procedures again to clarify their understandings. Stipek et al. (1998) support views that teachers who develop competence and mastery tend to establish positive classrooms environments and display affect for student learning. In Study 2, the value and importance of the lesson was clear to students because the teachers explained the purpose of the lesson within the context of other mathematical learning, helped students make learning connections and were prepared to repeat explanations until satisfied that students understood. Additionally, Park et al. (2012) found that feelings of being connected to learning and relating to task importance were important factors underlying emotional engagement and although more strongly associated with high achieving students it was also found to be an important need for low achieving students.

**Practices that Promote Content Goals**

Each of the Study 2 teachers used practices that supported a classroom mastery goal structure that conveyed a consistent approach towards learning and engagement (Anderman & Patrick, 2012). Teachers who establish a mastery goal approach in their classrooms used practices to emphasize the goals of the lesson by explicitly linking concepts and making connections, clarifying and rephrasing explanations to support student understanding. Practices that promote content goals observed in Study 2 are presented in Table 8.4.
<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makes content goals clear</td>
<td>“So that’s what we are going to do. You’ve got them. We are going to talk about how to measure mass, the units we use, but most importantly – what is mass, what is the meaning of mass” (HM).</td>
</tr>
<tr>
<td></td>
<td>“Today our focus is going to be on indices but we are going to take it a little bit further because we are going to see today what do we do if we have one indices or one power to the power of another power. That’s what we are going to be focused on today” (LB).</td>
</tr>
<tr>
<td></td>
<td>“Today and for the rest of this week we are going to look at quadrilaterals”. LM</td>
</tr>
<tr>
<td>Reminds students about the task process/overall goal of the lesson</td>
<td>“What about tonnes to kilograms. We are going from big to small. When big to small -you multiply” (HM).</td>
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<tr>
<td></td>
<td>“We are going to look each property by itself and then we are going to look at it in terms of the whole shape” (LM).</td>
</tr>
<tr>
<td></td>
<td>“Girls I don’t want you losing sight of what it is we are looking for. So I don’t want you just memorising what you do I want you to understand what you are doing.” (LG).</td>
</tr>
<tr>
<td>Gives clear instruction/structure for tasks – rephrases if required</td>
<td>“So, we are ready to convert… I am going to give about five of these. I am going to write them on the board. In other words I want you to write the answers down and then turn your boards over” (HM).</td>
</tr>
<tr>
<td></td>
<td>“Can everyone with your coloured sticks please make a trapezium? You must use these colors - 1 orange, 2 yellows and 1 red. Yes you need 1 red” (LM).</td>
</tr>
<tr>
<td>Reviews conceptual knowledge related to the current lesson</td>
<td>“So if I was talking about the mass of your calculator what would we be talking about? What would be some of the matter, the things that made up your calculator?” (HM).</td>
</tr>
<tr>
<td></td>
<td>“That’s right there is nothing stopping us from what we did with the numbers - we can do the same with algebraic terms and expressions” (LB).</td>
</tr>
<tr>
<td>Connects responses to prior knowledge /experiences</td>
<td>“You have done some work on mass in science. Who agrees? Excellent, so you guys are already experts” (HM).</td>
</tr>
<tr>
<td></td>
<td>“Let me take you a couple of days back when we were multiplying and dividing-what did we multiply first, the pro-numerals or the numbers?” (LB).</td>
</tr>
<tr>
<td></td>
<td>“Last week we looked at triangles do you remember and we looked at types of triangles and we talked about the angle sums of triangles which is…?” (LM).</td>
</tr>
<tr>
<td>Elaborates meaning or gives examples showing typical use</td>
<td>“So your mass wouldn’t change if you got in a rocket and went to the moon…you’ve still got all the stuff inside you, all this matter that you have on earth [use gestures to show]. So it’s not that the mass has changed but the weight changes because what changed?” (HM).</td>
</tr>
<tr>
<td></td>
<td>“So the sides next to each other are perpendicular. Did you know that this wall is perpendicular to the floor (points) because it is a right angle?” Student: “And the roof?” Teacher: “Yes well done, and the roof?” (LM).</td>
</tr>
</tbody>
</table>
Each teacher articulated the goals of the lesson and activities within the lesson to the students and adapted instruction to suit their needs. When explaining a particular concept, both Mr Tower and Miss Marsh referred to concrete examples to help the students understand abstract ideas. For example, as way of helping students understand the terminology she was teaching in the lesson, Miss Marsh periodically asked students to recall the meaning of ‘adjacent’ to reinforce its meaning. Mr Tower gave an example of the difference between mass and weight by explaining that, even though his weight may change if he “went to the moon”, his mass would not. In both cases the teachers used examples to help clarify these mathematical terms and concepts believing them important for the students to have a clear understanding of their meaning and how to apply them appropriately. Mr Tower had also investigated the students’ prior knowledge about mass through his discussion with the Year 7 science teachers. This enabled him to create a key link between different subject areas and establish the extent to which the students had retained their understanding of mass and weight from previous learning settings.

The Study 2 teachers were effective by not only providing clear and explicit instructions, they actively sought ways to provide all students with opportunities to engage in mathematical thinking and develop mathematical understandings (Anthony & Walshaw, 2009; Sullivan, 2011). Within the context of the Study 2 classrooms, the teachers provided supportive instruction discourse, which was scaffolded by establishing what students knew and challenging them to make new connections with prior knowledge. In Mrs Church’s and Miss Field’s classes, the students asked questions and for help and those in Miss Field’s class asked to stay behind after the lesson to pursue their understanding by practicing further problems. The teachers were observed using these opportunities to re-explain the work in different ways—sometimes breaking down procedures into small steps. The teacher practices focused on meaningful and interesting tasks, recognised students efforts, promoted positive learning environments, which all interacted to support student learning (mastery) and motivations for learning.

**Practices that Promote Varied Strategy Use and Self-Regulation**

Strategy use and self-regulation are largely aligned to cognitive engagement as they are concerned with how students are strategic in managing and regulating their
involvement in learning (Cleary & Zimmerman, 2012). Strategy use also supports student self-regulation of learning and is frequently associated with metacognitive dimensions and mastery orientations towards learning. Cleary and Zimmerman (2012) suggest that motivational factors such as self-efficacy beliefs and interest in learning, influence students’ willingness to engage cognitively in self-regulated learning. Teachers who encourage students to use strategies increase the effectiveness of their learning and supports motivational factors that have been found to sustain engagement (Lutz et al., 2010). The teachers’ practices that were supportive of strategy use and self-regulation are described in Table 8.5.

Table 8.5
Practices that Promote Varied Strategy Use and Self-Regulation

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highlights appropriate strategy use</td>
<td>“How might you combine all that information to … go from tones into kilograms, kilograms into grams, grams into milligrams, and then the reverse way?” (HM). “What do you reckon would be a quick method for us to solve the problem? What rule do you reckon we could make up to help us solve this problem?” (LB). “Girls, we have covered decimals, fractions, algebra – you need to be studying over the weekend- look at the review sections [in the textbook]. So go back over that chapters look at the area that you had a hard time and you can come ask me questions on Tuesday” (LG).</td>
</tr>
<tr>
<td>Refers to previous strategy use/use to scaffold strategy application</td>
<td>“You have seen this before and you could repeat it but you may be able to come up with your own? … How could you convert… Very good, a lot of you have remembered past ways of doing it” (HM). “Think about what is in the brackets, think about what is its power and then remember the rule we just made up? What are you going to do with the power inside the brackets with outside it?” (LB). Student asks if 18 can be divided by 5 using long division rather than using a calculator. Teacher confirms and student explains her working as the teacher records it on the board. (LG).</td>
</tr>
<tr>
<td>Prompts students to self-regulate</td>
<td>“So if you have problems with decimals it is your responsibility now to come and talk to me. Is that clear?” (LG). Provided students with a checklist for upcoming assessment. E.g., Can you add mixed numerals? Can you subtract a fraction from a whole number? ; Put a star next to the ones you find difficult and tick the ones you know (LG).</td>
</tr>
<tr>
<td>Summarises the lesson with/without students input</td>
<td>As the students identify each of the key aspects covered in the lesson, the teacher writes these on the board and creates a summary of aspects of the topic (HM) Provides a checklist of key concepts on topics and works through an example of each with the students input (LG).</td>
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</tbody>
</table>
All Study 2 teachers reminded students about using particular strategies to enhance their understandings. For example, Mr Tower and Mrs Church challenged their students to come up with ways to show a process or method for connecting mathematical information in each case referring back to what the students had already seen and knew. In this way, the teachers demonstrated their expectation and beliefs that the students were capable of applying their thinking in new ways and supported the students as they strove to reason and explain their mathematical thinking. Miss Marsh was observed congratulating a student on his study program over the weekend and then reminded him of the added benefit of continuing his study until the test later in the week. Teacher practices that promoted strategy use and self-regulation supported behavioural motivation for planning and managing work, in addition to supporting students’ beliefs about their capabilities.

Miss Field took time to explain to her students several strategies that she believed would be effective for revision and in the process modelled ways for her students to self-regulate their learning. For example, she suggested that rather than study concepts they already knew, it would be more effective (although not as enjoyable) to study concepts they did not understand. She also suggested that it would be best to do the revision section in the textbook to test their understandings and if they found out they needed to revisit a concept it was important that they asked her to revise it. Miss Field also provided an end of topic checklist so that each student could identify aspects of the topic they had mastered or needed more revision and commented that she believed the checklist to be a useful tool for the students personal planning and regulation of learning. Miss Field’s practice of providing the topic checklist not only encouraged her students to expend effort and persist with studying for the upcoming test it also offered students strategic choices and modelled reflective processes.

*Practices that Promote Competency*

Students’ needs for competence relates to their beliefs that they can identify and use appropriate strategies to complete and master tasks and activities (Park et al., 2012). Hardré, Sullivan and Crowson (2009) identified that perceived competence was one of the factors that influence not only interest but also intentions for future study. Further, maintaining students’ self-efficacy through promoting perceptions of
competence is identified as an important teaching practice in mathematics classrooms for student engagement (Stipek et al., 1998). Table 8.6 presents the results of how Study 2 teachers promoted student competency.

Table 8.6
Practices that Promote Competency

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides opportunities to demonstrate skills or share responses</td>
<td>“There is a difference between weight and mass. Who can explain the difference? [pauses] Who can explain the difference?” (HM).</td>
</tr>
<tr>
<td></td>
<td>“You have all got 20 counters. If I want to find ¼ of 20 what is that? How many would that be? Show me with your counters” (LG).</td>
</tr>
<tr>
<td>Provides opportunities for mastery through repeated success</td>
<td>Students completed several conversions using mini-whiteboards—teacher assessed whole class after each one (HM).</td>
</tr>
<tr>
<td></td>
<td>Students completed several problems as a group—teacher assessed each group as she walked around (LB).</td>
</tr>
<tr>
<td>Notices and addresses uncertainties</td>
<td>“Who agrees that mass and weight are the same? Who says they are different? Who’s not sure? Uh-huh! Okay so we are going to talk about it” (HM).</td>
</tr>
<tr>
<td></td>
<td>“I know the language is a bit tricky. Sometimes if we see it as a fraction, the amount makes a bit more sense—we can picture a hundred squares and colour in 2. Does that make sense?” (LG).</td>
</tr>
<tr>
<td>Encourages learning from errors</td>
<td>“That’s interesting isn’t it? Things are much heavier than we give them credit for” (HM).</td>
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<td></td>
<td>“You got to be very careful about that because there is a difference between 2 times x squared and x squared times x squared” (LB).</td>
</tr>
<tr>
<td>Asks students to clarify solutions</td>
<td>Teacher: “So is everyone clear? Summarise for me Nathan. What is mass then?”</td>
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<td></td>
<td>Student: How much matter is in an object</td>
</tr>
<tr>
<td></td>
<td>Teacher: Yes, how much matter is in an object”(HM)</td>
</tr>
<tr>
<td></td>
<td>Teacher: “Lina, how did she [another student] get 2 over 21- what did she do?”</td>
</tr>
<tr>
<td></td>
<td>Student: Because 2 times 1 is 2 and 3 times 7 is 21.</td>
</tr>
<tr>
<td></td>
<td>Teacher: Perfect” (LB).</td>
</tr>
<tr>
<td>Draws on students to explain correct solutions</td>
<td>“Who got it right who could explain to the class? Raymond what did you do?” (HM).</td>
</tr>
<tr>
<td></td>
<td>Teacher: “Three times- good boy. Why three times?”</td>
</tr>
<tr>
<td></td>
<td>Student: Because its cubed</td>
</tr>
<tr>
<td></td>
<td>Teacher: Very good because it’s cubed” (LB).</td>
</tr>
<tr>
<td>Seeks to clarify correct use of terms</td>
<td>“Calculate. I’m interested in that word. What do you mean by calculate? Is it different from measure? You don’t think so… Okay we might come back to that – but you said calculate so let’s put that on the same line [as measure]” (HM).</td>
</tr>
<tr>
<td></td>
<td>“Remember a pro-numeral is a letter and these little guys here (circles numbers) are indices or powers” (LB).</td>
</tr>
<tr>
<td></td>
<td>“I want you talk about dividing I don’t want to hear you talking about taking off zeros” (LG).</td>
</tr>
</tbody>
</table>
Student competency was promoted by the teachers through their intent on understanding and mastery of concepts. Competency was not measured by grades or test performance that aimed to please the teacher. Instead, students were encouraged to demonstrate their understanding and ask questions and this provided the teacher with opportunities to clarify terms and concepts as well as identify uncertainties. When teachers noticed uncertainties or errors in students’ explanations, workings or questioning the teachers were sensitive to how they responded, taking care not to belittle or embarrass students. The teachers were observed gently probing to assess the extent of the students misunderstanding or uncertainty (Mr Tower), patiently re-explaining procedures to individuals or the whole class (Mrs Church and Miss Field) or continually repeating or asking for recall of information from the students (Miss Marsh). Prompts for student self-regulation for understanding were evident, predominantly in Mr Tower’s and Miss Field’s classes. Not only did Miss Field continually ask students to check their understanding as she worked through concepts during the lessons, on several occasions she explicitly told her students that it was their responsibility to check what they did and did not know by going through checklists or revisions sections for homework and then tell her about areas they needed help. During his lessons Mr Tower tended to ask his students to write responses to questions then discuss their answers with their desk partners or compare their thoughts and solutions with other students in the room—suggesting that the students justified why or why not they agreed with each other or if they would have used different words or workings.

Teacher practices that promoted competency are associated with mastery and aim to encourage students to approach and persist with tasks, thereby supporting students’ inner motivational resources. Meeting students’ needs for competency also satisfies their needs to be effective in their pursuits and to master challenges in the classroom environment and is therefore supportive of positive functioning, motivation and engagement.

Practices that Promote Autonomy

Students’ needs for autonomy are met when they are involved in decision making and offered choices about their learning such as how and what to learn. Greater student autonomy is supported when teachers exert less controlling styles of
instruction. Autonomy-supportive teaching styles that welcome students’ thoughts, feelings and behaviours are associated with positive learning outcomes (Raphael et al., 2008; Reeve, 2009). Teaching approaches that offered students choice, let them work at their own pace, and held students accountable for learning were observed in the Study 2 classrooms and are detailed in Table 8.7. These practices meet students’ psychological needs for personal autonomy and sustain all types of student engagement by supporting underlying motivational factors (Reeve, 2009).

Table 8.7
Practices that Promote Autonomy

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimises external control/allows choice on tasks/ways of working</td>
<td>“Show it to the person next to you. Now hold up. Have a look around and see other peoples as well” (HM).</td>
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<tr>
<td></td>
<td>“That’s fine. It doesn’t matter. You can use whatever method you like. It doesn’t matter guys which way you want to do your working out” (JB).</td>
</tr>
<tr>
<td></td>
<td>“If this does not make sense to you … you can do it the way you learned with long division… but we will do it one more time” (LG).</td>
</tr>
<tr>
<td>Allows time on task to vary for individual students</td>
<td>“Some will be a little harder than others and I will give you a bit more time” (HM).</td>
</tr>
<tr>
<td></td>
<td>“Girls work at it. If you have a question, raise your hand” (LG).</td>
</tr>
<tr>
<td>Holds students accountable for making an effort to understand/fix their work</td>
<td>“Check with the person next to you now. So you might have to change your whiteboards now if you didn’t quite get that” (HM).</td>
</tr>
<tr>
<td></td>
<td>“This may be one of the only times you see it and you are expected to remember it for your test. So that means if you don’t understand it now – you need to tell me. So make sure you ask questions today if you don’t understand it” (LG).</td>
</tr>
</tbody>
</table>

When students asked if they could use another method to solve problems, Mrs Church, Miss Field and Mr Tower confirmed they could use methods they felt comfortable with or could show more than one method in their workings. Opportunities for students to work at their own pace were limited and this may have been due to the nature of these particular lessons. However, there were times during Mr Tower’s lessons where he acknowledged that some students may need more time than others to think of solutions or re-write definitions in their own words.

In two of the low achieving classrooms, the students’ lack of understanding influenced the pace of the lesson. In Miss Marsh’s class, clarifying the terminology and properties of different quadrilaterals left limited time for the practical part of the lesson. The latter part of Mrs Church’s lesson was rushed as she spent a longer time
than was anticipated during the lesson attending to students misunderstandings. In both of these classrooms the opportunity to work autonomously was limited and did not occur until the end of the lesson.

**Practices that Promote Collaboration**

The promotion of collaboration in the form of student-to-student interactions emphasise communication and present opportunities to share and clarify explanations and create openings for students to learn from each other (cognitive engagement). Collaboration also requires active participation and involvement as students complete tasks and activities together. Boaler (2008) argues that learning in a ‘togetherness’ environment is what students prefer. Hannula (2004) believes that since classrooms are social places, participating positively in activities and tasks also satisfies needs for social connectedness (emotional engagement). Teachers can make students feel included by promoting collaboration and supporting students to think for themselves and at the same time, act to sustain engagement (Anthony & Walshaw, 2009; Lutz et al., 2010). In Table 8.8, observed teacher practices that promoted collaboration associated with sustaining engagement are described.

**Table 8.8**

*Practices that Promote Collaboration*

<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creates tasks which require direct and</td>
<td>“Check if someone next to you has got it wrong or you think they have made a little mistake…give them a little bit of support. Now hold up [the mini whiteboards], have a look around and see other peoples as well” (HM). Group or table activities required students to discuss and share understanding (HM, LM, LG &amp; LB).</td>
</tr>
<tr>
<td>indirect collaboration</td>
<td></td>
</tr>
<tr>
<td>Encourages students to share their</td>
<td>“Show it to the person next to you. If you agree, say why you agree. If you disagree – if they have used a word and you think ‘I wouldn’t use that word’ – talk about it for about 30 seconds” (HM). “When do we need to make the denominators the same? Who can answer Lina’s questions?” (LG).</td>
</tr>
<tr>
<td>understanding</td>
<td></td>
</tr>
<tr>
<td>Establishes purposeful groupings</td>
<td>Partnered more able with a lesser able students for support (HM).</td>
</tr>
<tr>
<td>Makes groups accountable for learning</td>
<td>“Who said more than 3 kilos? Put your hand up. Only one group is still in it!” (HM). “You are going to be working at a team. You have to consult with the others to check your answer is correct” (LB). “If you are stuck or finding it difficult you can ask someone from your team.” (LG).</td>
</tr>
</tbody>
</table>

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Each of the Study 2 teachers promoted collaborative opportunities during their lessons and this was mostly aligned to a particular activity within the lesson. Each teacher planned for group or paired work during their lessons and organised the classroom for this by moving students to sit together for practical purposes. Mr Tower used purposive pairings, matching a more and less able student together so that assistance could be provided by the more able student. Similarly, students were able to collaborate through discussion in Miss Marsh’s lesson when making quadrilaterals using the manipulative objects she provided. Mrs Church grouped her students into six groups requiring them to work as a team to complete their algebra worksheets. At the end of Miss Field’s lesson the students played games such as ‘Fractions Bingo’ working in teams to support each other.

Mr Tower planned for his students to collaborate in a variety of ways. The students worked together in pairs to complete a quiz sheet while they waited for their turn at the weighing station. The students worked in groups of four at the weighing station and were required to estimate, weigh and record the weights of several objects together. On other occasions, Mr Tower asked the students to “write what you think and now share it with your partner” so that students could explain and justify their mathematical thinking to others. On several occasions he urged them to help each other correct their work in a supportive way.

Providing opportunities for students to collaborate not only supports clarification of understanding through discussion with others, it also provides time away from direct instructional time by the class teacher, offers variety, sustains interest and provides opportunities for social connectedness. These are positive factors associated with adaptive classroom environments and supportive of all types of student engagement.

**Practices that Promote Monitoring and Feedback**

Teacher practices that monitored student progress and participation during lessons supported learning orientations. Practices observed during Study 2 are set out in Table 8.9 and included: assessing student understanding; using formative feedback; clarifying students’ explanations; and emphasising understanding and mastery.
<table>
<thead>
<tr>
<th>Teacher Practices</th>
<th>Exemplars</th>
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</table>
| Provides positive and substantive information about progress | “Hold up to me so I can see them. Okay good. Right. Everyone’s on target, some have written more than others” (HM).  
“This worksheet is much harder than the assessment so try it - if you can do the first two rows you are ready” (LG).  
“A lot of you had a hard time with decimals that’s what you need to start with. Start with the section that you found the hardest – I know it is not the most fun but that is the way you are going to well on your assessment” (LG). |
| Explores prior knowledge | “Write those four words [terms of units] in order – lightest first… Now before I get you to hold them up I want to see if you know their abbreviations. Write the letters we use to abbreviate them next to the word” (HM).  
“We are going to do a quick re-cap of what we did yesterday to make sure we are all on the same page. Can someone tell me how I write this [0.2] as a fraction? How do you say that? “(LG). |
| Clarifies/explains/affirms students’ responses | Teacher: “Now I know you’ve said, can hold – what did you mean by that?  
Student: How much is inside  
Teacher: Okay, so how much matter an object can hold - how much matter is inside an object” (HM).  
Teacher: “2x means two times x  
Student: But Miss, doesn’t 2x mean x plus x?  
Teacher: Yes, it also means x plus x” (LG). |
| Checks/assesses for whole class understanding | “Is everyone clear? Hold them up (answers on mini-whiteboards) so I can see them” (HM).  
“Is there anyone who is sort of confused – want to go back a step?” (LB).  
“The lowest common denominator of two and four is four. Does anyone not know that?” (LG). |

In the examples provided in Table 8.9, Mr Tower and Miss Field were both explicit when monitoring their students’ progress and understanding as they advanced through the lesson. Mr Tower was able to monitor understanding quickly, often by viewing his students’ responses on their mini-whiteboards. He often verbalised feedback, for example: “Yes you have got it”; and “I like what I see”. At other times, he re-phrased a student’s response or required a student to clarify what they meant such as: “Can hold- what did you mean by that?”.
Miss Field constantly checked with the whole class that they understood each step as she worked through examples asking “Does this make sense?” and regularly called on students to contribute as she worked through solutions. On several occasions, Miss Field reminded her class about concepts they had mastered which also served to provide feedback about their progress. Miss Field provided the students with a ‘Review Checklist’ of 15 outcomes for fractions and decimals. She worked through each one, drawing on the students to provide examples so that they could monitor the extent of their understanding.

Both Miss Field and Miss Marsh reminded their students about ways to study effectively for learning. Providing feedback to students about their substantive progress helps foster views that learning is an incremental process and their achievement level is malleable and can be facilitated by regulating and using learning strategies. Feedback was provided in terms of how it could improve students’ understanding by probing for clarity and encouraged students’ efforts to work towards mastery of skills and concepts. Feedback in this form is associated with learning orientations and overall goals for mastery that also promote engagement.

Summary of Teacher Practices

Engaging Teacher Practices

The teacher practices displayed during the observed lessons included practices that were effective for teaching mathematics and for promoting motivational factors that fostered engagement for learning mathematics. Hardré and Sullivan (2008) identified that classroom environments have important motivational influences on teachers and students, viewing teachers’ motivating practices and students’ motivation as reciprocal—each “influencing and being influenced” by each other (p. 2060). Anthony and Walshaw (2007) also believe that elements of effective instruction should not be considered in isolation, nor should factors of engagement be considered to operate separate to classroom teaching and activities. Further, “teachers who produce effective classroom communities care about student engagement” and pay “attention to developing interrelationships that are orientated towards enhancing students’ capacity to think, reason, communicate, reflect upon and critique” (Anthony & Walshaw, 2007, p. 197).
The teachers in Study 2 portrayed beliefs and practices of effective instruction characterised by promoting relevance, content goals, strategy use, collaborative support, autonomy, self-regulation, feedback and a positive classroom environment. Specifically, they attended to affective engagement practices. The results of Study 2 reflected that motivational supportive practices are embedded within the teachers’ practices for teaching mathematics. The results revealed that, despite teaching classes of either high or low levels of achievement, student engagement was promoted by using different practices. The practices were tailored, or prioritised to meet the needs of the students and the contextual factors and dynamics of individual classrooms.

**Absence of Practices Hindering Engagement**

As expected, few practices hindering engagement (Lutz et al., 2010; Raphael et al., 2008) or controlling teacher styles (Reeve, 2012) were observed by the Study 2 teachers. For example, teacher expectations of task completion and mastering concepts were high across both the high and low achieving classrooms. Overall, lesson material was carefully considered so that it met the learning needs of the students. However, there were occasions when it was observed that the level of active participation by some students was low.

In Miss Field’s class several students sitting at the back of the class, paid less attention to the revision lesson on fractions and decimals. Although they completed questions set they also quietly talked amongst themselves when Miss Field was explaining working to the rest of the class. When asked about the lack of participation of these students in the post-lesson interview, Miss Field commented that she was not sure if they were engaged, stating: “The ones at the back are the ones that always get it”. Miss Field also noted that although she put a more difficult question on the board for these students they completed it quickly.

It was observed that during the lesson Miss Field made specific eye contact with one particular student and when asked about this Miss Field reported that the student: “probably could have taught that lesson. She is quite advanced”. Although Miss Field reported she tried to motivate this student she was not sure whether or not this student or the other capable students were engaged. By contrast, in the pre-lesson interview, Miss Field did report identifying a student in her class earlier in the year that she perceived was high achieving but disengaging. Miss Field identified the student because the student was not doing work and ‘acting out’, yet Miss Field
suspected the student was very capable. After speaking with the student and demonstrating that she cared about what was happening, they agreed on a strategy for setting target grades for tests and which resulted in increased student engagement and achievement levels and “seemed to have really focused” the student.

These examples are interesting because they reveal that Miss Field was able to identify and offer strategies for students she perceived were disengaging in mathematics. However, it also shows that overt indicators of disengagement such as ‘acting out’ and non-compliance were attended to, whereas less obvious and passive decreases in levels of engagement were noticed but seen as temporary or tolerable. This implies that vigilance for all types of engagement is important, particularly as some students may comply with classroom expectations of behaviours, yet mask their emotional and cognitive engagement for the benefit of the teacher.

It was also observed that Miss Field was concerned about supporting the needs of the less able students in her class. Similar observations were made of Miss Marsh and Mrs Church, who also taught low achieving classes. Despite these three teachers being aware that there were more capable students in the class as well, for most of the lesson their attention was on addressing the needs of the students who had difficulties understanding the work. It was also observed that when students were unsure of concepts, the teachers would re-explain work for the whole class, so that students who did understand the work were required to listen to explanations again. There were few opportunities for the students in these three classes to work independently or receive adequate challenges, which are seen as important for developing mathematical thinking (Anthony & Walshaw, 2007). By contrast, Mr Tower reported several lower achieving students in his high achieving class, and he was mindful of the practices he used to support these students. For example, one student who Mr Tower reported as the “least mathematical” in the class perceived that the student “compensates for his deficiencies by being a little bit of a clown”. Mr Tower is careful to take the student seriously when he asks a question, so that he promotes the importance of understanding mathematics concepts for this student and maintains his engagement, as he sometimes struggles with the “pace and depth” of the lesson.

This brings attention to a general finding about teacher practices across both Study 1 and Study 2. Teachers interviewed in both studies reported a wide range of student capabilities in their mathematics classrooms, even in classrooms that were streamed or banded based on achievement. Drawing from the teacher responses in
interviews and observations of the Study 2 teachers, practices specifically addressing students with seriously low levels of engagement were not often discussed. Some teachers in Study 1 reported that they were unsure of how to engage seriously disengaged students. Although some teachers felt helpless about this, some reported that despite their attempts some students could not be engaged in mathematics, implying that extending their attempts further was futile and ultimately not their responsibility.

Although serious levels of disengagement were not evident or observed in Study 2 classrooms, the results reveal that high achieving students in low achieving classrooms and low achieving students in high achieving classrooms, were at risk of decreasing engagement because teachers practices tended to address the needs of the majority of the students and students who had other needs were often left unattended or not attended to effectively. This highlights the importance of meeting the needs of individual students, both for achievement and for engagement. While acknowledging this may prove to be difficult to accomplish, the findings of this research supports that attention to individual student engagement ‘profiles’ are critical for promoting and arresting declines in engagement.

Conclusion

Study 2 revealed that a wide range of teacher beliefs and practices were used by teachers to promote engagement in mathematics. The results confirmed that teachers who developed interpersonal relationships by connecting and relating to their students were better placed to support and engage students learning outcomes (Hardré et al., 2009). Skinner and Belmont (1993) identified that teacher involvement, structure for instruction and autonomy support were important dimensions of teacher practices that respectively meet students’ needs for relatedness, competence and autonomy to optimise student engagement. Stipek et al. (1998) also identified teacher practices for the promotion of engagement and achievement that included: encouragement of challenging and conceptual thinking; emphasis on learning and understanding; supporting autonomy; and authentic and meaningful activities.

The findings of Study 2 revealed that the precise ‘shape’ or form of some teacher practices varied according to the specific needs of the students in high and low
achieving classes. In particular, teachers who were sensitive to students’ unique differences used supportive practices to promote factors influencing student engagement while taking into account the contextual dynamics of specific learning environments. Variations in how practices were applied were revealed through the examples drawn from the lesson observations. For example, in lower achieving classes, Mrs Church, Ms Field and Ms Marsh often led student learning, employing step by step instructions, provided numerous opportunities for mastery and regularly checked for understanding—practices viewed as engaging for low achieving students (Lutz et al., 2010). By comparison, Mr Tower’s practices regularly challenged students by requiring them to organise concepts, summarise and explain their understandings to the teacher or peers and to link new learning to existing conceptual frameworks or schema.

In each of the four cases, the teachers’ beliefs and practices were focused on achieving understanding and mastery rather than performance and this was evidenced by the teachers’ interest in seeking accounts and demonstrations of student thinking. Although all the Study 2 teachers used practices that probed and checked for understanding during instruction, Mr Tower regularly pressed his students for deeper levels of understanding by expecting them to explain their answers. Once concepts were mastered, Mr Tower often provided additional challenges to extend his students thinking—practices found to influence engagement for high achieving students (Lutz et al., 2010).

The lesson observations also revealed an absence of non-motivational practices. Pushing students too fast or expecting too much may result in superficial understanding. Since each teacher indicated beliefs and practices that emphasised a learning orientation they were prepared to repeat explanations and follow up until student understanding was reached. Notably, the teachers demonstrated a strong desire to support students by helping them make connections with their learning and clarifying misunderstandings, helping to increase feelings of competence and reduce feelings of anxiety—factors that are associated with engagement. For the teachers in Study 2, the promotion of student engagement in mathematics was believed to be fundamental to learning mathematics. Promoting engagement was not viewed as something to be attended to if the teachers ‘found time’, nor did they believe that engagement was only relevant to high achieving students. Rather, the teachers in Study 2 considered student engagement as an innate and significant part of learning
and achieving. Student engagement was considered an important part of mathematics learning for every student, reflected in their beliefs and supported by their practices.
Chapter 9

Conclusion

The present research addresses problems underlying declines in student engagement and achievement in mathematics (McPhan et al., 2008; Tytler et al., 2008). A disproportionate number of students are becoming disengaged from mathematics (Sullivan et al., 2006) and are disinclined to pursue further mathematics study later in secondary school or beyond (Brown et al., 2008; Forgasz, 2006; Mack & Walsh, 2013). Particularly, dips have been reported during the middle years of schooling (Hill et al., 1993; Siemon, 2001), which highlight the need for a better understanding of the motivational factors that influence student engagement and achievement, and warrant a closer look at the specific factors that influence student engagement and teacher beliefs and practices that promote it during this crucial period of schooling. Hence, the purpose of this research was to enhance teachers’, and researchers’ understandings of student engagement relative to student achievement in the year students transit from primary to secondary school.

Accordingly, two qualitative studies, nested within a larger project, were designed to examine and connect students’ and teachers’ perceptions of engagement and achievement (Study 1) to teachers’ beliefs and practices for engaging students in mathematics instruction (Study 2). The objectives were to establish factors that contributed to shifts in students’ engagement and achievement and to identify effective pedagogy that promoted high levels of student engagement in mathematics in Year 7. Specifically the study sought to answer the following questions:

1. What individual and classroom level factors do Year 7 students perceive as influencing their engagement, motivation and achievement in mathematics?
2. How do teachers perceive students’ engagement and motivation in mathematics and how is this reflected in their teaching practices?
3. How do teachers motivate and engage middle years students in mathematics?
   a. What beliefs do teachers who are effective at promoting engagement hold about students’ motivation and engagement in mathematics?
b. How do teachers differentiate their practices to motivate and engage students of varying levels of achievement?

This chapter will discuss the significance of the findings according to the research questions. It will highlight limitations of the research and make suggestions for further study.

**Significance of the Findings**

*Study 1: Interview Study*

Study 1 addressed the first two research questions. It was designed to investigate the perceptions of ‘engaging’ and ‘disengaging’ students who were both ‘high’ and ‘low’ achieving. Investigating the perceptions of students who were: low achieving + disengaging (LAD); low achieving + engaging (LAE); high achieving + disengaging (HAD); and high achieving + engaging (HAE) achieved two aims. First, a comprehensive and detailed set of factors influencing engagement levels of students with these characteristics was revealed. Second, students’ levels of engagement, ranging from fully engaged to disengaged (LAE & HAE; LAD & HAD) and their levels of achievement (LAE &LAD; HAE &HAD) were explored in distinct ways. This approach is significant because the majority of research investigating student engagement tends to focus on either engagement or disengagement but not both, resulting in singular perspectives of the engagement construct (Brown et al., 2008; Kong et al., 2003; Nardi & Steward, 2003). Additionally, by disentangling engagement from achievement, greater clarity about the degree to which certain factors might influence student engagement was gained. Further, students’ self-reports of their perceptions provided accurate, detailed and highly individualistic information (Reschly & Christenson, 2012, p. 9). This is critical for assessing aspects of engagement that are not easily observable, such as emotional and cognitive engagement (Appleton et al., 2006; Fredricks & McColskey, 2012) and for gaining insight into students’ subjective experiences of negative emotions and motivations that are central to understanding disaffection in school mathematics (Lewis, 2013).

The findings suggest that high levels of achievement are not necessarily associated with higher levels of engagement and that students with low levels of achievement are not inevitably ‘disengaging’. This ambiguous picture of student engagement in mathematics learning, although already considered by some
researchers (Grootenboer & Hemmings, 2007; Schweinle et al., 2006), is a concerning one and requires further investigation by specifically differentiating between the factors influencing the engagement and disengagement of students with high and low achievement.

Both individual and classroom level factors were perceived as influential for students who were becoming more or less engaged during the first year of secondary school mathematics lessons. When compared, the characteristics of high/low achieving and engaging/disengaging student groups revealed that the students were more ‘alike’ in terms of their levels of engagement than in their levels of achievement. For example, shared factors were found amongst ‘engaging’ students such as attitudes and interest (emotional engagement), persistence, planning and task management (behavioural engagement) and help-seeking strategies, homework completions and study strategies (cognitive engagement). Nonetheless there were differences between high and low achieving engaging students. For example, high achieving students used more sophisticated learning strategies, reported greater control of their learning and were keen to explore more complex and challenging work.

By contrast, ‘disengaging’ students reported a number of maladaptive factors such as self-handicapping, uncertain control, failure avoidance and anxiety, and relatively low levels of adaptive factors such as persistence, self-efficacy, mastery orientation and task management. Differences between high and low ‘disengaging’ students were also found. For example, levels of uncertain control and anxiety were not as intense for high achieving disengaging students as they were for low achieving students. However, it is important to emphasise that students in both disengaging groups had not ‘given up’ at mathematics. For high achieving disengaging students, a lack of challenge and an emphasis on performance rather than mastery of concepts were identified as issues. For low achieving disengaging students, their frustrations at not being able to master concepts and achieve success, coupled with a lack of knowledge about strategies for regulating learning was significantly linked to their negative feelings about mathematics. In fact for some students, where strong emotional factors were negatively influencing the shifts in engagement levels (e.g., LAD students) attending to factors that influenced engagement appeared to be critical as learning opportunities were hindered by their lack of engagement. Although the order or priority of attending to engagement factors before achievement factors was not a focus of this research, this is an aspect worthy of further inquiry.
Significantly, the findings in Study 1 illustrate that student achievement levels are not reliable indicators of their engagement. This was evident with the students who were high achieving yet disengaging from mathematics (HAD) and the students who were low achieving and engaging (LAE). The identification of factors influencing engagement has important implications for teachers. Rather than assessing their mathematical progress solely by achievement scores, teachers need to monitor students’ engagement with a view to improving overall student engagement and participation levels.

The findings have implications for mathematics teachers, suggesting that paying attention to students’ engagement and meeting individual students’ engagement needs is likely to impact upon achievement outcomes. This is consistent with research involving achievement motivation and mathematics that highlights the significance of emotional factors on cognitive outcomes (Zan et al., 2006). Over the last two decades, research has identified that emotions (Hannula, 2004; Linnenbrink-Garcia & Pekrun, 2011) as well as behaviours and cognitions are interrelated factors that influence learning outcomes. Therefore, just as teachers differentiate tasks and practices to meet students’ cognitive needs, differentiating practices to meet the engagement needs of their students is also important. The student ‘profile’ that was used to present results of the engaging and disengaging student categories in Chapter 5 is an example of a tool that teachers can use to appraise student engagement levels.

Rather than assuming that students and teachers perceive student engagement in one or the same way, the present study sought perceptions of student engagement from teachers as well as the students. This approach allowed a more accurate account of student engagement in mathematics classrooms. Significantly, the findings confirmed that teachers perceived multiple levels of student engagement; being aware of various indicators for ‘disengaged’, ‘variably engaged’ and ‘substantially engaged’ students in mathematics. Although prior research has considered hallmarks of ‘disaffected’ students (Nardi & Steward, 2003) and those who lacked interest in studying mathematics (Brown et al., 2008), the area between engagement and disengagement has not been pursued in detail. Therefore, the findings of Study 1 are important because they shed light on the full range of engagement and identify possible reasons for shifts and variations in student engagement during the early secondary years.
Additionally, students who were neither ‘disengaged’ nor ‘substantially engaged’ were reported as displaying various types of engagement. For example, some students were highly engaged in terms of their behaviour but less so emotionally and cognitively. Importantly, the teachers in Study 1 posited reasons for variations in students’ levels of engagement, revealing information about possible causes for shifting engagement in mathematics. Such causes were perceived by teachers to be tied to student feelings of competency, past experiences and affective factors such as students’ interest, beliefs and attitudes.

Teachers perceived variably engaged students as compliant but needing encouragement. It was found that their emotional states included an overall lack of interest in mathematics and that cognitive strategies, such as organisational and self-regulation skills, were either poor to non-existent. Therefore, an implication for practice involves the professional development of teachers to equip them with strategies to develop students’ skills to monitor, regulate and ultimately develop greater control over their learning. Such strategies are influential components of cognitive engagement and although the goal orientations of students are likely to vary within the mathematics classrooms, the teacher is in a position to mediate classrooms goals and strategies for planning, regulating and monitoring learning. Strategies to support student organisation, time management, promote autonomous monitoring and control of learning tasks and emotions are important dimensions of academic functioning.

Additionally, it was revealed that variable engagement was not confined to low achieving students, but was also evidenced in students who experienced success in mathematics; therefore indicating that variable engagement occurs across different achievement levels. The teachers tended to categorise students according to different sets of characteristics. One set of characteristics pertained to students who were perceived as competent at mathematics but required greater challenges, another depicted students who were low achieving in mathematics and reluctant to engage due to anxiety, lack of confidence or shyness. Important advice to teachers arising from this finding is the need for them to be cautious of making assumptions about a student’s lack of engagement in mathematics based solely on behavioural indicators. Feelings of anxiety and perceptions of incompetence could be the root of student poor participation and active involvement in the classroom.
The identification of indicators for both the types and levels of student engagement perceived by teachers was an important finding. The process of ‘unpacking’ the many features characterising student engagement was aided by the Engagement Spectrum. The dimensions of the Engagement Spectrum are consistent with both multidimensional and interrelated conceptualisations of the engagement construct. As the Engagement Spectrum delineated types and levels of engagement, the perceptions of the teachers also provided detailed information about underlying motivational factors influencing engagement. This was helpful for several reasons. First, identifying motivational factors added clarity about the relative influence of particular factors on types of engagement. Second, attention to particular factors was helpful for monitoring shifts in student engagement. Further, it is suggested that appreciating the indicators for different levels of student engagement is helpful for understanding and anticipating shifts in engagement. By linking motivational factors, which are not easily observed, to engagement, which is observable via student behaviours, teachers can more clearly understand why and how certain types of engagement are influenced by collections of underlying motivational factors.

The use of two complementary theoretical frameworks provided links between a range of adaptive and maladaptive motivational factors (Martin, 2007) and types of engagement (Fredricks et al., 2004). Understanding the association between particular motivational factors and types of engagement is helpful for teachers. It is likely and understandable that most teachers lack in-depth knowledge of student motivation, relying instead on overt indicators of engagement to judge how motivated students are. However, teachers cannot always reliably diagnose reasons why students lack motivation and engagement (Hardré & Sullivan, 2008). As confirmed by the current investigation, many teachers are also unsure how to address poor student engagement even when they recognise it.

The results of Study 1 support moving away from general assessments of students being described as simply engaged or disengaged and instead encourages specificity to identify the ways and degrees to which students may be engaging or disengaging in mathematics. Using a tool such as the Engagement Spectrum can help teachers decipher the engagement levels of their students and more clearly understand which types of engagement are most in need of support. In this way, instructional strategies for specifically targeting student engagement needs can be developed.
Further study is needed to determine how effectively teachers might be able to utilise the Engagement Spectrum for these purposes.

A further finding of Study 1 revealed that teachers reported differentiating motivational strategies according to the perceived general class achievement level. In several cases, teachers were particularly alert to the sensitivities of low achieving students and the difficulties they faced with understanding mathematics. Strategies were therefore directed towards student interest and building positive relationships that aimed to maintain their participation in mathematics learning. This suggests that in the short term, maintaining participation in mathematics learning is perceived by teachers as an effective strategy to compensate students with low motivation and engagement before including more powerful strategies that explicitly support academic success in the longer term.

Study 2: Case Study

The purpose of Study 2 was to explore what actually took place in mathematics classrooms, thus addressing the third research questions and its two contributing questions. Accordingly, a central aim of Study 2 was to explore the beliefs and practices of teachers whose classes had been identified as comprising motivated students.

To gain a comprehensive understanding of how teachers promoted engagement in mathematics classrooms, teachers of both low and high achieving mathematics students were investigated, thereby identifying beliefs and practices that were shared and different amongst teachers of students with varying levels of achievement. The four teachers in Study 2 believed that student engagement was an important element for learning mathematics and this was reflected in the way attention to students’ engagement was embedded in their beliefs and practices. Their beliefs were supportive of positive motivational factors and were evident in their approach to lesson planning and responses to students’ needs (Anthony & Walshaw, 2007; Doig, 2005; Sullivan, 2011). Although emphasising different approaches to instruction because of the needs of the students in the low and high achieving classes, all four Study 2 teachers’ beliefs and practices were focused on achieving understanding and mastery rather than performance and their practices supported cognitive engagement. This implies that supporting student learning using specific practices such as checking for understanding, seeking accounts of student thinking,
and demonstrating strategies that help process and manage information, are essential to help students master skills and comprehend complex ideas. It is through supporting cognitive engagement that students’ emotional and behavioural engagement needs are also satisfied.

The lesson observations in Study 2 revealed very few non-motivational practices used by the four teachers. In fact, there were many instances where it was observed that the four teachers actively used practices to reduce student disengagement by establishing positive learning environments, supporting students’ competency, and providing opportunities for task success and reducing anxiety—strategies that many teachers in Study 1 seemed unaware of. In all four classes, despite being identified as either high or low achieving, the teachers reported that there was still a range of achievement levels in the class. Although all four Study 2 teachers regularly used a wide range of practices for effectively promoting student engagement, attending to the needs of students whose achievement was very high or low appeared to be more difficult for the teachers. In particular, the results indicated that in lower achieving classes, the teachers concern for supporting lower achieving students dominated their practices, and students who understood the mathematics work were left unchallenged. This implies that teachers need a wide variety of practices that they can draw upon to meet the varying engagement and achievement needs of students in their mathematics classes. Empowering teachers with greater knowledge about specific types of student engagement, how to assess student engagement and its relationship to achievement along with knowledge of available strategies to support engagement are crucial for addressing engagement concerns.

It was also revealed that the Study 2 teachers used practices that at times engaged the whole class and at other times specific practices were targeted toward individual students. Although this was not a specific focus of the present study, investigating how and why teachers effectively attend to whole and/or individual student engagement should be pursued.

Limitations and Future Directions

Several limitation of the current investigation should be noted. First, it is acknowledged that interviews and observations are time consuming both in terms of
collection and analysis. However the rich amount of data sourced was crucial for eliciting detailed information about student engagement. Further research that incorporates mixed methods would be welcomed in the field as rich and significant data is yielded.

While this study focused on Year 7 students, replicating the study using different year groups and/or incorporating longitudinal investigations would further our understanding of why and how shifts in students’ engagement levels occur over time. Although the students interviewed for this study were willing to answer questions about their mathematics experiences, some students found it difficult to clearly articulate what they wanted to say. Advice for future investigations would be to incorporate stimulus tasks such as drawings (Deed, 2008) or sets of cards representing emotions and mathematics experiences (Lewis, 2013) to assist students articulate and express their thoughts and feelings about mathematics learning.

The findings of this study specifically investigated students who evinced the most significant shifts upwards and downwards in engagement and achievement over a one-year period. Therefore the findings report on the most extreme students in the sample and did not consider other students who displayed lesser shifts. Although for the purposes of this study the findings elicited large quantities of data explaining reasons for significant shifts in student engagement and achievement, investigating students with smaller shifts or with no shifts at all should be pursued as they may indicate other factors influencing levels of engagement.

From a practical perspective, several of the students displaying large shifts in engagement and disengagement were unable to participate in the study because the teachers of those students had retired or moved to other schools. Several of the teachers identified as effective for promoting students’ engagement were also unable to participate in Study 2 because they had relocated. Despite not being able to obtain data from all the participants, the data collected were significant both in terms of quantity and quality.

The focus of Study 2 was on four classrooms that were identified as having motivated students and the beliefs and practices of the class teachers were explored. It would be beneficial to expand the number of cases to explore the generalisability of the findings. It would also be advantageous to include investigations of classrooms with unmotivated students to compare the beliefs and practices of teachers in diverse settings and for a longer period of time. Further probing of teacher beliefs and
practices that are considered non-motivating would be helpful for illuminating knowledge of factors influencing disengagement in mathematics classrooms.

The results of this study revealed that teacher perceptions and beliefs about cognitive engagement were less extensive and detailed than for behavioural and emotional engagement. This likely reflects that cognitive indicators, such as planning, task management and self-regulation strategies, are less observable than student behaviours and so go unnoticed. The findings did reveal that some teacher perceptions of students’ cognitive engagement were restricted to the homework they did and unsophisticated study strategies but little was reported about students’ planning, monitoring and evaluating their learning during lessons. Therefore it is also possible that teachers are unaware of or do not feel confident about assessing indicators of cognitive engagement. Additionally, instructional practices that promoted cognitive engagement were not widely reported by Study 1 teachers. In contrast, teachers who believed in engaging students in strategic mathematical thinking and regulated their learning, including the teachers in Study 2, regularly used a variety of instructional practices to promote cognitive engagement. Therefore, it is proposed that further research examining how teachers identify specific indicators of cognitive engagement, and how their practices might support individual students’ task management, strategic thinking and regulation of their learning is warranted.

Conclusion

This research emanated from concerns about declines in student participation, interest and achievement in mathematics in the middle years of school. The aims of the study were twofold: to establish the factors contributing to shifts in student engagement and achievement in mathematics as students move from primary to secondary school; and second, to identify effective pedagogy that promotes high levels of student engagement in mathematics in early secondary school.

Students’ and teachers’ perceptions of behaviours, thoughts and emotions were elicited and a range of factors influencing both types and levels of engagement were revealed. The identification of factors influencing individual student engagement levels are helpful for addressing concerns raised about student participation, interest and achievement not only in early secondary years but for later when mathematics
study is no longer compulsory. Apart from establishing positive classroom climates, developing inter-personal relationships with students, attending to student needs for understanding mathematical concepts, the present study identified that teachers who believed in the importance of engaging students in mathematics and regularly used practices that promoted all types of engagement, resulted in classrooms of motivated students.

In the process of addressing the specific aims of the study, the research has also directed attention toward several chronic and persistent issues associated with student engagement in mathematics. For instance, identifying and investigating why some low achieving students remain engaged in learning and why some high achieving students do not, has led to a more thorough understanding of the range of motivational factors at play. It is clear from the findings that motivational factors are pivotal influences on how students behave, think and feel about mathematics and if underlying factors are not identified and addressed then it is unlikely that improvements in levels of student engagement will occur of their own accord.

Recognising that improvements in student engagement require specific attention highlights the important role of teachers in the ways that they perceive student engagement and the strategies used in mathematics classrooms to promote engagement and hinder disengagement. The findings illustrated that teacher strategies that met students internal needs by satisfying individual motivational characteristics were the most effective for promoting cognitive and emotional engagement. The findings revealed that some indicators of cognitive engagement are harder for teachers to notice than others due to the lack of overt student displays. However, whether identifying student cognitive engagement is easy or difficult should not excuse a lack of attendance to engagement. Findings from the study showed that teachers who believed in engaging students in strategic mathematical thinking and regulated their learning also used a variety of instructional practices to promote cognitive engagement and the students in their classes were identified as being highly motivated.

The implications of these findings are particularly exciting for teacher education programs and providers of teacher professional development as insights for the identification of relevant factors influencing student engagement can be more accurately and effectively made and subsequently addressed by specific teacher practices.
References


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Reeve, J. (2009). Why teachers adopt a controlling motivating style toward students and how they can become more autonomy supportive. *Educational Psychologist, 44*(3), 159-175.


### Appendix A

Mathematics achievement assessment instrument

**Mathematics Quiz (Allow 15 Minutes - Exactly) Research purposes only**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<tr>
<td>1</td>
<td>19</td>
<td>( \div 5 )</td>
</tr>
<tr>
<td>2</td>
<td>( \frac{152}{27} )</td>
<td>( 32 + 4 = )</td>
</tr>
<tr>
<td>3</td>
<td>( \frac{926}{799} )</td>
<td>( \frac{15}{5} = )</td>
</tr>
<tr>
<td>4</td>
<td>( \frac{2}{3} + \frac{1}{4} = )</td>
<td>( \frac{3}{2} + \frac{1}{2} = )</td>
</tr>
<tr>
<td>5</td>
<td>( 0.34 = ) ( % )</td>
<td>( 24 \times 26 )</td>
</tr>
<tr>
<td>6</td>
<td>( \frac{2}{3} ) of 35 =</td>
<td>( \frac{2}{3} \times \frac{4}{5} = )</td>
</tr>
<tr>
<td>7</td>
<td>Write as a common fraction in lowest terms:</td>
<td>( \frac{4.3}{3.6} )</td>
</tr>
<tr>
<td>8</td>
<td>( 0.025 = )</td>
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<td>24</td>
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</table>
Appendix A (cont’d)
Mathematics achievement assessment instrument

<table>
<thead>
<tr>
<th>Question</th>
<th>Calculation</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>$6xy + 2xy$</td>
<td>______</td>
</tr>
<tr>
<td>26</td>
<td>Add: $-a - 2b - 25$</td>
<td>______</td>
</tr>
<tr>
<td></td>
<td>$a - b + 21$</td>
<td>______</td>
</tr>
<tr>
<td></td>
<td>Factorise: $6x^2 - 12x$</td>
<td>______</td>
</tr>
<tr>
<td>28</td>
<td>$\frac{a^2 - a - 6}{a + 2}$</td>
<td>______</td>
</tr>
<tr>
<td>29</td>
<td>Reduce: $\frac{3d^2 + 3d}{d^3} \times \frac{5d - 5}{d^2 - 1}$</td>
<td>______</td>
</tr>
<tr>
<td>30</td>
<td>$f(x) = 5x^2 + 3x - 7$ Find $f(-2)$</td>
<td>______</td>
</tr>
</tbody>
</table>

THAT IS THE END OF THE QUIZ
PLEASE CHECK YOUR ANSWERS– THANKS!
Appendix B

Interview protocol for students: Study 1

1. What is your favourite subject at school and why?
2. Has this always been the case? Why/why not?
3. What class are you in at the moment (for mathematics)?
4. Who is your teacher (for mathematics)?
5. Who do you sit with in mathematics lessons? (are these your friends?)
6. Do you work with someone to complete mathematics tasks or do you work on your own? What does it depend on?
7. Do you enjoy mathematics? Why/why not?
8. Do you look forward to mathematics lessons? Why/why not?
9. What do you like doing most/least during mathematics lessons?
10. Describe what typically happens in your mathematics lessons?
11. Do you do well in assessments in mathematics?
12. Why do you think that is the case?
13. If you could change mathematics lessons so that you enjoyed them more, what would you do?
14. Do you have the chance to use technology in maths lessons? What other types of technology would you like to use in maths?
15. How much homework do you get each night?
16. Can you do your homework without help?
17. Do you work from a textbook in class?
18. What do you think of the textbook?
19. Do you ever talk to your friends about maths?
20. When you think back about maths in primary school what do you feel?
Appendix C

Interviews protocol for teachers: Study 1

1. How long have you been teaching? Which class are you teaching at the moment?
2. Do you work with other teachers to develop programs or lessons? If so, who?
3. Do you share good teaching ideas with other teachers? Why/why not?
4. What strategies (or tasks or activities) do you use to ‘engage’ students in learning mathematics?
5. How do you know these strategies engage students? What do you mean by engaged?
6. What resources do you use to find engaging mathematics activities or tasks?
7. Which students in your class at the moment are particularly ‘engaged’ in the mathematics you are teaching them?
8. How do you know these students are engaged?
9. Which students are not very engaged at the moment? Why not?
10. Are there particular aspects of mathematics which seem to engage students more? Why do you think this is the case?
11. Which aspects of mathematics are less engaging? Why?
12. Did you find mathematics engaging at school? Why/why not?
13. If you could change the mathematics syllabus so that it would promote engagement in mathematics, what would you change and why?
14. Do you use technology when teaching maths?
15. If so what kind? (IWB’s, tablets, online programmes, etc.)
16. Do you ever ask your students what they like or dislike about maths?
17. Do you think students should enjoy maths or is it a subject they have to do know?
18. How do you provide feedback to your students? How do you make it specific to particular students?
19. Do you feel understanding the student’s context is important in making a personal connection with them? If so how – or give an example?
Appendix D

Pre-lesson observations interview protocol: Study 2

1. What mathematics forms the focus of today’s lesson?
2. What activities/learning experiences have you planned for today? What has influenced your decisions to approach your lesson this way?
3. How do you think your students will respond to today’s topic/lesson/activities?
4. Do you anticipate any difficulties for students? If so, how will you address these?
5. Do you think the work will sufficiently challenge all students?
6. How confident are you the student’s ability to understand the mathematics content?
7. Are there particular students you will focus on in today’s lesson and if so why?
Appendix E

Post-lesson observation interview protocol: Study 2

1. Did the students engage with the mathematical ideas in this lesson as you had anticipated?
2. What tells you the students were/not engaged?
3. Did you change any content of the lesson from your original plans? Why?
4. Did you change or adjust any of your teaching strategies/approaches from your original plans? Why/why not?
5. Are you satisfied with the outcomes of this lesson? If not, how would you change the lesson and why?
6. What kind of feedback do you provide to students

I’d like to ask you some questions about specific aspects of the lesson to help clarify for me your thinking behind them. (At this point discuss particular aspects of the lesson that were observed).
Appendix F

Teacher beliefs and practices survey: Study 2

**Appendix – Teacher Survey**

**PART B**

For each of the following statements, please tick the column that best indicates your level of agreement.

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I like to use maths problems that can be solved in many different ways.</td>
<td></td>
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<tr>
<td>2. I regularly have my students work through real-life maths problems that are of interest to them.</td>
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<tr>
<td>3. When two students solve the same maths problem correctly using two different strategies, I have them share the steps they went through with each other.</td>
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<td>4. I tend to integrate several strands and/or sub strands of mathematics within a single unit of work.</td>
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<tr>
<td>5. I often learn from my students during maths lessons because my students come up with ingenious ways of solving problems that I have never thought of.</td>
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<tr>
<td>6. It is not very productive for students to work together during maths lessons</td>
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<tr>
<td>7. Every child in my room should feel that mathematics is something he/she can do.</td>
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<td>8. I integrate maths assessment into most maths activities.</td>
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<tr>
<td>9. In my classes, students learn maths best when they can work together to discover mathematical ideas.</td>
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<td>10. I encourage students to use concrete materials to explain their mathematical ideas to other students.</td>
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<tr>
<td>11. When students are working on maths problems, I put more emphasis on getting the correct answer than on the process followed.</td>
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<tr>
<td>12. Creating a set of criteria for marking maths questions and problems is a worthwhile assessment strategy.</td>
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<tr>
<td>13. In my class it is just as important for students to learn about other strands and topics like Chance and Data as it is to learn multiplication facts.</td>
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<tr>
<td>14. I don’t necessarily answer students’ maths questions but rather let them puzzle things out for themselves.</td>
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<tr>
<td>15. A lot of things in maths must simply be accepted as true and remembered.</td>
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<tr>
<td>16. I like my students to master basic mathematical operations before they tackle complex problems.</td>
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<tr>
<td>17. I teach students how to explain their mathematical ideas.</td>
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<tr>
<td>18. Using computers to solve maths problems distracts students from learning basic maths skills.</td>
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<tr>
<td>19. If students use calculators they don’t master the basic maths skills they need to know.</td>
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<tr>
<td>20. You have to study maths for a long time before you see how useful it is.</td>
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</tr>
</tbody>
</table>

Any person with concerns or complaints about the conduct of a research study can contact the Senior Ethics Officer, Ethics Administration, University of Sydney on (02) 9351 4811 (Telephone), (02) 9351 6705 (Facsimile).

Study 4 of MYTEAM Project

Please complete pages 1 - 2
## Appendix G

Field notes pro-forma: Study 2

<table>
<thead>
<tr>
<th>Case Study Observations</th>
<th>Date/time of lesson</th>
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<tbody>
<tr>
<td><strong>School:</strong></td>
<td><strong>Lesson 1 or 2</strong></td>
</tr>
<tr>
<td><strong>Teacher:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Class:</strong></td>
<td></td>
</tr>
</tbody>
</table>

- **Lesson opening** – include greeting/tone

- **Main Content/focus**

- **Teaching Strategies used** – variations /for specific reasons/to specific students?

- **Lesson conclusion** – how/links to other learning/use of context to link maths

- **Classroom atmosphere/ student behaviour**

- **Samples of student work collected**

- **Diagram of classroom**
## REVIEW CHECKLIST

**FRACTIONS AND DECIMALS**

<table>
<thead>
<tr>
<th>I CAN....</th>
<th>CHECK</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Put fractions in ascending or descending order.</td>
</tr>
<tr>
<td>2. Find equivalent fractions.</td>
</tr>
<tr>
<td>3. Reduce a fraction to its lowest equivalent form.</td>
</tr>
<tr>
<td>4. Add and subtract fractions.</td>
</tr>
<tr>
<td>5. Express improper fractions as mixed numerals and vice versa.</td>
</tr>
<tr>
<td>6. Add mixed numerals.</td>
</tr>
<tr>
<td>7. Subtract a fraction from a whole number.</td>
</tr>
<tr>
<td>8. Multiply and divide fractions and mixed numerals.</td>
</tr>
<tr>
<td>10. Express one quantity as a fraction of another.</td>
</tr>
<tr>
<td>11. Add, subtract, multiply and divide decimals.</td>
</tr>
<tr>
<td>12. Put decimals in ascending or descending order.</td>
</tr>
<tr>
<td>13. Understanding what happens when we multiply or divide by a number less than one.</td>
</tr>
<tr>
<td>14. Use the correct notation to show recurring decimals.</td>
</tr>
<tr>
<td>15. Convert terminating decimals to fractions.</td>
</tr>
</tbody>
</table>