HIGH SCHOOL MATHS MOTIVATION IN AUSTRALIA: ITS NATURE AND THE SOCIAL CONTEXT

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I declare that this thesis reflects my own work and includes no material which has been submitted or accepted for the award of another degree or diploma in any other university or institution. To the best of my knowledge this thesis contains no material previously written or published by another person, except where due reference is provided.

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Abstract

In Australia, participation in maths-related training and careers is declining and girls are under-represented amongst those who do pursue an interest in maths. Students in rural high schools are also more likely to have teachers without specialist training in maths. The purpose of this thesis was to comprehensively examine the nature, development and social context of maths motivation for Australian rural high school students.

Students from three public high schools completed the Student Motivation and Engagement Scale (Martin, 2007a) in the second semester of the school year and again a year later in a longitudinal cohort design. They also completed scales addressing affiliation with their maths teacher, parents and peers, as well as their maths attainment.

The results showed that maths motivation is complex and multifaceted. A range of core motivational theories was needed to explain the network of associations amongst the facets of motivation. Ratings of adaptive maths motivation decreased across grades 7 to 10, while disengagement increased. However, ratings of maladaptive cognitions and self-handicapping remained steady. Utility valuing showed the strongest effect with the decline of ratings accelerating after Grade 8. Girls reported stronger anxiety, uncertain control and failure avoidance than boys. However, they also showed more mastery interest and study planning. Furthermore, each adaptive facet of motivation and maladaptive behaviour was significantly predicted by affiliation with parents, maths teacher and peers. However, uncertain control and failure avoidance only showed significant paths with peer affiliation. Despite expectations, no sources of affiliation negatively predicted maths anxiety.

These results hold important implications for theories and models of academic motivation and socialisation. They demonstrate that the core theories of motivation can be incorporated into a more comprehensive model and that the quality of different social relationships are relevant to specific facets of maths motivation. This can contribute to a broader model of maths motivation within a relevant social

context. The findings also have valuable practical implications for those wanting to support the learning experience of maths students and Australian rural high school maths students in particular. For example, they bring to light that adaptive facets, particularly utility values, tend to decline during high school and that girls may be more vulnerable to anxiety-based cognitions than boys. These findings can assist educators, counselors and parents to tailor effective strategies for individuals that promote students' adaptive engagement and involvement in maths.

Chapter 1
Introduction

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

1.1 Background to the Studies

Mathematics (hereafter called maths) and numeracy skills underlie a wide range of everyday and business activities. These skills extend beyond pure maths disciplines and help meet Australia's needs in all types of industry, including building, engineering, mining, agriculture, health and technology (Australian Academy of Science [AAS], 2006; Department of Education, Science and Training [DEST], 2006). Well developed maths skills are relevant to Australia's continuing economic growth and international competitiveness (AAS, 2006; DEST, 2006). However, concerns have been raised about Australia's ability to develop maths trained individuals. This discussion can be observed in the press, as well as in more formal mediums such as government inquiries and reports (see Brown, 2009). Recently maths and science have been the subject of frequent media stories, mostly reporting about their declining enrolments and teacher quality (Dobson, 2007). Furthermore, many institutions are experiencing little demand for their educational courses, and employers are having difficulties in recruiting maths specialists. Consequently, while job growth for professions, such as mathematicians, engineers and maths teachers is expected to increase (Centre of Policy Studies [COPS], 2004), the current supply of maths-skilled individuals is inadequate and expected to worsen (AAS, 2006; Committee for the Review of Teaching and Teacher Education [CRTTE], 2003; DEST, 2006).

Skilled teachers are needed to inspire students so that training and development involving mathematics is sustained. However, the Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA] (2003) has raised concerns about difficulties in recruiting teachers in maths, science and technology subjects. These teacher shortages mean that maths classes are often taught by teachers without appropriate training. The Trends in International Mathematics and Science Study (TIMSS) is an international assessment of the mathematics and science achievement and learning environments of fourth and eighth grade students (Thomson, Wernert, Underwood & Nicholas, 2008). The 2002 TIMSS showed that 72% of Australian Year 4 students were taught by teachers without a major in science or maths (Martin, Mullis, Gonzelez, & Chrostowski, 2004). There is also a shortage of appropriately qualified maths teachers in Australian high schools, especially up until grade 10 (Ainley, Kos, & Nicholas, 2008; Thomson & Fleming, 2004). This shortage is likely to restrict the curriculum that can be offered (National Numeracy Review Report [NNRR], 2008) and teachers without specialised mathematics training are also unlikely to be perceived as enthusiastic role models (Lyons, Cooksey, Panizzon, Parnell, & Pegg, 2006). The lack of trained, high quality maths teachers suggests that it will be increasingly difficult to encourage students to engage in this field and subsequently maintain a high standard at the professional level (DEST, 2006; Harris, Jensz, & Baldwin, 2005; Rennie & Goodrum, 2007; Tytler, 2007).

The decrease in maths-skilled individuals is reflected in declining enrolments in relevant training over the past 20 years. Although overall participation in tertiary education has increased, the proportion of students graduating with maths, science, engineering and technology qualifications has decreased (see Ainley et al., 2008), with enrolments halving within some maths and physical science disciplines (Australian Bureau of Statistics [ABS], 2004; DEST, 2006). Dobson (2007) observed from 1989 to 2005 an approximate one third reduction in tertiary science students enrolled in maths. These trends are concerning because in 2003 only 0.4% of Australian university students graduated with qualifications in maths or statistics, compared with the OECD average of 1% (AAS, 2006).

How can we come to understand the difficulty in finding adults interested and skilled in maths? One major option is to consider what is happening in the pathways leading to these types of futures and high school is often a gateway to future maths-related study and participation. The skills shortage in the broader community is already reflected in maths participation amongst secondary students. Since the early 1990s, the proportion of Australian students enrolled in secondary science (Fullarton &

Ainley, 2000) and maths subjects has declined, particularly in advanced maths, chemistry and physics (Barrington, 2006; Dekkers & Malone, 2000; DEST, 2006; Fullarton, Walker, Ainley, & Hillman, 2003; Harris et al., 2005). Although the percentage of Australian Year 12 students enrolled in the physical sciences decreased from 1991 to 2007, this is part of a long-term trend of declines from 1976 (Ainley et al., 2008). Furthermore, a decreasing number of Year 12 students are choosing maths-based clusters of subjects (Fullarton et al., 2003). The decrease in Year 12 participation in advanced and intermediate courses has been matched by increased participation in low level maths (Barrington, 2006; Dekkers & Malone, 2000; NNRR, 2008). For example, 37% of Year 12 students were enrolled in low level maths in 1995 and this increased to 46% in 2004, while those taking advanced maths declined from 14% in 1995 to 12% in 2004, and intermediate from 27% in 1995 to 23% in 2004 (Barrington, 2006). Although this trend of opting for less challenging maths courses and avoiding multiple maths subjects may reflect increasing study choices for students, they may also indicate that students are expressing less enthusiasm to engage with mathematics than previously.

Gender trends in maths participation are also a concern because compared to boys, girls are under-represented in maths enrolments both during high school and university (Collins, Kenway, McLeod, 2000; Thomson, Cresswell, & De Bortoli, 2004). More than double the number of Year 12 boys tend to take maths and physical science subjects than girls (Collins et al., 2000; Fullarton et al., 2003). Furthermore, Year 12 male students are more likely than female students to enroll in advanced maths courses (Fullarton & Ainley, 2000) and the proportion of this gender difference did not change between 1990 and 2001 (Fullarton et al, 2003). This gender difference continues post-high school with more males than females enrolling in maths and science higher education courses (Forgasz & Leder, 2001). In 2006, females made up only 14% of Australian undergraduate enrolments in engineering (Ainley et al., 2008). Although few gender differences in average high school maths and science literacy have been found (Thomson et al., 2004), fewer females are pursuing science and maths-related tertiary courses (Forgasz & Leder, 2001; Thomson et al., 2004).

Consistent with these trends, higher education and industry groups have raised concerns about students' level of preparation for post high school study and employment. There are suggestions that many graduates are underprepared and not meeting basic numeracy skill requirements (DEST, 2006; Harris et al., 2005). Only advanced level high school maths involves the knowledge needed for tertiary courses such as engineering, physical or computer sciences (Fullarton et al., 2003). However, disciplines such as mathematics are sequential, and so mastering early skills is often needed to access further education and training (Singh, Granville, & Dika, 2002). Unfortunately, participation in less challenging secondary maths courses may limit students' post-high school options, as well as the level of training that undergraduate programs can provide (AAS, 2006).

A question that arises in response to declining maths participation is how do we encourage young adults to pursue an interest in maths? High school maths experiences may be crucial to addressing participation in maths-related fields after secondary school. The likelihood of enrolling in undergraduate science and maths courses is greater for those involved and successful in high school maths than those with less positive experiences (Ainley et al., 2008). However, although maths is a core discipline within the primary and secondary school curriculum, disproportionately few students pursue an interest in it beyond compulsory enrolment. This suggests that many students are failing to engage with maths in a meaningful and lasting way. Consequently, there are calls for a greater focus on stimulating participation during secondary school to better prepare mathematicians for the future (AAS, 2006; NNRR, 2008).

Contrary to popular assumptions, ability and achievement do not necessarily predict confidence or continuing involvement in learning activities (Dweck, 1986; Miserandino, 1996). The "Maths? Why Not?" report (McPhan, Morony, Pegg, Cooksy, & Lynch, 2008) surveyed maths teachers and career professionals about why they thought capable students do not take higher-level maths in senior secondary school. A range of factors were considered, such as timetable restrictions, course availability, career advice, ability beliefs, interest, parental expectations and gender stereotypes. The most important influences identified were ability perceptions, interest in maths, usefulness of maths, its perceived difficulty and previous achievement. Students' interpretations of events and themselves were identified as having the strongest effect on their reactions to learning. Consequently, there is a strong suggestion from those closely in contact with students that patterns in maths enrolment and career choices can be understood from a motivational perspective.

1.2 Defining Motivation and its Importance

Motivation is a broad term and clarification is needed to understand what taking a motivational perspective means. Motivation can be thought of as the focus, intensity, commitment and quality of one's thoughts and actions (Appleton, Christenson, Kim & Reschly, 2006; Maehr & Meyer, 1997; Singh et al., 2002). More specifically, motivation refers to the psychological processes underlying behaviour (DEST, 2005), while engagement describes the subsequent behaviours (DEST, 2005; Ryan, 2000). Both motivation and engagement are crucial for the learning process because they can produce valuable outcomes such as concentration and achievement, while an absence of them can produce failure which can have serious repercussions for a student's wellbeing and future opportunities. A motivational perspective considers the reasons as to why and how people act by addressing the beliefs and emotions that direct behaviour (Wentzel, 1999).

Understanding intention and behaviour mobilisation makes motivation in itself a fascinating and important phenomenon. While assisting learning, motivation also promotes purposeful behaviour, which leads to a personal sense of achievement and opportunities that people might not otherwise experience had they not 'had a go'. Humans can dedicate immense commitment and effort in all areas of life, such as relationships, sport, the arts and work that produce feelings of achievement, satisfaction, and success. However, these same contexts may also make others extremely apathetic or distressed, which can have extreme consequences for self-esteem, achievement, employment or relationships. Although motivation assists in developing skills, it is also important because it develops capacities that help individuals to live productive and rewarding lives (DEST, 2005).

Motivation and engagement are also important processes because engaging in productive work and feeling competent is associated with strong mental health (Bandura, 1997; Ryan & Deci, 2000a; 2000b; Smith, 2004; Taylor & Brown, 1988). For example, Kasser and Ryan (1996) found that placing importance on intrinsic aspirations is positively related to self esteem and inversely related to depression and anxiety. The positive value of having a sense of purpose is further supported by evidence suggesting that individuals without this drive are more likely to experience learned helplessness. Seligman (1975) describes learned helplessness as feeling one has no control over one's circumstances and choices. Those experiencing helplessness do not believe that their actions will increase their chances of a positive outcome. It is strongly associated with increased negative affect, such as anxiety, depression, low self-esteem (Rudolph, Lambert, Clark & Kurlakowsky, 2001) and deficits in motivation (Seligman, 1975). Consequently, exploring the nature of motivation is important because it promotes wellbeing by giving a sense of meaning and accomplishment to one's actions, which results in greater satisfaction with oneself. To promote both performance and wellbeing within maths, as well as in a range of other contexts, it is important then to understand what factors develop one's intentions to focus and invest effort and also which factors discourage such motives.

1.3 Interpersonal Relationships and School Adjustment

Central to individuals' wellbeing and functioning is the quality of their social environment. Individuals with better quality relationships tend to demonstrate greater stress coping, confidence and general life satisfaction than those with poor relationships (Armsden & Greenberg, 1987). As relationships are strongly linked to wellbeing, they may play an important role in contexts where resilience and goal directed behaviour are needed. Reflecting this realisation, an increasing emphasis is being applied to the relational context of the school environment. Adolescence is a period during which the social environment is very relevant to the attitudes, behaviours and choices individuals display. Furthermore, most adolescents (particularly young adolescents) report social acceptance as a more important school priority than academic competence (Bigelow & Zhou, 2001; Syngollitou & Daskalou, 2004). Consequently, relationships are central to adolescents' school adjustment. For this reason the quality of interpersonal relationships and their role in influencing students' orientation towards learning maths need to be considered in any attempt to fully understand motivation and engagement.

1.4 Significance of the Research

Motivation is an important concept to explore because it guides behaviour and helps us understand individuals' actions and choices. It can be a powerful process as on the one hand it can energise people to develop new ideas and skills whilst supporting a sense of wellbeing, whereas on the other hand an absence of it can produce apathy or even self-defeating behaviour. Relationships form a major part of student life (particularly for adolescents) and so relations with others within the school environment are also of great relevance to understanding students' orientation toward learning. The current shortage of maths-skilled individuals and the declining rates of maths participation make a study of mathematics motivation of potential value and relevance to our community. Indeed, a comprehensive analysis of students' motivational and interpersonal experiences in this subject seems warranted.

This research is based on the assumption that both motivation and interpersonal relationships are important factors in promoting maths participation. It is argued that motivation is a complex and multidimensional phenomenon, and that gender and developmental trends are best examined at the subject and construct specific level. It is also argued that students who feel a sense of affiliation with others are more ready to learn and constructively participate than students with less positive relationships with significant others.

This thesis extends research in the field of motivation and maths education contextually, conceptually and methodologically. Contextual considerations relate to addressing motivation with an Australian sample at a subject specific level and considering potential issues unique to grade and gender. Conceptual considerations relate to addressing a range of motivation constructs and the relative influence of a range of social partners, rather than a narrower subset of constructs. Methodological considerations suggest the use of a multi-group-multi-occasion design to evaluate longitudinal and cohort effects through structural equation modeling, as well as controlling for prior attainment when evaluating the influence of relationships. The potential significance of this study lies in comprehensively investigating and identifying the nature of maths motivation, its development across time and examining the social antecedents relevant during adolescence. Such knowledge has a real potential to improve student motivation and decrease disengagement with benefits for students' participation, achievement and wellbeing.

1.5 Overview of Dissertation

This thesis consists of two sections. It firstly presents a model of maths motivation through theoretical and empirical evaluations and then secondly, addresses the social context of maths motivation. The first study explores the nature of maths motivation, and then examines mean level ratings during high school according to grade and gender. The second study addresses the social antecedents of maths motivation by asking to what extent affiliation with parents, teachers and peers contribute to the development of each motivational facet.

Following from this introductory chapter, a review of relevant literature is presented which contextualizes Study 1 within the frameworks of academic motivation. Chapter 3 details the aims and method of Study 1, with the results then presented in Chapter 4. Chapter 5 discusses and evaluates the findings in relation to past research and theory on academic motivation, as well as gender and developmental trends. It also discusses in detail the associations and development of each motivational construct in relation to the core theories of academic motivation introduced in Chapter 2.

The second section of the thesis then begins in Chapter 6, which introduces literature addressing the social context of academic motivation and engagement, focusing on affiliation with significant others. Chapter 7 details the aims and method of Study 2, with the results presented in Chapter 8. Chapter 9 discusses and evaluates the results of Study 2 in relation to past research and theory on affiliation, academic motivation, the nature of social influence and the moderating role of gender.

The final chapter firstly summarises the main aims of the thesis and the methods used to address these research questions. Conclusions are then drawn based on studies 1 and 2, as well as the literature reviewed in chapters 2 and 6. The limitations of the research and directions for future research are also described.

Chapter 2
Theories of Academic Motivation and Development in Maths Motivation

2.1 Outline of Chapter 2

The first section of this thesis addresses the nature of maths motivation. It presents a multidimensional approach as the most helpful perspective in understanding students' orientation towards learning maths. This chapter firstly introduces the pivotal theories of academic motivation underlying most research over the past 20 years. Their core themes and constructs will be defined, as well as the behavioural outcomes that they aim to explain. The limitations of current theoretical approaches are then summarised and the Student Motivation and Engagement Wheel (the Wheel) is presented as a comprehensive model of academic engagement. Next, grade and gender trends in maths motivation are reviewed, with special attention given to longitudinal and Australian research. This then leads to a summary of the literature that identifies questions that have been overlooked and issues needing more attention.

2.2 Review of Core Theories of Academic Motivation

Motivation gives behaviour intention and meaning. Consequently, it is important because it helps explain how and why individuals may or may not approach tasks and situations. In casual conversation we may hear others speak of motivation as a uni-dimensional concept, that someone is either motivated or not motivated. However, people may choose to engage, or not to engage in a behaviour for a variety of reasons. For example, although two students may skip class, one may do so because of lack of interest and the other because they feel the work is too hard and not worth even attempting. Although their behaviour appears to be the same, they are driven by two very different attitudes towards school. As a result, explanations of someone's behaviour can be quite different, depending on the perspective from which their actions are viewed.

Not surprisingly then, research into academic motivation has stemmed from a wide range of perspectives and so a variety of theoretical viewpoints are currently active in the literature (see Eccles & Wigfield, 2002; Pintrich, 2003). Traditional behaviourists approach motivation as largely reflexive to the environment, with people driven to satisfy their needs by either receiving rewards or avoiding punishment. More recent approaches apply a cognitive perspective, stressing the mental processes shaping motivation. Cognitive approaches emphasise students as processors of information, with their beliefs and emotions being the main influences on behaviour (Geen, Beatty, & Arkin, 1984)**.** These perspectives tend to focus on constructs such as self-efficacy or perceptions of control in determining outcomes such as persistence, self-regulated learning and achievement (Ames, 1992; Bandura & Schunk, 1981). Despite the range of explanations, research on academic motivation has largely centered on several theories that reflect core dimensions of motivation. These theories will now be reviewed in relation to their central themes, as well as their cognitive and behavioural implications for academic engagement. Although the current research is primarily concerned with maths, the review of motivation theories addresses their general application to academic motivation, drawing on findings within maths when possible.

2.2a Need Achievement and Self-worth Theories

The Need Achievement and Self-worth theories suggest that student behaviour towards learning essentially reflects efforts to experience competency (Atkinson, 1957) and maintain a personal sense of worth (Covington, 1992). It is this fundamental goal of maintaining a positive self-perception of value that guides behaviour (Covington, 1992). Self-worth is an individual's affective response to their identity based on perceptions of performance or expected performance (Schunk, Pintrich & Meece, 2007). This is because the degree to which one accepts and values oneself is linked to one's demonstrated ability (Covington, 1992). When poor performance is experienced, there may be negative consequences for one's sense of self-worth because students may associate failure with low ability and low ability as reflecting their low personal value (Covington, 1992). Consequently, students have a need to strive for success and avoid failure (Atkinson, 1957).

Self-worth theory considers how students define success as determining which situations are perceived as threats to self-worth. Success-orientated students are mostly concerned with trying their best, making their self-worth closely associated with self-improvement. However, failure-orientated students define success as achieving and tend to evaluate their self-worth according to their performance relative to others (Atkinson, 1957; Covington, 2000). Covington (1992) suggests that in some students, the need to protect self-worth drives a fear of failure. This fear may stem from their own personal judgments of appropriate standards or be driven by concerns with others judgments, such as parents or classmates (Crocker & Wolfe, 2001). Failure-orientated students' focus on performance can lead them to act defensively by consciously or unconsciously applying strategies that avoid the implications of failure (Covington, 1992). This can include a strategy called defensive pessimism, in which students disregard the value of a task or set unrealistically low expectations to regulate feelings of anxiety that may arise if they were to invest any effort (see Covington, 2000). Covington (1992) described two types of students who are primarily driven to avoid threats to their self-worth. One group becomes passive work avoiders who accept failure and actively avoid self-worth threats by reducing effort or not participating in challenging tasks. The other group is failure avoidant because they strive to avoid being perceived as incompetent and subsequently put in extra effort to ensure achievement to avoid appearing 'stupid'.

Failure orientated students tend to have low academic confidence and are very anxious of being perceived as having low ability (Middleton & Midgley, 1997). Students with a high fear of failure tend to avoid tasks in which they feel unconfident and uncertain of success (Katz, 1967; Taylor & Brown, 1988). They may also avoid potentially negative information about themselves by reducing their preparation (Martin, Marsh & Debus, 2003; Tice & Baumeister, 1990) or procrastinating (Onwuegbuzie, 2004; Urdan, Midgley, & Anderman, 1998), so that these circumstances, rather than their lack of ability will be perceived as the cause if their performance is poor (Covington, 1992). Students who have a failure-avoidant approach are likely to experience burnout, negative affect and less intrinsic interest (Thompson, 1994). Consistent with this, protecting one's self-worth to the extent of having a fear of failure (whether this is failure-accepting or failure-avoidant) has negative relationships with self-regulation and academic achievement (Martin, Marsh, & Debus, 2001; Urdan et al., 1998; Midgley & Urdan, 2001). On the other hand, success-orientated students tend to show more optimism, challenge seeking, establish realistic learning objectives and report less anxiety regarding others' judgments, as well as their performance outcomes (Martin & Marsh, 2003). Consequently, students who experience the learning process as a threat to their self worth are likely to demonstrate a less adaptive approach towards school compared to those without a fear of failure who are willing to 'have a go'. According to the Need Achievement and Self-worth approaches then, feelings of anxiety are positively related to protective behaviours such as self-handicapping and failure avoidance, which are negatively related to adaptive facets of motivation such as competency beliefs, intrinsic interest and self-regulation.

2.2b Attribution and Control Theories

While self worth theory focuses on what students need, attribution and control theory extend this idea by considering how a positive self-view is maintained in the face of challenges. Attributions refer to students' beliefs about the causes of success or failure (Weiner, 1979, 1985, 1990) and these causal interpretations have consequences for students' subsequent cognition, affect and behaviour. These approaches argue that those who perceive some influence over outcomes are likely to engage in and persist during challenging tasks (Connell, 1985; Weiner, 1979, 1985). This is because a sense of control credits both failures and success to something manageable, thereby maintaining the belief that one's actions will improve chances of success (Weiner, 1985).

The need for attribution and control has emotional and behavioural implications because it influences students' responses to satisfaction and disappointment (Covington, 1992). Students anticipating success experience feelings of pride, which encourages success-orientated behaviour such as exerting more effort. Consequently, a student with a sense of control whose performance is poor may modify their behaviour to improve their likelihood of future success, such as studying more. If their preparation was low, they may also feel a sense of guilt or shame, which encourages them to try harder next time (Weiner, 1979). In this way, having a sense of control is adaptive because negative feedback may be perceived in an unthreatening manner (Taylor & Brown, 1988). A student who believes their efforts contribute to success is likely to feel satisfied and competent, with a greater sense of optimism, coping and confidence towards future tasks (Weiner, 1979). In contrast, students with low perceived control may interpret a poor performance as indicating low ability, which is beyond their personal control. Therefore an attribution of failure to low ability may trigger feelings of hopelessness and pessimism regarding success in the future. This negative orientation may lead to a helpless approach where a student is likely to avoid situations in which success is uncertain (Weiner, 1979). Also, because those who feel ineffective cannot rely on themselves to explain the causes of an outcome, such students tend to focus more heavily on external sources for feedback, such as the judgements of others (Connell, 1985).

Consistent with Weiner (1979, 1985) and Connell's (1985) suggestions, perceptions of causation and control have been linked with other achievement related cognitions and behaviour. Students with low perceived control tend to attribute success to luck, rather than effort because they do not recognise their role in achievement (Skinner, Wellborn, & Connell, 1990). They also tend to experience negative affect, such as boredom or anxiety (Dweck & Leggett, 1988) and in response are likely to engage in self-handicapping or avoid tasks (Skinner, 1996). Consequently, those that develop generalized assumptions of their inability to influence events are particularly vulnerable to learned helplessness (Garber, Weiss, & Shanley, 1993). In contrast, students with a high sense of control tend to report less boredom and anxiety, exert more persistence and participation, as well as self-monitoring strategies, such as study planning (Gordon, 1998; Patrick, Skinner, & Connell, 1993; Perry, Hladkyi, Pekrun, & Pelletier, 2001; Skinner, 1996; Skinner et al., 1990). For example, Skinner et al. (1990) found that a key factor for the most actively engaged primary school students was their belief that effort is important for school success. Associating effort with success and having a sense of control over outcomes has implications for behavioural engagement because a student is more likely to continue trying if they feel effective, rather than powerless. In this sense, perceptions of control should be positively related to self-regulation, feelings of competency and interest, while negatively associated with anxiety, disengagement and self-handicapping.

2.2c Self-efficacy Theory

A primary theme relating to processes of self-worth and control are feelings of competency. Students are more likely to feel a strong sense of self-worth and control towards tasks that they feel capable of achieving. Many competency beliefs, such as self-confidence, self-concept and success expectancies have been conceptualised in achievement research. However, Bandura's (1997) conceptualisation of self-efficacy is the most prevalent competency construct. Self-efficacy refers to beliefs about one's perceived ability to accomplish future tasks (Bandura, 1986; Bandura & Schunk, 1981). It is different from constructs such as self-esteem and self-concept because it is situation and task specific (Bandura, 1986; Klassen, 2004; Pajares, 1996). Self-esteem is a global measure and although self-concept is domain specific, it is not task specific (Bandura, 1981; De Fraine, Van Damme, & Onghena, 2007).

Central to self-efficacy theory is that competency beliefs are fundamental in exercising control and personal agency (Bandura, 1986). This is because motivation largely stems from beliefs about what we can do, which then generate perceptions and reactions to situations that guide strategies and courses of action (Bandura, 1986). Self-efficacy supports positive emotional development through enhanced coping abilities by regulating other cognitive and emotional processes such as stress, anxiety or depression (Bandura, 1986, 1993, 1997; Bandura & Schunk, 1981). Because a person with strong self-efficacy believes they are capable, they behave in a proactive manner represented by greater persistence, effort and optimism (Bandura, 1997; Smith, 2004). Bandura (1997) argues that because feelings of control are positively related to self-efficacy students with high self-efficacy are likely to perceive a challenging task as attainable and approach them calmly. However those with low self-efficacy may perceive challenges as risky, bringing about feelings of apprehension (Bandura, 1986, 1997). Furthermore, feelings of helplessness or sadness may develop when an unattainable outcome is also considered valuable. Consequently, students with low self-efficacy are more susceptible to achievement anxiety than those with strong self-efficacy and amotivation may develop if this is coupled with perceptions of low control over a valued outcome (Bandura, 1993).

Consistent with Bandura's argument, self-efficacy appears to be a driving force underlying adaptive motivation and achievement. The powerful influence of self-efficacy was demonstrated in Miserandino's (1996) study of above average ability Grade three and four students. Miserandino (1996) found that despite their actual high ability, students with low perceived ability reported more negative affect (such as anxiety and sadness) and disengagement (characterised by boredom, apathy and poor concentration) than those perceiving themselves as highly capable. Self-efficacy was also implicated in achievement as low self-efficacy predicted lower maths grades. Others have found self-efficacy to also positively associate with perceptions of maths as useful and mastery goals, as well as persistence, resilience, self-regulation and better performance (Bong, 2008; Gallagher & De Lisi, 1994; Kenney-Benson, Patrick, Pomerantz, & Ryan, 2006; Klassen, 2004; Martin & Marsh, 2003; Pajares, 1996; Pajares & Miller, 1994; Simpson, Licht, Wagner, & Stader, 1996). On the other hand, individuals with low perceived ability tend to have poor resilience during difficult tasks. They tend to become anxious, focus on their weaknesses and perceive situations as worse than they really are (Pajares, 1996; Patrick et al., 1993; Stader & Licht, 1992). Consequently, self-efficacy is negatively related to academic anxiety (Hackett, 1985), helplessness (Smiley & Dweck, 1994) and self-handicapping (Urdan et al., 1998). It links with processes of control and self-worth to negatively relate to maladaptive cognitions and behavioural disengagement and positively associate with adaptive beliefs and behaviours.

2.2d Expectancy-Value Theory

Self-efficacy has also been conceptualised in terms of expectancies, involving perceptions of ability and likelihood of success beliefs. These constructs combine to suggest that students who believe both that they are capable and that success is likely are more motivated than those that do not. In the Expectancy-Value Theory (EVT), Eccles and her colleagues (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000; Wigfield & Gutherie, 1997; Wigifeld et al., 1997; Wigfield & Meece, 1988; Wigfield, 1994) emphasise the interaction of these expectancies with the incentive values associated with a task in understanding motivation and predicting achievement behaviours. EVT argues that persistence, choices and performance can be explained by expectancies and the incentive value students attach to outcomes (Wigfield & Eccles, 2000).

Task values are an incentive for engaging in activities and reflect how an activity meets an individual's priorities (Wigfield & Eccles, 1992). Values may be driven by intrinsic interest or by external factors. Intrinsic valuing involves the enjoyment and liking of an activity and doing something because it is interesting (Lepper, Corpus, & Iyengar, 2005; Ryan & Deci, 2000b; Wigfield & Eccles, 1992). However, extrinsic values have external factors such as gaining rewards or avoiding punishment as an incentive. EVT presents three main types of extrinsically based values: utility, attainment and cost. Utility value relates to the usefulness of a task in achieving goals and attainment value reflects the personal importance of achieving (Eccles & Wigfield, 2002). Thirdly there is cost value, which refers to what an individual has to do or give up in order to complete a task (Eccles et al., 1983).

A substantial amount of research has applied one or more expectancy-value constructs when assessing motivation and found that they positively predict students' interest (Lopez, Brown, Lent, & Gore, 1997), effort (Wentzel, 1998), persistence (Feather, 1985; Wigfield & Eccles, 2000; Wigfield & Guthrie, 1997), achievement (Lepper et al., 2005; Pokey & Blumenfeld, 1990; Singh et al., 2002) and course enrolment (Durik, Vida, & Eccles, 2006; Hardre & Reeve, 2003). The important role of values in achievement was demonstrated longitudinally by Knesting and Waldron (2006) in a study of high school withdrawal. Knesting and Waldron (2006) identified grade seven to nine students at risk of dropping out of high school before graduation, as indicated by behavioural problems and poor academic performance. A key predictor of retention for these students was a belief that something positive would result from their effort and engagement. Although the particular incentives differed between students, overall the results were consistent with EVT, as those who valued school for some reason and also believed they could succeed were more likely to persist and remain enrolled.

When considered separately, expectancies and values appear to have different predictive outcomes. Longitudinal research indicates that values are more useful in predicting behavioural choices, such as course enrolment, whereas expectancy beliefs are more closely associated with the level of achievement within educational courses (Meece, Wigfield, & Eccles, 1990; Wigfield & Eccles, 1992). For example, Meece et al. (1990) looked at the influence of expectancies and values on the anxiety, achievement and course enrolment intentions of Grade 7 to 9 high school maths students. They found that performance expectancies predicted math grades, whilst students' values predicted their course enrolment intentions (Meece et al., 1990). These findings within the expectancy-value framework are particularly relevant to the current project because they indicate that multiple cognitive constructs need to be taken into account when assessing academic motivation and achievement behaviour.

2.2e Achievement Goals

The self-efficacy, control, and self-worth theories mainly focus on what students need. Goal orientation adds to the picture of academic motivation by conceptualising how the different reasons students may have for achieving are represented in different ways of approaching activities (Ames, 1992; Dweck & Leggett, 1988; Nichols, 1984). Achievement goals involve different beliefs, attributions and ways of processing information (Ames, 1992; Dweck & Leggett, 1988; Elliott & Dweck, 1988). Goals are hypothesised to be a main predictor of the level and quality of behavioural engagement (Anderman & Maehr, 1994) because they provide a standard by which students judge themselves and guide evaluations of their performance (Maehr, 2001). Although achievement goals have received different labels from various researchers, conceptually they consist of two comparable types. Elliott and Dweck (1988) name them learning and performance goals, Nichols and his colleagues (Maehr & Nicholls, 1980; Nicholls, 1984) refer to task and ego goals, while Ames (1992) uses the labels performance and mastery goals. Learning, mastery and task-involvement goals can be distinguished from performance and ego-involvement goals (Ames, 1992). The main theoretical difference between the goal theory approaches is that some consider them relatively stable because they are influenced by personal characteristics (Dweck & Leggett, 1988), whereas others such as Ames (1992) present goals as more contextually based and so they are more susceptible to environmental influences.

A mastery orientation largely reflects a desire to learn skills and achieve because feelings of personal satisfaction and competence are derived from learning (Ames, 1992). Consequently, a belief that effort and outcomes co-vary is essential to a mastery goal (Ames, 1992). Mastery goals are also more resilient to self-worth threats because performance is associated with effort rather than ability. On the other hand, performance goals represent a concern in receiving favourable judgments from oneself or others for achieving relative to others (Ames & Archer, 1988; Dweck & Legget, 1988; Elliott & Dweck, 1988; Wentzel, 1998). Consequently, achievement goal theory generally conceptualizes students as being primarily driven by either a desire to learn or a desire to achieve more than others. A more recent critique of this approach includes a third type of goal, involving an avoidance construct. Avoidant goals are when students strive to avoid demonstrating incompetence and failure (Elliot & Harackiewicz, 1996). Driven by a fear of failure they strive to avoid others perceiving them as 'stupid' or incapable (Middleton & Midgley, 1997). This may be achieved through either performance avoidance, avoiding challenging tasks, or failure avoidance, in which effort to achieve is made primarily to avoid negative judgments from others. Failure avoidance seems particularly relevant for high school students as adolescents often experience self-consciousness, as well as pressure from adults to achieve.

In support of the multidimensionality of goals, Middleton and Midgley (1997) found that performance, mastery and failure avoidant goals load on separate factors, indicating that they are unique constructs. In a study of sixth Grade students, they also found that failure avoidance negatively predicted self-efficacy and was positively associated with test anxiety (Middleton & Midgley, 1997). Compared to other goals, failure avoidant goals are associated with increased anxiety because students are pre-occupied with revealing a lack of ability (Elliot & Thrash, 2004; Middleton & Midgley, 1997). This fixation on demonstrating incompetency is also associated with self-handicapping, procrastination (Eliot et al., 2001; Urdan, 2004; Wolters, 2004), as well as lower persistence, help-seeking, (Elliot & Thrash, 2004) and achievement (Lau & Nie, 2008). Performance goals tend to be maladaptive because students with this orientation often associate effort and anxiety together. As a result, they may avoid challenging tasks or self-sabotage if they are uncertain of success (Ames, 1992; Covington, 1992; Dweck, 1986; Dweck & Leggett, 1988; Elliott & Dweck, 1988; Pintrich & Schunk, 1996; Urdan, 2004). In summary, avoidant goals are associated with negative cognitive, affective and achievement outcomes.

For mastery orientated students, the focus of attention is on the intrinsic value of learning (Ames, 1992; Dweck & Leggett, 1988) and it is commonly displayed through greater interest (Duda & Nicholls, 1992), effort, planning and persistence (Bandura & Schunk, 1981; Dweck & Legget, 1988; Lau & Nie, 2008; Wolters, 2004), as well as stronger competency and control beliefs (Middleton & Midgley, 1997; Shell, 2008). Mastery goals are also related to more adaptive help-seeking strategies and a preference for challenging work (Meece, Blumenfeld & Hoyle, 1988). Such students are less threatened by failure and are unlikely to engage in self-handicapping (Middleton & Midgley, 1997). Consequently, mastery goals are the ideal achievement goal because they are associated with stronger positive cognitive and behavioural orientations towards school compared to performance or avoidant goals.

2.2f Anxiety

Feelings of effectiveness, confidence and wellbeing, as well as values and goals, have been implicated in influencing the planning, persistence, and challenge seeking that students exert towards learning. These constructs represent theories largely concerned with the importance of maintaining positive perceptions of one's worth and competence during learning tasks. Importantly then, motivation includes adaptive coping strategies during challenges to manage stress and anxiety.

To some extent, all theories of motivation are concerned with students' reactions that avoid excessive feelings of stress because successful emotional regulation is crucial for adaptive coping (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). The self-worth, control and self-efficacy theories each suggest that failure to maintain a positive self-perception of competency and causal influence produces feelings of uncertainty and anxiety that have negative implications for engagement and achievement. If anxieties are left unaddressed, students may develop poor coping strategies such as self-handicapping or gradually disengage from the learning context associated with negative affective experiences. Although anxiety is one of the most common obstacles associated with learning maths (Baloğlu & Koçak, 2006), it is often overlooked and not explicitly included in multidimensional measures and models of academic motivation. This is surprising given that maths anxiety seems to be a common part of student life, as they may worry about upcoming exams, being asked questions in class or being perceived as 'stupid'.

Academic anxiety refers to much more than a lack of self-belief. It involves negative affective and cognitive reactions, with feelings of nervousness and tension, as well as self-deprecatory thoughts (Wigfield & Meece, 1988). Anxiety is an important construct because it is consistently associated with maladaptive behaviours such as failure avoidance (Martin, 2002a), self-handicapping (Thompson & Richardson, 2001), procrastination (Schraw, Olafson, & Wadkins, 2007), poor self-regulation (Wolters & Pintrich, 1998) and also poor grades (Betz, 1978; Fennema & Sherman, 1976). However, it is an interesting construct because a certain level of anxiety also facilitates performance (Meece et al., 1990; Stevens, Olivarez, & Hamman, 2006) and is associated with increased planning, study management and learning values (Hunsley, 1987; Martin, 2003a, 2007b; Meece et al., 1990).

Within the context of self-efficacy theory, Bandura (1986; 1993; 1997) argues that anxiety results when individuals perceive a lack of control over a potentially negative outcome because of low self-efficacy. Consequently, those with stronger competence beliefs are likely to have lower anxiety levels when confronted with a challenge than those with poor self-efficacy. While self-efficacy appears to play a role in anxiety, values are also relevant in its development. Meece et al. (1990) found that high school students' maths anxiety was negatively predicted by their importance values, as well as their expectancies for success. However, their measure of maths anxiety assessed only the affective dimension of this construct. In another study, Wigfield and Meece (1988) addressed both the affective and cognitive aspects of maths motivation. Consistent with Meece et al. (1990) negative affect was negatively associated with interest, importance and usefulness values, as well as ability beliefs. In contrast, the cognitive factor showed positive associations with maths values and a weaker negative relationship with ability beliefs. Consequently, maths anxiety is complex and its implications may depend on which facet is under the spotlight. Nevertheless, in an older sample of psychology university students, Hunsley (1987) found that maths anxious students reported lower ratings of preparedness, expected lower grades and felt less satisfaction with their performance compared to students low in anxiety. This tendency for maths-anxious students to have pessimistic self-appraisals is likely to have negative consequences for their behavioural engagement because negative evaluations are associated with poor coping styles such as avoidance or self-handicapping, rather than increased effort. Considering the emphasis put on grades and test results in high school, particularly as students progress towards senior grades, a measure of maths motivation should include an assessment of students' anxiety to gauge to what extent their behaviours are driven by stress.

2.3 Behavioural Outcomes

The motivational theories that have been reviewed all concern cognitive and affective processes that encourage behavioural engagement and discourage maladaptive approaches to learning. The next section will briefly review the three key behavioural outcomes that motivational theories tend to address: self-regulation, self-handicapping and disengagement.

2.3a Self-Regulation

In combination, the core theories of academic motivation suggest that adaptive motivation involves effective learning and problem solving strategies (Garner, 1990) that promote the attainment of challenging and valued goals (Dweck, 1986). In other words, adaptive attitudes towards learning should lead to self-regulated behaviour. Self-regulation is when students actively promote their learning (Zimmerman, 1986). It concerns the effort that students expend towards monitoring, planning and improving their learning (Carr, Borkowski & Maxwell, 1991; Zimmerman & Martinez-Pons, 1990). Zimmerman (1994) describes self-regulation as consisting of three 'how, what and where' dimensions. The 'how' aspect refers to students' cognitive methods for learning, such as elaboration or rehearsal to improve their memory. The 'what' aspect involves efforts to regulate their own behaviour to encourage a good outcome, such as organising and planning their study timetable. The third dimension is 'where' and this is students' environmental management to ensure optimal learning opportunities. This may include the social or physical environment, such as seeking positive role models or selecting an appropriate space in which to study. Generally though, self-regulation includes a range of behaviours such as organising and establishing a good study environment (DiPerna, 2006), memorization techniques, persistence and help-seeking (Pokay & Blumenfeld, 1990).

Zimmerman (1989) suggests that self-regulation strategies are particularly linked with self-efficacy and that these processes interact in a reciprocal manner. Self-regulation is an essential part of academic motivation because students need behavioural engagement to learn and practice new skills. For example, Wolters and Pintrich (1998) found that interest and value beliefs tend to encourage a student choose to become involved in a task, but once involved self-regulation behaviours and adaptive efficacy beliefs were more important in predicting students' performance. Consequently, self-regulation has a facilitative role in achievement because a student with adaptive cognitions also requires some level of persistence and study skills if they are to develop and apply their knowledge.

2.3b Self-Handicapping

In contrast to self-regulation, as suggested by the self-worth, control and goal orientation theories, students commonly manage their anxieties regarding potential failure through self-handicapping or disengaging from tasks altogether. While there may be several different possible reasons for self-handicapping, its consequences for subsequent performance and participation may be serious. Although some research has suggested that self-handicapping has initial benefits of minimizing the impact of failure (Deppe & Harackiewicz, 1996), others have found that it increases the likelihood of failure, as well as negative affect and attitudes towards learning, characterised by anxiety, poor control, mastery orientation, self-efficacy and low achievement (Martin et al., 2001, 2003; Midgley et al, 1996; Midgley & Urdan, 2001;

Schraw et al. 2007; Urdan et al., 1998). Martin et al. (2001, 2003) looked at the relationship between self-handicapping and various predictors based on self-worth theory. Both studies found that university students' mastery goals negatively predicted their self-handicapping, while performance goals positively predicted self-handicapping. However, while Martin et al. (2001) found that uncertain control was significantly related to self-handicapping, Martin et al. (2003) found no significant relationship between these factors. Nevertheless, both studies showed self-handicapping as negatively associated with persistence, participation, as well as organising one's timetable and study environment (Martin et al., 2001, 2003). Students high in self-handicapping also received lower end-of-year grades and were less likely to be enrolled one year later than did students less inclined to self-handicap (Martin et al., 2001).

2.3c Disengagement

A major concern of educators and parents is how to maintain students' connection with learning. Whilst self-handicapping reflects efforts to protect self-worth, it does not mean that students have lost all incentive to try as it is associated with contextual control and success expectancies. However, disengagement reflects a serious withdrawal from the learning process because students lack the intention to act. This may because the learning material holds no incentive value or disengagement may reflect a more serious combination of self-depreciatory cognitions. Amotivation is hypothesised by some to be associated with poor competency beliefs and an external locus of control (Bandura, 1986; 1997; Deci & Ryan, 2000). As a result, disengaged students become failure accepting and no longer strive to experience achievement or protect their self-worth. This reflects the emotional and cognitive state that has been termed helplessness (Abramson, Seligman & Teasdale, 1978; Seligman, 1975) in which individuals behave helplessly, even when the opportunity for achievement is possible. Seligman (1975) argues that once outcomes are perceived as uncontrollable, this acceptance inhibits an individual's coping mechanisms and they tend to experience depression. In this sense disengagement is similar to helplessness, as students who have lost all hope that they can succeed tend to experience negative affect towards learning and give up trying (Otis, Grouzet, & Pelletier, 2005). Consequently, amotivation, is particularly concerning because its feelings of boredom or frustration can lead to underachievement and even course or school dropout.

2.3d Summary of Behavioural Outcomes

Although strategies such as self-handicapping and avoidance may initially reduce stress levels, in the long-term they are maladaptive coping styles because withdrawing effort right when it is needed is likely to result in lower performance and participation. Constructs such as values, competency and control beliefs are useful in conveying how a student is feeling and their likelihood of engaging in self-regulation. However, they do not necessarily reflect how students behaviourally operationalise maladaptive cognitions, such as anxiety or a fear of failure. Consequently, in view of the decreasing rates of maths participation and girls' avoidance of maths, measures of amotivation, self-handicapping and self-regulation are crucial to include in a study of maths motivation and engagement.

2.4 Shortcomings of Current Theoretical Approaches

Although the motivational theories reviewed contribute a valuable understanding of the factors encouraging and impeding academic achievement, they do have shortcomings. Of primary concern is that they are each limited in the range of motivational processes they consider. For example, although EVT helps in understanding the likelihood of putting in effort, it does not address why students may develop a fear of failure. Although self-worth theory does offer such an explanation, it does not explicitly address the role of incentive values. Another limitation of motivational theories is that they share many overlapping constructs and it is not always clear how they differentiate from each other. It could be argued that a mastery goal orientation is conceptually very similar to intrinsic interest, as Murphy and Alexander (2000) observe that students with mastery goals are highly likely to show intrinsic interest. Similarly, failure avoidance within achievement goal theory stems from concerns about protecting self-worth. As both approaches address a fear of failure, there is theoretical and practical overlap between the achievement goal and self-worth theories. Consequently, academic performance is better predicted by a combination of constructs rather than a singular approach and by an approach that identifies the overlap between constructs, as well as the unique aspects each theory contributes.

The numerous theoretical perspectives have not resulted in a comprehensive model of academic motivation. Although there are many studies testing specific relationships between a subset of constructs, these rarely provide a clarification of their processes within larger theoretical frameworks (Schunk, 2000). Consequently, no particular model conveys a comprehensive picture of academic motivation (Bong, 1996). This means that interpreting motivational research is often difficult and fragmented because the constructs measured and their labels vary greatly between studies. One study may apply a self-efficacy approach to predicting persistence, while another focuses on control in predicting 'self-regulation', although both studies may be broadly described as studying the influence of cognitions on effort.

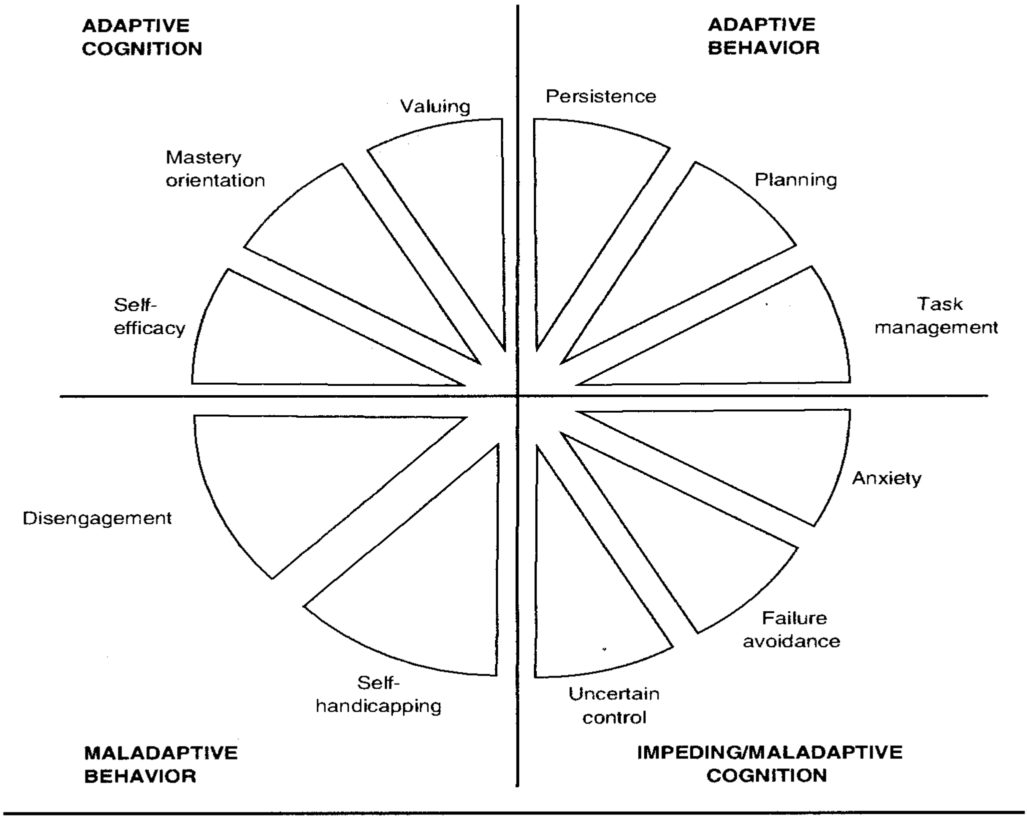
An inclusive picture of student motivation would address a range of experiences and perceptions. Rather than considering each theory in isolation, it may be useful to combine the core principles they elucidate and investigate how they relate to each other. Generally, the theories do not appear to be in conflict with each other, instead they each seem to contribute important parts to painting the full picture of motivation. Instead of students being either 'motivated' or 'unmotivated', they may simultaneously hold different attitudes and behaviours to varying degrees. Consequently, the development of a general model appears possible. Integrating the theories has the practical benefit of assisting researchers and educators in locating specific processes promoting or impeding a student's motivation, as low grades may reflect for example, poor self-efficacy, perceived usefulness of school, high anxiety, or a combination of these factors (Lepper et al., 2005). Motivation is much more complex than previously assumed and research needs to acknowledge this complexity.

2.5 The Student Motivation and Engagement Wheel

Recognising these concerns, Martin (2001, 2003a) argues that students display many attitudes and behaviours towards learning and that simply assessing one of them does not necessarily reflect their overall style or level of motivation. Martin (2003a) argues that a multidimensional measure of motivation that includes a range of theoretical approaches is more useful and practical in assisting students and educators than a singular approach. Consequently, he has developed the Student Motivation and Engagement Wheel (the Wheel) that draws on the core themes of the major theories to reflect the complexity of academic motivation. This model that addresses multiple cognitive and behavioural dimensions may provide a more useful picture of how and why students think and behave in certain ways towards school and learning than is otherwise currently available.

The Wheel is presented at two levels by which it can be interpreted. At the higher-order level there are four factors comprised of adaptive cognitions, adaptive behaviours, impeding cognitions and maladaptive behaviours (see Figure 1). The allocation of constructs to the higher-order factors is based on Martin's (2001, 2003a, 2007b) observation that many theories and models of motivation share a distinction of cognitions versus behaviour, as well as adaptive versus maladaptive engagement. The lower-order structure of the Wheel incorporates 11 attitudinal and behavioural components that may encourage or impede academic achievement. These constructs stem from key theories of academic motivation including self-efficacy (Bandura, 1997), EVT (Wigfield & Eccles, 2000), goal orientation (Ames, 1992; Elliott & Dweck, 1988; Nichols, 1984), self-worth (Covington, 1992), control (Connell, 1985) and attribution (Weiner, 1985) theories. The lower-order constructs are self-efficacy, valuing, mastery orientation, planning, task management, persistence, anxiety, failure avoidance, uncertain control, self-handicapping and disengagement. Martin's conceptualisation provides a logical and practical integration of the core theories and the overall structure of academic motivation. The higher-order allows a concise understanding of academic motivation, which can be easily understood and applied. However, the lower-order factors provide a more detailed and multidimensional picture of the learning experience. By assessing constructs reflecting strong motivation as well as those reflecting poor motivation, this approach offers the benefit of identifying both the strengths and weaknesses of a student's academic engagement.

The Wheel is operationalised in a measure, named the Motivation and Engagement Scale-High School (MES-HS) which taps all 11 facets in a self-report questionnaire (Martin, 2007b). Research (Martin, 2001, 2003a, 2003b, 2004, & 2007b) with this instrument demonstrates its reliability and supports its factor structure and construct validity. Furthermore, this scale has shown measurement invariance across gender at both the lower-order (Martin, 2004) and higher-order level (Martin, 2007b, 2009). It has also shown invariance with different age groups across secondary school (Martin, 2007b), as well as across elementary, high school and university students (Martin, 2009). Martin (2001, 2003a, 2003b, 2007b) has also found that gender and grade differences may exist for some constructs and not others.



Source: Martin (2003c)
Figure 1. The Student Motivation and Engagement Wheel

Most research with the MES-HS has been concerned with general academic motivation. Overall, these studies have shown that middle high school students (those in Grades 9 and 10) tend to show less adaptive motivation than junior (Grade 7 and 8) and senior (Grades 11 and 12) students. More specifically, middle high school students tend to score lower on adaptive behaviours and cognitions than junior and senior high school students (Martin, 2003a, 2003b, 2007b). However, senior students tend to report the most academic anxiety (Martin, 2003a, 2003b, 2007b), whereas junior high school students report less control over outcomes and higher failure avoidance than middle and senior students (Martin, 2003a, 2003b). Although younger grades tend to report more self-handicapping, senior grades are the most disengaged (Martin, 2007b). In terms of gender differences, girls tend to report stronger valuing of school, mastery orientation, planning, task management and persistence on the MES-HS, but also more anxiety, while boys report more self-handicapping (Martin, 2003a, 2003b, 2004, 2007b). Main effects for gender in self-belief, uncertain control and failure avoidance have generally not been found with this scale (Martin, 2001, 2003a, 2003b, 2004, 2007b). Furthermore, although both genders show decreases in self-belief, valuing and mastery goals across grades until middle high school, Martin (2003b) found only girls' motivation improved in later grades. In relation to general academic motivation this multidimensional approach reveals that not all grade changes are necessarily detrimental and that gender differences are complex.

2.6 Motivation is Subject Specific

Although research on general academic motivation is important, students study multiple subjects and are often positive and interested in achieving in one subject but not another (Bong, 2001; Simpson et al., 1996). Consequently, there is a new movement to address motivational processes within subject-specific contexts (Anderman, 2004). Self-concept research by Marsh and his colleagues (Marsh, Byrne, & Shavelson, 1988; Marsh, 1989, 1990) has found that students' academic self-concept is multifaceted. Self-concept involves individuals' general evaluations of their ability or likelihood of performing well in a given domain (Skaalvik, 1990). Marsh (1990) and Marsh et al. (1988) argue that although subject-specific self-concepts are related to each other, they are unique constructs that are best measured separately rather than as a general, singular construct. Furthermore, whilst gender and grade differences exist for particular facets of motivation, they also vary across subjects (Jacobs, Lanza, Osgood, Eccles & Wentzel, 2002; Skaalvik, 1990). For example, Jacobs et al. (2002) found gender differences in students' competency beliefs for language but not mathematics. The need for subject-specificity is also important in understanding grade trends, as mean level changes across time may differ between subjects (Wigfield et al., 1997).

The subject specificity of the MES-HS was tested by Green, Martin and Marsh (2007) in a sample of Australian high school students from metropolitan areas. They found moderate support for the domain specificity of motivation across maths, science and English. However, some constructs were more subject specific than others. Between subject correlations for valuing were comparatively low compared to the between subject correlations for task management and anxiety. The authors suggest that this may be because some cognitions are more reflective of general tendencies, whereas others such as utility values may be more context specific. The subject specific approach supports Marsh's (1990) recommendation that researchers interested in particular school disciplines should apply measures specific to those subjects. Consequently, the accuracy of mathematics motivation assessment and intervention should be improved by addressing students' attitudes and engagement with a scale addressing this particular context (Bong, 2001; Martin, 2001).

2.7 Gender and Developmental Trends in Mathematics Motivation

As discussed in Chapter 1, maths motivation deserves a particular focus because participation in maths orientated educational courses and careers are declining. Fewer students are choosing to study maths, particularly advanced courses. Furthermore, despite few mean differences between boys and girls in maths literacy, girls are under-represented in maths-related study and careers. In response to these trends, research has looked towards mathematics motivation for an explanation.

2.7a Developmental Trends in Mathematics Motivation

Research on developmental trends generally shows a decline in mathematics motivation from primary to middle high school, particularly after the transition to high school (Anderman & Midgley, 1997; Jacobs et al., 2002; Eccles, Adler, & Meece, 1984; Eccles et al., 1983; Marsh, 1989; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991; Wigfield et al., 1997). Although much research on maths motivation has involved primary aged children (Chouinard & Roy, 2008; Murphy & Alexander, 2000), those with older participants also tend to observe a decline across the school years (Fredricks & Eccles, 2002; Jacobs et al., 2002). These declines include ratings of competency beliefs, the usefulness, importance and liking of mathematics (Anderman & Midlgey, 1997; Fredricks & Eccles, 2002; Gottfried, Fleming, & Gottfried, 2001; Jacobs et al., 2002; Mason, 2003; Otis et al., 2005; Watt, 2004; Wigfield et al., 1991; Wigfield et al., 1997), coinciding with increased ratings of maths anxiety (Ma & Cartwright, 2003; Wigfield & Meece, 1988). For example, Wigfield et al. (1997) found that students' ability beliefs for maths declined across the elementary grades. Although these declines continued into middle high school, they were largest directly after the transition into junior high school. This highlights that beginning high school may be a delicate period for students' maths competency beliefs. Declining maths motivation during early adolescence is concerning because this is when the skills for more sophisticated thinking in this discipline should be developing.

Decreasing motivation into mid high school is also problematic because the middle years are the period of compulsory education during which attitudes consolidate and students make decisions about what they will and will not later pursue (Tytler, 2007). Whilst the transition to high school is important, motivation throughout high school has been comparatively understudied. Those following students through middle high school have found a mixed pattern of results, with some studies indicating a continuing decline (Wigfield & Eccles, 2000), whereas others report a slight rise in indicators of mathematics motivation towards senior high school (Fredricks & Eccles, 2002; Gottfried et al., 2001; Marsh, 1989). Fredricks and Eccles (2002) found that while ratings of maths importance declined from 1st to 12th grade overall, this decline slowed after early high school and then ratings of importance increased slightly from Grade 10. However, they also found that maths interest decreased steadily over the school years, although slowing during high school. In support of a curvilinear trend, Wigfield and Meece (1988) observed an inverted u-shape as 9th Grade students reported the most maths anxiety, which was experienced as excessive worrying, while Grade 6 students reported the least across the school grades. In summary, despite research showing that expectancy-value constructs tend to decline, especially after the transition to high school, there is evidence that this decline may slow or begin to recover after mid-high school.

Others have found increases in negative affect during the senior high school years (Wigfield & Meece, 1988; Smith, 2004), as well as decreases in adaptive beliefs. The later years of high school are often considered the most important by students and adults because they hold key implications for students' post-school education and employment opportunities. Consequently, senior high school may involve increased negative affect compared to earlier grades (Smith, 2004). For Australian students, Grade 10 is usually the last year of compulsory mathematics enrolment. Those with negative feelings towards maths may opt for a less-challenging stream or withdraw during the senior grades. However, underachievement in this area may detrimentally influence students' future study or work opportunities, as well as their personal sense of satisfaction and wellbeing. Consequently, it is essential that a focus remains on encouraging adaptive motivation throughout high school, rather than only during the elementary years and transition to junior high school.

2.7b Gender Trends in Mathematics Motivation

While mathematics is associated with developmental trends, educators and industry groups have also raised concerns about gender differences (Collins et al., 2000; Gallagher & De Lisi, 1994; Rowe & Rowe, 2002). Although a closer look at maths motivation helps us understand these differences, as with grade trends much research is based on single theoretical approaches. Consequently, findings on gender differences in mathematics motivation are fairly inconsistent (Skaalvik, 1990) and they depend on the particular construct being tested. When gender differences do arise however, they tend to reflect gender stereotypes with boys reporting stronger maths self-belief than girls (Chouinard, Karsenti, & Roy, 2007; Eccles et al., 1983, Jacobs et al., 2002; Stipek & Gralinski, 1991; Wigfield et al., 1991), maths self-concept (Marsh et al., 1988; Skaalvik & Skaalvik, 2004) and usefulness (Forgasz, 1995), while girls report more anxiety (Chapell et al., 2005; Frenzel, Pekrun, & Goetz, 2007; Llabre & Suarez, 1985; Pajares & Miller, 1994; Watt, 2004; Wolters, Yu & Pintrich, 1996) as well as mastery goals (Ablard & Lipschultz, 1998; Chouinard et al., 2007; Kenny-Benson et al., 2006; Watt, 2004) and effort than boys (Chouinard et al., 2007). There have also been reports that boys may be more likely to engage in self-handicapping than girls (Urdan et al., 1998). However, other studies find no gender differences in maths motivation, particularly in maths values (Anderman & Midgley, 1997; Greene, DeBacker, Ravindran, and Krows, 1999). The inconsistent findings may arise because different facets of motivation are studied, as well as different age groups.

However, the most consistent gender effect reported is that girls tend to express more maths anxiety than boys. Some have suggested that gender differences in maths course enrolments are driven by gender differences in experiences of negative affect towards maths (Fennema & Sherman, 1978; Meece, Eccles, Kaczala, Goff, & Futterman, 1982). Girls' maths anxiety has been shown to increase at a faster rate than boys' during high school (Ma & Cartwright; 2003) and mean level differences are also found in university populations (Llabre & Suarez, 1985; Pajares & Miller, 1994). As a result, anxiety may be central to women's avoidance of mathematics fields. However, Greene et al. (1999) found that despite Year 12 female students reporting greater maths anxiety, they did not report greater avoidance behaviours, such as self-handicapping. Consequently, while girls may report more anxiety than boys, the consequences of this for other facets of motivation are not well understood.

Demonstrating the multidimensionality of motivation, gender differences in maths anxiety may be related to competency and control beliefs. In a study of negative maths affect, Stipek and Gralinski (1991) applied an attribution theory approach and found that while boys tended to associate success as reflecting their ability, girls were less likely to perceive their own ability as enabling them to succeed. Furthermore, after failure girls tended to report more negative affect and a greater concern than boys about public humiliation, such as shame. Some argue that it is specifically evaluative situations in which females experience greater anxiety than males (Baloğlu & Koçak, 2006). Gender differences in maths anxiety may reflect a tendency for girls to internalise academic failure and make self-derogating attributions more than boys, who tend to use a self-enhancing pattern (see Georgiou, 1999). This may lead to different implications of anxiety for boys and girls. Perhaps anxiety initially produces more effort and self-regulation for females because they attribute their success to effort rather than ability. However, boys' self-enhancing drive may bring about self-handicapping behaviours if success is uncertain. As a result, girls' fear may be more based in shame, whereas that of boys' is in failure. For example, boys are more reluctant than girls to learn or try new things when they are uncertain of success, particularly if previous attempts have been unsuccessful (Ludowyke & Scanlon, 1997). Consistent with this, D'Aily (2004) found that the relationship between self-efficacy and task interest was stronger for boys than girls. This suggests that when boys are showing interest in something it may be more of an ability-based response than girls. As anxiety rarely shows direct relationships with performance, a closer look is needed at its relationships with other facets of motivation to understand its role in gender maths participation trends.

2.8 Longitudinal Research on Gender Differences in Maths Motivation

There is also a need to look at gender trends across time. Inconsistencies in gender differences may reflect interactions between gender and grade that are not accurately identified in cross-sectional analyses. It is possible that few gender differences in maths beliefs are found in primary school, with differences emerging in late elementary school or early high school. For example, there is some evidence that boys begin to feel more academically confident than girls in early high school (Meece et al., 1982; Pintrich & De Groot (1990). However, only a few studies have addressed the developmental trajectory of maths motivation within a multidimensional framework. There have been three key longitudinal studies from Northern America addressing maths motivation of high school students. Two use the same data set and involve U.S students (Fredricks & Eccles, 2002; Jacobs et al., 2002) and the third is a more recent Canadian study (Chouinard & Roy, 2008). Each of these studies applied an expectancy-value framework and the third also included an achievement goals approach.

Fredricks and Eccles (2002) and Jacobs et al. (2002) tracked the maths competency and value beliefs of students from grades 1 to 12. Jacobs et al. (2002) found that maths competency beliefs decreased steadily across grades. Although boys in elementary grades reported more maths competency than girls, ratings of these beliefs decreased more steeply than girls. This meant that while boys reported stronger maths competency in primary school, by high school their ratings were not significantly different. Jacobs et al. (2002) used a global measure of values comprised of importance, intrinsic interest and utility values. They found decreases in maths value beliefs across grades 1 to 12 and no gender differences in their mean ratings or rates of change. Furthermore, Jacobs et al. (2002) also found that ability beliefs predicted the change in valuing beliefs. Using the same data set as Jacobs et al. (2002), Fredricks and Eccles (2002) tested ability, interest and importance beliefs as separate constructs. They found no overall gender differences in ratings of competency or value beliefs and both types of value beliefs showed negative trends. However, maths interest declined steadily, whereas importance beliefs showed a quadratic trend, increasing slightly after Grade 10. There were no gender differences across time, as importance and interest ratings declined for both genders in a similar way across the school years. Overall, both studies showed that competency and expectancy beliefs declined across high school. However, Jacobs et al.'s (2002) use of a global measure of maths values appeared to mask the curvilinear trend found by Fredricks and Eccles (2002) for importance beliefs. This highlights the need for a multidimensional approach to fully understand trends in maths motivation.

With a sample of French-Canadian high school students, Chouinard and Roy (2008) looked at changes in maths expectancy, value and goal constructs across grades 7 to 11 in a cohort-sequential design. In contrast to those claiming that girls have a stronger decrease in adaptive motivation (Watt, 2004), consistent with Jacobs et al., (2002), Chouinard and Roy (2008) found that boys experienced a greater decrease in maths motivation during high school. Although there was no main grade effect for competency beliefs, there was an interaction with gender. Boys began with higher competency beliefs than girls in year 7 but did not show a difference in later grades. This is because girls' maths competency beliefs remained stable and even increased slightly after Grade 9, whilst that of boys decreased across grades resulting in similar ratings in the later grades. Chouinard and Roy (2008) did observe an overall grade decline for maths utility value and mastery interest, which was accentuated between grades 9 and 11. Furthermore, the decrease in utility values was more pronounced for males, while overall girls reported a stronger mastery orientation than boys. Neither performance nor work avoidance goals showed significant changes across time. Chouinard and Roy (2008) concluded that boys tend to experience a greater decrease in motivation than girls, with girls in later high school showing more positive attitudes towards maths. Highlighting the importance of longitudinal research that lasts beyond the transition to high school, Chouinard and Roy (2008) demonstrated that students' maths values became particularly negative after Grade 9 and during the later years of high school boys' motivation may be particularly vulnerable.

In summary, these three longitudinal studies found that boys' ability beliefs decreased more rapidly than girls'. Fredricks and Eccles (2002) and Jacobs et al (2002) found this trend in primary aged students, while Chouinard and Roy (2008) also observed it with high school students. Although the former two studies found no gender differences in valuing maths, Chouinard and Roy (2008) found boys reported lower maths mastery and utility valuing than girls. Nevertheless, overall these studies confirmed cross-sectional findings that maths motivation becomes more negative as students progress through high school and that in some facets girls may show more adaptive maths motivation than boys. Although, Chouinard and Roy (2008) found no declines in competency beliefs, each study found maths values were problematic. In support of a multidimensional approach they suggest that utility values and intrinsic interest decline steadily, while importance beliefs may show some improvement after mid-high school.

2.9 The Australian Context

Research addressing the development of maths motivation mostly comes from North America. Despite declining involvement in maths education and employment in Australia, there is comparatively little longitudinal Australian research on mathematics motivation. Although research from other countries is very valuable in offering an understanding of motivation and how different constructs may change and relate to each other, it should not be assumed that the experience of Australian students is identical to that of students in other countries. Students' experiences should be considered within their cultural context, as Australia has a different school system and curriculum structure. In the U.S, students generally attend an elementary school from 1st Grade to 6th grade, then a middle school for Grades seven to nine, with high school including Grades 10 to 12. In Australia, generally primary school includes grades 1 to 6 and high school covers grades 7 to 12. In the Australian New South Wales (NSW) educational system, Grades 7 and 8 are focused largely on strengthening material learnt in primary school (Watt, 2004). Then in grades 9 and 10 students are streamed into ability levels, and in the senior grades students can choose if they study maths and at which level (Watt, 2004). This context is likely to influence how students approach mathematics and an understanding of students in the Australian school system is needed.

Watt (2004) performed a longitudinal study with Australian high school maths students within an expectancy-value framework consistent with previous longitudinal research (Jacobs et al., 2002; Fredricks & Eccles, 2002). In a cohort-sequential design including grades 7 to 11, students' ability and value beliefs were tracked and an overall decrease in beliefs was expected. Watt (2004) found that across these grades, expectancies and values decreased, with the transitions into Grades 7 and Grade 11 showing the strongest negative effects. Consistent with Chouinard and Roy (2008), this indicates that students felt less positive about maths at both the transition to high school and the transition to senior high. Similar to Fredricks and Eccles (2002), there was a steep decline in intrinsic values during the junior grades of high school, which then plateaued in senior grades. However, utility values showed an increased decline in later grades, which is concerning because this period is when students may make decisions about which disciplines or careers they would like to pursue post high school. In relation to gender Watt (2004) found that overall, boys showed more adaptive maths motivation than girls. This was characterised by stronger competency beliefs and intrinsic interest than girls across all grades. However, there was no gender difference for utility values. Watt (2004) also found that gender differences in the Australian sample changed with time. During the middle grades (Grades 8 to 10), girls perceived maths as more difficult and needing more effort than boys. Whilst boys' success expectancies remained relatively stable, girls' showed a curvilinear pattern declining through junior high, and then recovering slightly in senior grades. Watt (2004) concluded that developmental changes in expectancies and values were negative through secondary school, particularly for utility valuing. Although gender differences favoured boys overall, Watt (2004) found that girls showed stronger declines than boys in earlier grades, while boys tended to have negative changes later in high school. Consequently, she suggests retaining a focus on girls' academic wellbeing while looking out for boys who may be most at risk during high school.

Watt's (2004) study is valuable because it showed that Australian high school students also report negative trends in maths expectancy-value constructs and it identified possible gender trends. However, the sample population were from Northern Sydney, consisting of an upper-middle class socio-economic group. This is a comparatively privileged population within a metropolitan area. Consequently, it is uncertain how well the results generalise to other Australian students, such as those living in a more rural or lower socio-economic setting. Country-wide trends indicating a low proportion of teachers trained in mathematics and dropping student enrolments are magnified in regional and rural areas (MCEETYA, 2003). Consequently, a major concern for Australian educators and educational policy is the quality and effectiveness of education in rural locations. Also, Watt's (2004) data collection did not occur at the same time every school year. The first two waves were at the end and middle of the school year consecutively, and the last two waves occurred during the beginning of the school year. Considering findings that motivation decreases within the school year, as well as across grades (Chouinard & Roy, 2008), the last two waves may have shown artificially high ratings. To account for within year fluctuations, a more accurate measure of maths motivation should assess students at the same time each year. Furthermore, much of Watt's (2004) study focused on expectancy-value constructs of maths motivation. While this is useful in understanding how students' competency and value beliefs change across high school, the trajectory of adaptive behaviours and maladaptive constructs for Australian students in mathematics remains unexplored.

There is some short-term longitudinal research on the general academic motivation of Australian high school students that indicates increases in anxiety and self-handicapping during the final year of high school. Smith (2004) measured the negative affect of Year 12 students studying for the NSW higher School Certificate (HSC) during their final year. Students completed questionnaires at the beginning of the school year, before their trial exams and then after their first round of exams before the finals. As expected, maths anxiety and self-handicapping increased, while self-efficacy decreased between the three stages of the final year of high school. Interestingly however, students' ratings of mastery and failure-avoidance tendencies, as well as learning strategies remained stable across the school year. Contrary to expectations, there was no continued increase in anxiety between the trial and final examinations. Smith (2004) offers an explanation that applies Bandura's (1986, 1997) self-efficacy theory, suggesting that anxiety increases when students feel low control over an event. However by the final examinations students had gained some understanding of the experience through feedback from their trial examinations. Rather than feelings of anxiety increasing, some students would have gained a sense of control whereas students who were disappointed by their initial feedback may have developed a helplessness orientation and this would result in overall mean anxiety ratings remaining steady. In relation to gender, although girls reported more stress and depression, it was boys who showed more maladaptive coping strategies through failure avoidance and self-handicapping. No gender differences between mastery goals and self-efficacy scores were found. Smith's (2004) results show that the pressure of final examinations may encourage a preoccupation with avoiding displays of incompetency. They also highlight the importance of exploring the darker aspects of academic motivation, and their development in later grades of high school.

2.10 Issues that Need More Attention

2.10a The Maladaptive Facets of Motivation

While understanding adaptive motivation is important, so too is exploring the development of maladaptive coping and disengagement. However, research on academic motivation has largely focused on the positive elements, such as expectancy and value constructs, with some focus on goal orientations. Consequently, the nature and trajectory of maladaptive constructs has been largely overlooked. This is surprising given that adolescence is a period susceptible to depression, anxiety and self-consciousness (De Fraine et al., 2007) where students need to manage school, social and parental demands. The negative side of motivation needs more attention because poor coping strategies decrease the likelihood that a student will attempt to improve their skills (Friedel, Cortina, Turner, & Midgley, 2007), making them more likely to experience disappointment and disengage from learning. The declines in maths participation suggest that students are not only feeling less positive towards maths but also that they may be actively avoiding and disengaging from it. Consequently, there is a need to look at the less positive facets of maths motivation. A longitudinal investigation is needed into experiences such as stress, locus of control and fear of failure, as well as their implications for learning behaviour.

Although anxiety has been given some attention, the development of maladaptive coping and its implications, particularly for each gender should be better understood. This leads to a question of whether only adaptive cognitions change during high school, or if their decline is mirrored with an increase in maladaptive cognitions and behaviours? A question also arises regarding the trajectory of maladaptive motivation for boys and girls. For example, do girls experience a range of maladaptive cognitions towards maths more strongly than boys or is it only for certain constructs? Answering these questions would reveal the nature of gender differences, as well as declines in adaptive motivation more comprehensively.

The association of anxiety-based beliefs with other facets of motivation also needs more clarity. There is uncertainty about the inherent negativity of some motivational constructs as it appears that anxiety-based beliefs have complex relationships with other facets of motivation. In relation to general academic motivation Martin (2003a, 2007b, 2009) found anxiety to positively correlate with some adaptive constructs within the Wheel. More specifically, anxiety has been positively associated with mastery orientation, valuing school, planning and study management but less so with persistence (Martin, 2007b). Failure avoidance has also shown positive relationships with planning and study management. Considering that some level of concern about outcomes is needed to achieve, anxiety and the desire to please others may have an energizing role to play in students' motivation. A more complete picture of motivation than what is currently available would address this and show the relations maladaptive constructs share with the positive elements of motivation. This would reveal their implications and work to help target interventions and support students more appropriately.

2.10b Relationships amongst Motivational Constructs

Much research has considered how different motivational cognitions and affect predict students' choices and achievement. However, these are fairly distal outcomes and it is less clear how these beliefs interact with more immediate factors reflecting engagement, such as persistence or self-handicapping. There are suggestions that different cognitions may be relevant for different aspects of behavioural engagement (Chouinard et al., 2007). For example, maths anxiety is not usually a powerful predictor of grades when other constructs such as aptitude, self-efficacy or usefulness are included (Llabre & Suarez, 1985; Meece et al., 1990; see Pajares & Miller, 1994). Perhaps then anxiety plays a more indirect role and is relevant in influencing the motivational cognitions and behaviours leading towards or away from achievement. Consequently, an exploration of the relationships amongst facets within a comprehensive model is needed.

2.10c Longitudinal Relationships amongst Motivational Constructs

As motivation involves sustaining an activity or goal, often over lengthy periods (Pintrich & Schunk, 1996) there is also a need to understand the longitudinal nature of academic motivation (Schunk, 2000). This includes how facets of motivation relate to each other, as well as the stability of different constructs within maths. Theories of motivation tend to address concurrent experiences, rather than how one facet of motivation may influence how another develops in the future. Furthermore, little empirical research has followed how the different facets of motivation work together across time. An exception may be self-efficacy research, which has found self-efficacy to be a driving force, positively associated with adaptive cognitions and behaviours and negatively associated with maladaptive constructs. In their longitudinal study on maths motivation, Jacobs et al. (2002) looked at the role of competency beliefs in explaining changes in the value of maths. They found that competency beliefs accounted for much of the change in values across grades 1 to 12. Furthermore, Meece et al. (1990) found that ratings of maths self-efficacy predicted maths expectancy and importance beliefs, as well as maths anxiety one-year later. Consequently, not only does self-efficacy influence students' current beliefs regarding maths, it may also influence their future beliefs. However, further understanding is needed of how a more complete range of motivation constructs relate to each other across time. For example, a fear of failure is associated with self-handicapping. However, does a tendency to work in order to please others relate to a future likelihood of self-handicapping? If so, this may help identify students early in high school who at risk of self-sabotaging in later grades.

Gauging the stability of psychological constructs is also very important. Firstly, while comparing mean ratings between groups tells us about general trends in motivation, stability coefficients provide valuable information about changes in individual level ratings relative to others (Wigfield et al., 1997). Secondly, assessing stability is important because the consistency of maths motivation indicates to what extent each construct can be tracked longitudinally and may be susceptible to intervention. Longitudinal assessments are only warranted if a cognition or behaviour shows some level of consistency across time, so that changes in ratings can be interpreted meaningfully. If a student's previous engagement is unrelated to their current experience of maths engagement, then longitudinal research is unnecessary. For example, if maths motivation shows very low stability across one-year, it indicates that these perceptions fluctuate greatly and perhaps this is too long an interval to accurately capture students' experiences. On the other hand, high stability coefficients indicate that a student's current maths motivation has long-term implications for their future learning orientation.

Previous research with expectancy-value constructs (Wigfield et al., 1997) and anxiety (Ma and Xu, 2004) has tested the stability of maths competency beliefs, values and anxiety across time. Wigfield et al. (1997) looked at the competency and value beliefs of primary aged children, while Ma and Xu (2004) tested the maths anxiety of high school students. Both studies found strong stability across a one-year interval, showing some consistency in how students feel towards maths from year to year. However, Wigfield et al. (1997) found that intrinsic interest showed stronger stability than utility values, while competency-beliefs were more consistent than both of types of values. Furthermore, research on subject-specificity (Green et al., 2007) suggests that some facets, such as anxiety may reflect general personality tendencies. These trait-like constructs may be more stable across time compared to those of others such as utility values which may fluctuate more because they are more context dependant. More research is needed to clarify the longitudinal stability of a broader range of relevant motivational constructs.

2.10d Factor Structure of Maths Motivation

The numerous single theoretical approaches make interpreting the nature of and trends in maths motivation difficult. Given the variations in definitions and uses of motivational terms, some may wonder to what extent motivational constructs differ from each other, theoretically and practically. Consequently, a research question arises regarding the nature of motivation in relation to its factor structure and the number of constructs that are practically applicable. Traditional cognitive approaches generally consider motivation as involving a cognitive and a behavioural component (see Finn, 1989) and more recent approaches have included a third affective element (see Appleton et al., 2006; Archambault, Janosz, Fallu, & Pagani, 2008; Fredricks et al., 2004). However, numerous constructs have been hypothesised and it is not always clear how they can be differentiated from each other.

The unclear factor structure means that some constructs are inconsistently presented as distinct facets of motivation. Much research, particularly within the expectancy-value approach refers to value beliefs, however the term 'values' is often vague. This may refer to a global variable consisting of multiple types of incentives, whereas others may specify a particular focus, such as utility or intrinsic values. For example, Eccles and Wigfield (1995) found that competency beliefs, utility, importance and intrinsic interest loaded on separate factors. In contrast, others have found that these constructs are not empirically distinct from each other (Greene et al., 1999; Cocks & Watt, 2004). In a survey of Australian Year 6 students' maths and English attitudes, Cocks and Watt (2004) found that maths competence and intrinsic value beliefs loaded together on the same factor, while mastery goals formed a unique factor. However, within English the same items reflected three distinct factors. Cocks and Watt (2004) suggest that the normative assessment processes in maths may lead ability and liking beliefs to be more similar than in English. Also, although the value constructs are conceptually distinct, this may be at an abstract level at which students do not distinguish them or perhaps presenting items with concretely different meanings is difficult.

Another aspect of motivation that is quite vague in the literature is behavioural engagement. Past research often refers to 'effort' (see Chouinard et al., 2007;

Ntoumanis, 2001; Legault, Green-Demers, & Pelletier, 2006; Greene et al., 1999) but what this actually means is not clear and can vary greatly between studies. It can refer to objective behavioural indicators such as attendance or being prepared for class, such as bringing a pencil (Singh et al., 2002) or effort can involve psychological perceptions of trying. For example, Chouinard et al. (2007) had an item stating '*I work hard in mathematics*' (p.506), whereas Legault et al., (2006) had students rate the statement, '*I don't have the energy to study'.* These sorts of measures do not convey what actual behaviours students do or do not engage in, such as planning their homework, persisting or help-seeking. Consequently, a model of maths motivation needs to include behavioural engagement in a way that is specific and concretely operationalised.

Usually measures of 'effort' aim to capture students' self-regulation towards learning. Generally, self-regulation involves time and environmental management, as well as persistence (Zimmerman, 1994). However, at a more specific level it includes many behaviours such as memorising, organising and transforming, goal setting, planning and self-monitoring, as well as help-seeking (Zimmerman & Martinez-Pons, 1990). As a result, definitions of self-regulation vary substantially between studies and very few provide a definition or theoretical rationale underlying their terms and chosen measures. Furthermore, these constructs are sometimes combined to form global measures (Ames & Archer, 1988; Middleton & Midgley, 1997; Wolters & Pintrich, 1998; Kenney-Benson et al., 2006) or sometimes measured as separate constructs (Zimmerman, 2000; Patrick, Kaplan, & Ryan, 2007; Pintrich & De Groot, 1990). For example, Miller and his colleagues (Miller, Behrens, & Greene, 1993; Miller, Greene, Montalvo, Ravindran, & Nicholls, 1996) describe self-regulation as involving goal setting, monitoring progress and adjusting study behaviour. However, self-regulation was measured as a global construct comprised of these behaviours and then a second construct was applied to operationalise persistence. Considering that models and studies of self-regulation differ greatly in the combinations of factors they present, further exploration of the self-regulation factor structure is needed.

2.11 Summary of Chapter 2

Academic motivation is conceptualised by a variety of theories. While there appears to be growing evidence that academic motivation is multidimensional, researchers tend to be more focused on distinguishing their particular approaches, rather than considering how they may actually complement each other to form a more complete picture of motivation. As a result, a comprehensive understanding of how the core cognitions and behaviours work together or across time is lacking. This includes the factor structure, as well as the strength and direction of relations between constructs and the stability of motivation. A comprehensive but effective model of maths motivation would include only factors that are both empirically and theoretically distinct from each other, while only retaining a manageable number of factors that reflect the multidimensionality of maths motivation.

Although of great practical importance, grade and gender trends in relation to the range of motivational constructs are currently unclear. Overall, gender and developmental differences appear to be complex. Much research looking at these trends tends to apply a single theoretical perspective, focussing on the expectancy-value, goal orientation or self-efficacy theories. Although such studies find that students' beliefs towards maths tend to become more negative with age, there is some inconsistency as to whether the middle grades experience the lowest motivation or if the decrease continues through to senior high school. Some cross-sectional findings show boys to be more positive about learning maths than girls. However there is longitudinal evidence to suggest that they experience greater declines in adaptive motivation than girls during high school. The varied pattern suggests that multiple constructs should be measured to gain a complete picture of where gender and grade differences are occurring and what their implications are. Although boys may appear more confident than girls in early high school, this does not necessarily mean that they are more behaviourally engaged. Furthermore, motivation research has also usually focused on young children (during grades four to eight) and undergraduate students, with less attention paid to motivation throughout high school (Murphy & Alexander, 2000). There is also a tendency for the literature to overlook the maladaptive aspects of motivation, come from North American populations and be cross-sectional. In summary, there is a need to develop a comprehensive understanding of high school students' maths experiences and psychological processes and of students in Australian rural high schools in particular.

Chapter 3
Study 1 The Nature of Maths Motivation and Its Development during High School

Because the multidimensionality of maths motivation and the development of its many facets throughout high school have not previously been addressed, the primary purpose of this study is to explore the nature of the mathematics motivation of Australian high school students through a longitudinal study. The current study asks how a variety of positive and negative motivational constructs develop within the context of Australian rural high schools. Martin's (2003c) Student Motivation and Engagement Wheel will be applied as a model of academic motivation because it is a comprehensive representation of the multiple positive and negative facets of motivation. The current study will examine year to year changes in maths motivation and gender differences to ascertain if Australia is following similar trends to Northern America, despite a different educational system and cultural context. Previous research with Australian high school students has tended to apply an expectancy-value framework and little has addressed the learning experiences of rural students, despite the possible educational disadvantage of this demographic. Consequently, it is important to understand how the maths motivation of rural high school students develops. It will extend previous cross-sectional and longitudinal research by considering grade and gender trends in both maladaptive, as well as positive aspects of maths motivation.

3.1 Aims and Hypotheses

The first aim of Study 1 is to examine the psychometric properties of the MES-HS when applied to mathematics. Research with the Student Motivation and Engagement Wheel and its scale, the MES-HS has been cross-sectional and almost exclusively within a general academic framework. Consequently, assessing the factor structure within maths and the relationships amongst factors from a longitudinal perspective is needed.

The factor structure of maths motivation will be explored by testing the lower-order and higher-order structure of the MES-HS. It is also of interest to test if motivation can be captured more concisely to help make conceptualisations more manageable by ensuring only distinct constructs are included. This will be considered by applying alternative models, as well as the original 11-factor model. The alternative models to be considered include one, two, four and 10-factor lower-order models.

The 10-factor model will combine the planning and study management factors. Although these self-regulatory behaviours may be conceptually distinguishable, their practical distinction is less clear. This will address previous inconsistencies regarding the factor structure of self-regulation in which time management, environmental management and persistence are sometimes presented as unique constructs and at other times as comprising a single construct. The four-factor model will present the Wheel's higher-order structure as the lower-order structure, with the 11 facets loading on cognitive and behavioural, adaptive and maladaptive factors of motivation. The four-factor model will be tested because previous research often combines the facets within these potential factors to form global measures, such as cognitive motivation (Singh et al, 2002), effort or amotivation (Legault et al., 2006; Mac Iver, Stipek, & Daniels, 1991). A two-factor model will be tested because traditional cognitive approaches tend to look at motivation from a cognitive versus behavioural perspective (Dweck & Leggett, 1988; see Fredericks et al., 2004 for a review; Miller et al., 1996; Pekrun, Elliot, & Maier, 2006; Pintrich & De Groot, 1990). If this model is supported, then student motivation could be conceptualised as a balance between what students think and what they do (Ryan, 2000). Finally, a one-factor model will be tested because it is also possible that despite all the academic theorizing, students simply perceive motivation as single construct, on which they rate themselves higher or lower along one continuum.

Consistent with previous research and in support of the multidimensionality of motivation, it is expected that the higher-order and lower-order 11-factor model will fit the data. However, it will be asked if the Wheel can be reduced to the 10-factor lower-order model by combining the planning and study management factors.

The measurement invariance of the MES-HS will then be examined across time and gender. It is expected that the model will show measurement equivalence across time and for both boys and girls. This would mean that any mean differences between time-points or genders are based on differences in strength rather than how the indicators are perceived or how motivation is structured.

This study will not test causal relationships between facets of motivation but will consider the dynamics between them. The core theories of motivation will be applied to the Wheel to assess how they account for the array of relationships between constructs. Rather than arguing that one motivational theory is superior to another, the current study will argue that each are useful in capturing the multifaceted experience of learning maths. These include attribution and control, self-worth, expectancy-value, self-efficacy and achievement goal theories. The strengths and weaknesses of each theory's ability to describe and explain the relations between the dimensions of the Wheel will be explored. This will highlight where different theories overlap, where they are complementary and also where there may be conflicting or unaddressed relationships.

The current study will then examine the stability of maths motivation because it may be possible that motivation fluctuates to such a large degree that year-to-year comparisons are not appropriate. Considering that in each grade students usually interact with new teachers and peers, and also have new demands in the curriculum, their current orientation to maths may only weakly relate to their engagement one-year prior. On the other hand, high school maths experiences are associated with future enrolment choices and students' self-concepts become increasingly stable with age (Eccles et al., 1989). Therefore, despite contextual influences, motivation is generally expected to show moderate stability. Based on EVT research, each adaptive cognition is expected to show stability, but with self-efficacy having stronger stability than the two valuing constructs. The relative stability of the other motivational facets remains unclear. Domain specificity research (Green et al., 2007) suggests that constructs such as planning, anxiety and self-handicapping are more 'trait-like'. If these tendencies are more personality based, they may show greater stability compared to more subject-specific and thus context-specific constructs such as utility valuing.

To provide a longitudinal model of maths motivation, the nature of relationships amongst constructs over time will be explored. For example, goal theory suggests that different goal orientations towards learning can influence behaviours, but what is the behavioural long term effect of this orientation? Does having a mastery orientation in an earlier grade relate to persistence one year later, or is failure avoidance related to self-handicapping one year later? With the exception of self-efficacy, little research has addressed these types of longitudinal relationships. Consequently, it is expected that self-efficacy may show a significant relationship with anxiety, valuing and mastery orientation one-year later. However, expectations regarding the other motivational constructs are unclear.

To gain a fuller understanding of developmental trends, the current study will ask whether grade and gender differences lie only within particular facets of motivation and if so, which ones? Cohort studies do not allow measurement of changes across time, whereas longitudinal studies include students repeatedly attending or remaining enrolled in mathematics. Consequently, the longitudinal nature of the design will illustrate to what degree motivation changes for the same group of students. A strength of the current design is its multi-cohort-multi-occasion design, which allows a comparison of longitudinal versus cohort effects. It is expected to replicate longitudinal grade and gender trends found in expectancy-value and achievement goal research (Fredricks & Eccles, 2002; Jacobs et al., 2002; Watt, 2004). Overall, adaptive motivation is expected to decrease across time, with Grade 7 showing the most adaptive motivation and Year 9, the least adaptive. Due to the lack of previous longitudinal research on maladaptive constructs, predictions regarding their grade trends will not be made. Watt (2004) suggests that Grades 7 and 8 may become bored, as the curriculum largely focuses on revising and linking together their current maths knowledge, then in Grades 9 and 10 students may feel pressure from increasing demands. Consequently, if concurrent rises in maladaptive ratings occur, while positive cognitions decrease it may reflect increasing stress and pressure as students progress through school. On the other hand, if maladaptive constructs such as anxiety or uncertain control remain steady or decline, this may be reflective of either boredom or learned helplessness as students become apathetic towards maths.

Study 1 will also investigate the gender differences in mean level ratings and changes in mathematics motivation. Due to inconsistent trends, it is uncertain which gender will show more adaptive maths motivation. When examining general academic motivation girls tend have more adaptive ratings than boys. However within maths, boys tend to show more confidence, as well as less anxiety and effort than girls. Consequently, if gender differences do arise they are likely to reflect traditional gender stereotyped trends, with boys reporting more self-belief and utility value of maths. Girls may report more mastery orientation and behavioural engagement but also more anxiety. Importantly, anxiety is likely to show the strongest difference in ratings between boys and girls. The current study will also explore the trajectory of motivation according to gender. It will examine if girls' anxiety increases faster than boys' ratings across time as suggested by Ma and Cartwright (2003). It will also seek to re-examine findings by Chouinard and Roy (2008) and Watt (2004), that boys show more adaptive mathematics motivation than girls during early high school, while girls improve relative to boys in later high school.

3.2 Method

3.2a Participants

Students were recruited from three NSW high schools in Australia. The initial sample included 797 students at Time 1 (Girls *N* = 442 and Boys *N* = 355) in Grades 7 (*N* = 273), 8 (*N* = 267), 9 (*N* = 244) and 10 (*N* = 13). As the study is a multicohort-longitudinal design, the first wave included students in Grades 7, 8, 9 and 10 who then completed questionnaires one-year later. The mean age of students in Grade 7 was 12.64 (*SD* = .50), Grade 8 was 13.61 (*SD* = .51), Grade 9 was 14.59 (*SD* = .50) and Grade 10 was 15.54 (*SD* = .52). The schools were coeducational government high schools located in regional centres of rural NSW. They followed the same academic curriculum and shared a similar socio-economic position according to the Index of Education and Occupation (Australian Bureau of Statistics, 2006) This index measures the general level of education and occupation skills in different geographical areas of Australia. The participating schools were from regions where individuals' level of education and job skills ranged from average to slightly above average relative to the general Australian population. The percentage of students speaking only English at home was 81.7%

while 12.4% reported also speaking a language other than English, with data for this item missing for the remaining 5.9% of students. Students indicated that the majority of mothers were educated to a Year 10 (18.4%), Year 12 (21%) or TAFE level (23.8 %), and that a majority of fathers also had Year 10 (20.6%), Year 12 (21.2%) or TAFE (17.6%) as their highest attained level of education. Information on education attainment was missing for 15.4% of mothers and 18.4% of fathers.

3.2b Materials

Student Mathematics Motivation and Engagement. An adaptation of Martin's (2007a) Motivation and Engagement Scale-High School (MES-HS) was used to assess cognitive motivation and behavioural engagement in mathematics (see Appendix A). This scale consists of 44 items measuring 11 dimensions of academic motivation and engagement. These dimensions include three adaptive cognitive (self-efficacy, valuing and task orientation) and three adaptive behavioural components (planning, mastery orientation and persistence), three maladaptive cognitive components (anxiety, failure avoidance and uncertain control) and two maladaptive behavioural components (self-handicapping and disengagement). Each construct is hypothesised to consist of four indicators and students rate themselves on a Likert scale of 1 (strongly disagree) to 7 (strongly agree) for each item.

The MES-HS is a measure of general academic motivation and engagement but for the current study it was adjusted to specifically assess maths, rather than general academic motivation. This involved replacing references to 'school' with 'maths', or placing 'maths' before words such as 'assignments'. For example, Martin's (2007a) original item that stated, 'I worry about failing exams and assignments' was changed to 'I worry about failing maths exams or assignments'. Within general academic motivation Martin (2001, 2003y, 2004, 2007b) has previously demonstrated this instrument to have good factor structure, distribution and reliability with Cronbach's alpha ranging from .74. to .88 across the various facets of motivation. Example items from each scale are provided below to illustrate each scale.

Adaptive Cognitions

• Self-efficacy (e.g. “If I don’t give up, I believe I can do difficult maths work”)

• Valuing (e.g. “What I learn in maths will be useful one day”)

• Mastery Orientation (e.g. “I feel very pleased with myself when I do well in maths by working hard”)

Adaptive Behaviours

• Planning (e.g. “I usually stick to a study timetable or study plan”)

• Task Management (e.g. “When I study maths, I usually try to find a place where I can study well”)

• Persistence (e.g. “If my maths work is difficult, I keep working at it trying to figure it out”).

Impeding Cognitions

• Anxiety (e.g. “I worry about failing maths exams and assignment”)

• Failure Avoidance (e.g. “Often the main reason I work at maths is because I don’t want people to think that I’m dumb”)

• Uncertain Control (e.g. “When I get a good mark in maths I’m often not sure how I’m going to get that mark again”)

Maladaptive Behaviours

• Self-handicapping (e.g. “Sometimes I don’t try hard at maths assignments so I have an excuse if I don’t do so well”)

• Disengagement (e.g. “Each week I’m trying less and less in maths”)

3.2c Procedure

Approval was first gained from the Australian National University and New South Wales Department of Education and Training research ethics bodies (see Appendix B). Then three schools were invited to participate by the researcher, based on their grade coverage (Years 7 to 12), geographical location and socioeconomic similarity. The three principals and three head-maths teachers consented to take part in the project. Information and consent forms were sent home with students and a reminder notice to complete and return the consent forms was also placed in the school newsletter. All participants provided their written consent before commencing the study. See Appendix C for all information and consent forms. Those students not participating either failed to gain parental consent, were absent on testing days or declined the invitation to participate. So that questionnaires could be matched longitudinally, students were asked to record their name on the questionnaire. As this was voluntary not all students did so, which reduced the number of matched responses.

The students were told that the purpose of the research was to learn more about their feelings about school, especially their attitudes and behaviour regarding maths. They were ensured that their answers would be treated as confidential and encouraged to be honest in their responses. Students were instructed to work by themselves, completing the questionnaire at their own pace and that there were no right or wrong answers. The researcher was present throughout testing to assist students with any queries or reading difficulties and collected questionnaires when they had finished. Questionnaires took approximately 40 minutes to complete (See Appendix D for a full version of the questionnaire). The researcher administered the questionnaire to Year 7, 8, 9 and 10 maths classes during normal lesson time in the second semester (spring) of the school year. Then during the second semester the following year, these cohorts completed the questionnaire again.

Chapter 4
Study 1 Results

4.1 Descriptive and Attrition Analysis

The data was entered into SPSS (Version 16) and assessed for accuracy of data entry. Cases with more than one response missing for a motivational construct were removed from further analyses. Then the participants present for both waves of data were identified. The number of participants available for the longitudinal analyses was *N* = 532, compared to the original pool of students *N* = 797 (see Table 1). This represented an attrition rate of 33.25%, which was due to a number of factors including school excursions, declines to participate, failure to gain parental consent, questionnaire incompletion, and dropping enrolments at participating schools, particularly for the Grade 11 cohort. It is common for students from the region to change to schools located in a nearby larger town for their senior years of high school. Despite efforts to avoid school events overlapping, due to the busy nature of school schedules, some students were away on school excursions during data collection. The students sampled from Years 10 to 11 were dropped from further analyses because of the very small number in this cohort (*N* = 13). This number of students is too small to perform Confirmatory Factor Analysis and Growth Modeling according to grade and gender groupings because approximately 200 participants for each group are needed (Marsh, Hau, Balla, & Grayson, 1998).

Table 1.
Initial Participants at Time 1

School	Females / Males	Grade 7	Grade 8	Grade 9	Grade 10	Total
1	F	61	37	36	2	136
	M	30	38	23	3	94
2	F	41	33	39	0	113
	M	30	20	50	0	100
3	F	51	89	50	3	193
	M	60	50	46	5	161
Total		273	267	244	13	797

Note. Grade at Time 1.

The final data set consisted of 519 students in grades 7 to 9 who were present for two waves of data collection (see Tables 2 & 3). This included 315 females, and 204 males in the seventh (*N* = 200), eighth (*N* = 176) and ninth grades (*N* = 143). Chi-Square tests were performed through SPSS to ensure that gender and grade ratios were similarly distributed. An overall Chi-Square supported a reasonable distribution of gender across grades showing non-significance ($\chi^2 = 2.41$, *df* = 2, p >.05). Then two more Chi-Square tests were performed between grades 7 and 8, and Grades 8 and 9. The Chi-Square test for Grade 7 and Grade 8 showed non-significance ($\chi^2 = 1.68$, *df* = 1, p >.05) and so did the Chi-Square between Grades 8 and 9 ($\chi^2 = .011$, *df*=1, p >.05). Descriptive statistics for each item at Time 1 and Time 2 are presented in Appendix E, including the mean, standard deviation, skewness and kurtosis.

Table 2.
Total Participants in Final Dataset by School

School	Females / Males	Grade 7	Grade 8	Grade 9	Total
1	F	48	29	25	102
	M	19	27	10	56
2	F	21	25	26	72
	M	17	10	14	41
3	F	44	57	40	141
	M	51	28	28	107
Total		200	176	143	519

Note. Grade at Time 1

Table 3.
Total Participants in Final Dataset by Gender

Grade	Grade 7	Grade 8	Grade 9	Total
F	113	111	91	315
M	87	65	52	204
Total	200	176	143	519

Note. Grade at Time 1

4.2 Statistical Calculations

Confirmatory Factor Analysis (CFA) and Structural equation modeling (SEM) in Mplus (Version 5; Muthén & Muthén, 2007) were used to assess model fit and measurement invariance of the MES-HS.

The most common method of estimation within Confirmatory Factor Analysis (CFA) is Maximum Likelihood (ML), which assumes that the observed variables are continuously and normally distributed (Dumenci, Erol, Achenbach, & Simesk, 2004). However, a more recent approach to survey data is to treat it as categorical data. This is because most items in questionnaires with graded ratings, such as Likert scales actually represent ordered-categorical, rather than continuous variables (Millsap & Yun-Tein, 2004). Although individual items are intended to measure a theoretically continuous construct, the responses reflect a number of categories with no assurance that they are spaced equally (Flora & Curran, 2004). Consequently, if data from Likert scales are treated as continuous there may be a difference between the Maximum Likelihood (ML) assumptions underlying the model and the data's characteristics (Flora & Curran, 2004). Also, in the case of ordinal scales, Pearson correlations tend to underestimate the strength of relations between items (Dumenci et al., 2004). To address these concerns ordinal variables can be analysed using a polychoric correlation matrix with a weighted least squares estimator (WLS) (McIntosh, 2007). Compared to ML, WLS is a more sensitive approach and less dependent on assumptions of multivariate normality. More specifically, Flora and Curran (2004) recommend a robust weighted least squares (WLSMV) estimation for CFA that use ordinal data (Flora & Curran, 2004). Consequently, the current study applied a categorical framework and used the Mplus WLSMV estimator for tests of model fit and measurement invariance.

4.2a Goodness of Fit

Testing model fit in CFA involves assessing if an observed covariance matrix reflects the covariance matrix suggested by a hypothesised model (Barrett, 2007; Flora & Curran, 2004). To determine model fit, the chi-square test statistic, as well as goodness-of-fit indices (GOF) including the Comparative Fit Index (CFI), Tucker-Lewis

Index (TLI) and the root-mean-square error of approximation (RMSEA) were considered.

A nonsignificant chi-square test indicates a fit between a hypothesised model and empirical data, suggesting that discrepancies between them are due only to sampling variability (Barrett, 2007; Dumenci & Achenbach, 2008). However, as sample size increases, so does the chi-square sensitivity, with trivial discrepancies between observed and expected values sometimes falsely interpreted as significant differences (Barrett, 2007; Schermelleh-Engel, Moosbrugger, & Muller, 2003; Tabachnick & Fidell, 2001). Consequently, the chi-square is often significant in large samples (Dumenci & Achenbach, 2008). It also tends to reject models with a large number of constraints (Levesque, Zuehlke, Stanek, & Ryan, 2004), or with small unique variances and reliable indicators (Goffin, 2007; Miles & Shevlin, 2007). Consequently, there is a strong likelihood of gaining false significant chi-squares when conducting CFA with multidimensional models in samples larger than 500 (Markland, 2007).

Because of these concerns regarding the oversensitivity of chi-square, other indices that refer to the degree of discrepancy between observed and expected models are also recommended in evaluating model fit (Barrett, 2007; Goffin, 2007; Miles & Shevlin, 2007; Wu, Chen, & Tsai, 2009). While the chi-square is a statistic of exact fit, GOF indices indicate the degree of approximation between a hypothesised model and the observed data (Mulaik, 2007). These indices are guides to model fit and the thresholds or values considered as indicative of an acceptable degree of fit varies somewhat between researchers.

Values for CFI and TLI usually range between 0-to-1, in which values greater than .90 (Bentler, 1990; Marsh, Hau & Wen, 2004) and .95 (Hu & Bentler, 1999; Yu, 2002) reflect acceptable and excellent fits, respectively. The TLI and CFI are valuable because they are sensitive to model misspecifications and do not depend on sample size as strongly as chi-square (Hu & Bentler, 1998). More specifically, the CFI is independent of sample size and model complexity (Cheung & Rensvold, 2002) and the TLI is relatively independent of sample size (see Marsh, Balla, & McDonald, 1988). The RSMEA however, is not influenced by model or sample size (Meade, Johnson, &

Braddy, 2008). If the discrepancy between covariance matrices equals zero there is an exact fit (Guttmannova, Szanyi, & Cali, 2008). A value of .05 or less indicates a close fit, while .1 or more indicates a poor fit (Browne & Cudeck, 1993). Generally, values of RMSEA at or less than .08 (Marsh et al., 2004) are considered reflective of an acceptable fit (Hu & Bentler (1999).

In relation to choosing the best fitting model, Dumenci and Achenbach (2008) discuss the rule of parsimony. This approach suggests that a model with more factors is only preferred over a model with fewer factors if it fits better. However, the exact determinants and values of a well fitting model are hotly debated and there is little consensus regarding GOF thresholds when comparing models (Glanville & Wildhagen, 2007). These arguments can be observed on the online SEM discussion group, Semnet (SEMNET@bama.ua.edu), which has regular discussions regarding the adequacy of chi-square and GOF in assessing model fit. Marsh, Hau and Grayson (2005) argue that conventional GOF criteria are often too restrictive when applied to multifactor models with multiple indicators. It can be difficult to form a good fitting model according to cut-off criteria for fit indices whilst also retaining an adequate number of items to also maintain construct validity (Marsh et al., 1998; Marsh et al., 2005). Furthermore, Hu and Bentler (1999) recommend that their cut-off suggestions for model fit should not be applied too rigidly and must be guided by theory. Likelihood ratio tests and GOF indices are useful and have strengths but are also limited in their capabilities and should always be considered in relation to a theoretical framework. Consequently, a degree of personal judgement is required in selecting the best model (Guay, Marsh, & Boivin, 2003). Model fit may be improved by using Modification Indices (MI) because they indicate sources of misfit. Freeing the parameters suggested by MI may increase the likelihood of gaining a non-significant chi-square and improving model fit. Although useful, this procedure risks freeing parameters that simply reflect sampling variability, without substantive meaning (Goffin, 2007; MacCallum, Roznowski, & Necowitz, 1992). Consequently, the current study added MI with caution to avoid over-fitting and applied goodness of fit suggestions as a guiding reference.

4.2b Measurement Invariance

Before assessing changes in maths motivation across time, it is first necessary to confirm that the factor structure of the Wheel fits in a similar way for each wave and gender. Testing for invariance ensures that scale items function similarly across groups (Meade & Lautenschlager, 2004) and time so that tests of mean differences are meaningful. This involves establishing a well-fitting baseline model for each group separately and then testing for measurement invariance between them (Byrne, Shavelson, & Muthén, 1989). For ordinal factor indicators, thresholds are modelled rather than intercepts or means as done for continuous variables (Muthén & Muthén, 2007). The fit of two nested models is compared, with one having factor loadings and thresholds constrained to be equal between groups and the other with factor loadings and thresholds free to vary across groups (Guttmmanova et al., 2008). Support for invariance of the factor structure and thresholds is found if the fit indices do not decrease substantially as equality constraints are imposed (Guay, Marsh, Dowson, & Larose, 2005). Factor loadings represent the degree to which an item is related to the factor. If a constrained model does not significantly differ from the baseline model, it indicates that the items load in similar ways for both groups. If factors are not reflected as intended by the items, it may suggest participants perceive the measures differently to what is intended. If the thresholds are invariant across groups, then at a given value of the latent variable, the expected value of the item is the same across groups (Glanville & Wildhagen, 2007). Comparison of factor covariances and mean differences between groups are meaningful when factor and threshold loadings are invariant.

To evaluate fit in nested model comparisons, the most common test is a chi-square difference test between a less constrained model and a model with equalities held constant. This was performed through Mplus with the chi-square difference test for the WLSMV estimator (Muthén & Muthén, 2007). Similar to chi-square tests of model fit, the chi-square difference tests are also sensitive to sample size (Meade & Lautenschlager, 2004). Also, if the baseline model shows a significant chi-square for model fit, the chi-square difference test may also be significant (Yuan & Bentler, 2004). As it is advised to not solely rely on chi-square tests in evaluating model fit, so is it not to rely solely on the chi-square difference tests in comparing nested models (Marsh et al., 2005; Cheung & Rensvold, 2002). Marsh et al. (2004) observe that GOF indices are useful for differentiating between nested models and Cheung and Rensvold (2002) recommend that changes less than or equal to .01 for fit indices between a less and a more constrained model are indicative of measurement invariance between groups.

4.2c Item Uniqueness

In structural equation modeling, each factor indicator has a uniqueness component. This represents the residual variance including error and any variance not explained by the latent construct (Marsh, Roche, Pajares, & Miller, 1997). Usually CFA a priori models assume that the residual variance associated with each indicator is independent from that of other indicators (Martin et al., 2003). However, when scales are used on multiple occasions, such as in longitudinal research, the corresponding residual error of items is likely to be correlated (Martin et al., 2003). The correlated residual error suggests that there is a uniqueness associated with each indicator that is not explained by the latent construct but is related to the uniqueness for the corresponding indicator in the other time-point (Marsh et al., 1997). If this correlation is not taken into account then the parameters between corresponding latent constructs will be overestimated and their relationships with other constructs may be negatively biased (Marsh et al., 1997; Marsh et al., 2005; Martin et al., 2003). To gain accurate parameter estimates, Marsh et al. (1996) recommend that all a priori models of stability include correlated uniqueness. Consequently, the current study included correlated item uniqueness across Time 1 and Time 2 in baseline and constrained models when testing the measurement invariance of the MES-HS.

4.3 Establishing Model Fit of the MES-HS

Firstly, separate Multigroup CFA were performed in each wave to examine the fit of the MES-HS factor structure and its measurement fit for both boys and girls. The responses were treated as categorical data and WLSMV was used as the estimator. The factor structure was tested against five models. The first was a 1-factor model in which the 11 facets load together. The second was a two-factor model based on traditional social-cognitive approaches with a cognitive and behavioural dichotomy. The third applied the four-factor second-order model as a first-order structure, with the 11 facets loading on cognitive and behavioural, adaptive and maladaptive factors of motivation. The fourth tested a 10-factor model with planning and study management combined. The fifth tested Martin's hypothesised 11-factor structure.

Overall, the 10 and 11-factor models showed the most acceptable fit in each wave compared to the alternative models. As shown in Tables 4 and 5, the 11-factor model showed a moderately acceptable fit at Time 1 and a poor fit at Time 2 (see models 11-Factor A). Interestingly, the 10-factor model (see models 10-Factor A) with the combined planning and study management factor showed a similar degree of fit as the 11-factor model. Apart from the chi-square values, the fit indices for these models reached the same values. The decrease in the Time 1 RMSEA from .089 to .088 in the 10-factor model is smaller than Cheung and Rensvold's (2002) recommendations for substantial differences between models. Although all the factor indicators were significant and the TLI values for the 10 and 11-factor models at both time-points were acceptable, the CFI and RMSEA values were below recommendations (Hu & Bentler, 1999; Marsh et al., 2004). As these values indicated a substantial degree of misfit between the models and the data, MI were considered to identify the potential sources of misfit. For consistency with previous research and theory with the MES-HS, the 11-factor model was explored initially rather than the 10-factor model.

Table 4.
Fit of the MES-HS Factor Structure for Time 1

Model	χ^2	*df*	CFI	TLI	RMSEA
1-Factor	3510.51	103	.38	.69	.252
2-Factor	2240.13	100	.61	.80	.203
4-Factor	1264.29	113	.79	.90	.140
10-Factor A	612.58	120	.91	.96	.089
11-Factor A	592.41	119	.91	.96	.088

Table 5.
Fit of the MES-HS Factor Structure for Time 2

Model	χ^2	*df*	CFI	TLI	RMSEA
1-Factor	3613.17	93	.32	.66	.27
2-Factor	2289.17	87	.56	.78	.221
4-Factor	1428.16	103	.74	.89	.157
10-Factor A	756.98	120	.88	.95	.10
11-Factor A	740.82	119	.88	.95	.10

For both time-points MI for the 11-factor CFA indicated that four items cross-loaded with multiple factors. At Time 1, items SM3, Pl21, A23 and Pl39 (see Appendix A) featured in MI, with the expected influence of freeing item A37 being the greatest on the chi-square. At Time 2, items SM3, Pl21, A37 and Pl39 also featured in MI, with the expected influence of freeing item Pl39 being the greatest. Two of these items were planning indicators (item Pl21-"*I get it clear in my head what I'm going to do when I sit down to study maths"* and item Pl39-"*I usually stick to a maths study timetable or study plan"*) and one was a study management indicator (item SM3-"*When I study maths, I usually study in places where I can concentrate"*). These items showed many cross-loadings, particularly with persistence and self-efficacy. The fourth indicator identified by MI was item A37 ("*When I do maths tests or exams I don't feel very good")*, which was hypothesised to load on the anxiety factor. For both waves item A37 showed cross-loadings on most other factors, particularly with disengagement.

Allowing these items to load on the suggested latent factors did little to improve the model fit. For example, the Time 2 MI indicated that item Pl39 cross-loaded with many factors, particularly persistence, disengagement and self-efficacy. Item Pl39 also showed a relatively lower loading on the hypothesised planning factor than other items (.34, compared to the other planning indictors that ranged from 76 to .87) (see Appendix F) and very high residual error (.88). Although parameters for this item were freed to allow the different cross-loadings, the model fit did not improve.

The risks in over-fitting the models according to MI based on chance findings were then evaluated. For both time-points the same items were signalled as problematic, suggesting consistency in their tendency to cross-load with other factors.

In addition, the wording of the items was considered for conceptual characteristics linking or differentiating them from other items and factors in the MES-HS. Unlike items Pl21 and Pl39 which referred to studying maths in general, the two other planning indicators referred specifically to studying for homework or assignments. Furthermore, item A37 was the only anxiety indicator to not inquire about feelings of worry. Instead it expresses general negative affect associated with maths, which is broader and not necessarily reflective of specific worries. Consequently, rather than forming post hoc cross-loadings that may not be replicable or meaningful, the four items identified by MI were removed from further analysis because they consistently failed to adequately distinguish between the factors.

As shown in Table 6, at Time 1 the 11-factor model with the four items removed showed an acceptable fit (model 11-Factor B). The model fit for Time 2 with the items removed was also acceptable (see Table 7, model 11-Factor B). However, MI showed that item A43 cross-loaded with self-handicapping and failure avoidance. This item "*In terms of my maths work, I'd call myself a worrier*" was distinguishable from the other anxiety indicators because it referred to maths work, rather than specifically assignments and exams as the others items did. It is possible that for the older cohort, general worries about maths performance may extend to other motivational constructs more than the younger group at Time 1. This may be driven by increased study pressures and self-consciousness during high school (Garber et al., 1993; Rankin, Lane, Gibbons, & Gerrard, 2004). Consequently, the path was freed and an alternative model (model 11-Factor C) for Time 2 with item A43 cross-loading on self-handicapping showed an acceptable fit.

Table 6.

Fit of the Post Hoc MES-HS Factor Structure for Time 1

Model	χ^2	*df*	CFI	TLI	RMSEA
11-Factor B	401.23	109	.95	.98	.072
10-Factor B	419.92	110	.94	.98	.074

Note. 11 Factor B and 10 Factor B- 11-Factor and 10-Factor model with items removed, respectively.

Table 7.

Fit of the Post Hoc MES-HS Factor Structure for Time 2

Model	χ^2	*df*	CFI	TLI	RMSEA
11-Factor B	436.88	110	.94	.98	.076
11-Factor C	405.66	112	.94	.98	.071
10-Factor B	443.73	111	.93	.98	.076
10-Factor C	413.79	113	.94	.98	.072

Note. 11-Factor B and 10-Factor B = 11-Factor and 10-Factor model with items removed, respectively; 11-Factor C and 10-Factor C = 11-Factor and 10-Factor model with items removed and item A43 cross-loading on self-handicapping.

Although the 11-factor model is the factor structure suggested by Martin (2007b, 2009), the initial current tests of model fit (see Tables 4 and 5) did not show a substantial difference between the 11-factor and the 10-factor models. After the items were removed, planning was left with only two indicators and study management with three indicators. Marsh et al. (1998) recommend that latent factors retain at least four items per factor for construct validity. Furthermore, planning and study management also correlated very strongly with *r* = .92 and *r* = .94 at Time 1 and Time 2, respectively and showed similar relationships with other factors in terms of strength and direction (see Appendix G). Considering this and the theoretical similarity on which the constructs are based, the 10-factor model with a combined planning and study management factor was considered in more detail.

A 10-factor CFA was performed on each wave with the remaining 40 items. As shown in Table 6, for Time 1 the 10-factor model showed an acceptable fit (model 10-Factor B), with factor loadings on the new planning factor ranging between .71 to .85. As shown in Table 7 for Time 2 this 10-factor model was also acceptable (model 10-Factor B), showing loadings consistent with Time 1, ranging from .72 to .81. However, MI again showed item A43 as loading on other factors, especially disengagement, self-handicapping and failure avoidance. Because of the possibility of this relationship being developmentally based, a post-hoc CFA with this parameter freed in the 10-factor model was performed. Allowing Time 2 A43 to cross-load on self-handicapping showed an acceptable fit (model 10-Factor C) with factor loadings on the new planning factor ranging between .72 and .81, while A43 loaded on self-handicapping relatively weakly at .21.

The main decision to be made regarding the tests of model fit was whether the 10 or 11-factor model would be chosen as the final factor structure. The fit indices indicated that these models were largely equivalent in their degree of fit (see tables 6 and 7). The rule of parsimony (Dumenci & Achenbach, 2004) suggests that a larger model should only be kept if it shows a substantially closer fit to the data than a model with fewer factors. On the other hand, the current study also wanted to maintain consistency with previous research on the MES-HS unless a different factor structure was absolutely warranted. Consequently, research decisions must find a balance between being empirically based and also retaining a theoretical grounding. The greatest change in fit indices was the CFI for both waves, which reduced by .01 in the 10-factor model to become .94 and .93 at Time 1 and Time 2, respectively. Both these values are still within the range considered as a good fit (Bentler, 1990; Marsh et al., 2004) and the difference between the models did not exceed the degree of change suggested by Cheung and Rensvold (2002) as reflecting a substantial difference between models. Although the 10-factor model showed an acceptable fit, it was not considerably better than the 11-factor model. Consequently, the 11-factor model with 40 items was initially selected for the further analyses testing the higher-order structure and measurement invariance.

However, the gender multigroup CFAs and tests of measurement invariance across time showed a non-positive definite latent variable covariance matrix, which meant that accurate factor scores with the 11-factor model could not be calculated. This can be caused by negative variance, residual error, correlations greater than 1 between latent constructs or a linear dependency between three or more factors. A non positive definite covariance matrix produces bias in parameter estimates, standard errors and fit indices and Mplus will not save the factor scores. An inspection of the Mplus output revealed no negative variances or residual variances. However, in the Time 1 gender multigroup CFA planning and study management were correlated at r = 1.18 and r = .98 for boys and girls respectively. The strength of these correlations suggested that fewer factors should be used in the model. The three longitudinal measurement invariance tests (girls across both waves, boys across both waves and all participants across both wave) also showed strong correlations between planning and study management approaching r = 1.00. An analysis was performed by adding one factor at a time to the model to identify which factors were causing the non positive definite covariance matrix. For the Time 1 gender multigroup CFA and all three longitudinal invariance tests, it was only when both planning and study management were included in the model that the warning occurred. Although the 11-factor model showed acceptable fit and measurement invariance across time and gender (see Appendix H), the linear dependency of planning and study management would produce biased estimates and Mplus would be unable to save the factor scores needed for further analyses. Planning and study management are very similar constructs both theoretically and practically, which was shown empirically in the model fit of the 10-factor model in Tables 6 and 7. Consequently, the remaining analyses were performed with the adjusted 10-factor model comprised of 40 items.

The next concern addressing the model fit was if the cross-loading for item A43 as suggested by MI should be applied. Adding this path resulted in a slightly better fit for Time 2 and was theoretically plausible. However its loading was only .21, which is below the recommended value representing an association with an underlying factor (Tabachnick & Fidel, 2001). Also, as it was a post-hoc adjustment, it was unclear if this relationship is replicable or based on chance findings unique to the current data set. Consequently, further analyses of model fit and measurement invariance were performed without this modification added.

4.4 Second-Order Factor Structure of the MES-HS

It was also of interest to test the model's higher-order factor structure. Martin (2007b, 2009) presents the MES-HS as comprising of four second-order factors according to adaptive cognitions and behaviours, as well as maladaptive cognitions and behaviours. For reasons of parsimony and practicality, being able to apply this higher-order factor model would assist greatly in following motivation across time and involving the MES-HS in larger path analyses. This would mean the model could be simplified without overlooking important relationships between facets of motivation. Two CFAs were performed with each time-point, one testing the four-factor higher-order model with all original 44 items (10-Factor A) and another with the four problematic items removed (10-Factor B). Unexpectedly, the higher-order structure showed a poor fit to the data at both time points. As seen in Tables 8 and 9, despite the TLIs showing an adequate fit, the χ^2 ratio, CFI and RMSEA all indicated a poor fit. Although the higher-order model with the items removed showed an improvement compared to the first model, the fit indices were beyond recommendations.

Table 8.
Fit of the Time 1 Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
10-Factor A	829.54	115	.87	.94	.11
10-Factor B	736.45	106	.89	.95	.11

Note. 10-Factor A = Second-order model with all items; 10-Factor B = Second order model with 4 items removed.

Table 9.
Fit of the Time 2 Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
10-Factor A	920.25	105	.84	.93	.12
10-Factor B	737.69	97	.87	.95	.11

Note. 10-Factor A = Second-order model with all items; 10-Factor B = Second order model with 4 items removed.

Post-hoc analyses were then performed to identify if an alternate second-order factor structure could be applied to the MES-HS. An exploration of the factor correlations revealed that the adaptive constructs were very highly correlated with each other and the maladaptive constructs moderately correlated together (see Tables 16 and 17). Consequently, a higher-order structure of two factors comprising the positive and maladaptive constructs was suggested for each time-point. However this showed an unacceptable fit for both waves (see models 10-Factor C in Tables 10 and 11). Disengagement was more strongly correlated with the adaptive constructs than the maladaptive cognitions, particularly persistence. It is possible that disengagement simply mirrors the adaptive constructs. Consequently, another two-factor second-order model was tested with disengagement negatively loading on the positive factor but this also failed to show an acceptable fit to the data (see model 10-Factor D in Tables 10 and 11). Anxiety and failure avoidance showed relatively lower correlations with the maladaptive behaviours, indicating they may belong to separate higher-order factors. However, the adaptive constructs all correlated with each other reasonably strongly ranging from *r* = .49- .89. A third model was performed with three second-order factors consisting of the adaptive constructs, maladaptive cognitions and maladaptive behaviours (see models 10-Factor E in Tables 10 and 11). Although showing a fit similar to the original higher-order structure, this alternative second-order factor structure also showed a poor fit. The relationships amongst the factors appear complex as there is no clear pattern to group factors by. Consequently, a final alternative higher-order structure was examined that considered these facets as all stemming from a single construct reflecting a tendency to be or not to be motivated. However, this single-factor second-order structure also failed to show an acceptable fit (see models 10-Factor F in Tables 10 and 11).

Table 10.

Fit of the Time 1 Post-Hoc Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
10-Factor C	1264.02	102	.79	.90	.15
10-Factor D	1088.26	99	.82	.91	.14
10-Factor E	767.51	104	.88	.97	.11
10-Factor F	1585.91	100	.73	.87	.17

Note. 10-Factor C = 2-Factor model with all adaptive constructs vs. maladaptive constructs; 10-Factor D = 2-Factor model with all adaptive constructs and disengagement vs. maladaptive constructs; 10-Factor E = 3-Factor model with adaptive constructs vs. impeding cognitions vs. maladaptive behaviours; 10-Factor F = 1-Factor model with all 11 constructs.

Table 11.

Fit of the Time 2 Post-Hoc Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
10-Factor C	1164.08	91	.79	.90	.15
10-Factor D	922.15	88	.83	.92	.14
10-Factor E	751.55	96	.87	.94	.12
10-Factor F	1507.77	94	.72	.88	.17

Note. 10-Factor C = 2-Factor model with all adaptive constructs vs. maladaptive constructs; 10-Factor D = 2-Factor model with all adaptive constructs and disengagement vs. maladaptive constructs; 10-Factor E = 3-Factor model with adaptive constructs vs. impeding cognitions vs. maladaptive behaviours; 10-Factor F = 1-Factor model with all 11 constructs.

In summary, the MES-HS data did not support the hypothesised four-factor second-order structure and alternative higher-order models also failed to reflect the data adequately. Consequently, further analyses were performed applying only the first-order factor structure with 10-factors. Similar results regarding the second-order structure were also found with the 11-factor model, as neither the hypothesised second-order structure nor the alternate models were observed for the 11-factor model (see Appendix I).

4.5 Model Fit and Measurement Invariance of the MES-HS by Gender

It was also of interest to assess model fit and measurement invariance across gender. This would assess if any differences found in the maths motivation of boys and girls were due to differences in styles or level of motivation. A series of CFAs were performed on each wave with students' sex as the grouping variable to establish the factor structure of the MES-HS for boys and girls. Firstly, the fit of the 10-Factor model was tested for each sex in separate CFAs, then Mulitgroup CFAs tested for measurement invariance holding factor loadings and thresholds equal across gender. The unconstrained model had thresholds loadings and factor loadings free across groups, factor means set to zero and scale factors set to one in all groups. The constrained model had thresholds and factor loadings held equal across groups, with factor means set to zero in the first group and free in the others and the scale factors set to one in the first group and free in the others (Muthén & Muthén, 2007). To avoid developing a nonreplicable model based on post-hoc MI adjustments, initial models allowed Time 2 item A43 to only load on anxiety, rather than also self-handicapping.

As shown in Table 12, Time 1 showed an acceptable fit for each sex, although the model appeared to fit girls slightly better than boys. A Multigroup CFA was performed without constraints and this showed an acceptable fit. Then another Multigroup CFA was performed holding factor loadings and thresholds equal across boys and girls. This resulted in a non-significant chi-square difference test ($p > .05$), indicating measurement invariance across gender for Time 1.

Table 12.

Fit of Time 1 Male-Female Multigroup CFA for 10-Factor Model

Model	χ^2	*df*	CFI	TLI	RMSEA	χ^2 *diff*
Males	171.43	66	.93	.95	.088	-
Females	261.02	85	.95	.98	.081	-
Both Genders	410.10	147	.95	.97	.083	-
Invariance	390.40	158	.95	.98	.075	p > .84

Note. Invariance = Both threshold and factor loadings constrained to be equal across gender.

The same process to test measurement invariance across Time 1 gender was then followed with Time 2 data. As shown in Table 13, separate CFAs for each sex showed a generally acceptable fit, although the RMSEA for boys (0.92) was above recommendations (Marsh et al., 2004). The multigroup CFA could not be calculated because at Time 2 boys only used six rather than seven categories in their responses for item V41. Inspection of the data revealed that males did not use category 2 for item V41, whereas female responses covered all seven categories. This item was "*It's important to understand what I'm taught in maths'* and the second category was the second most 'disagree strongly' option of the responses ranging from one to seven. A new variable was created combining categories 1 and 2 into a single category, leaving item V41 with six categories for both boys and girls. After making this adjustment, the Multigroup CFA without equality constraints showed an acceptable fit (see model A-Both Genders in Table 13). However, the chi-square difference test with the more constrained model showed non-invariance between girls and boys ($p < .05$).

An inspection of the parameters found that two items (M25 and M26) loaded more strongly on mastery focus for girls than boys. Item M25 was, "*I feel very pleased with myself when what I learn in maths gives me a better idea of how something works*" and Item M26 '*I feel very pleased with myself when I learn new things in maths*". Loadings for item M25 were .87 for girls and .76 for boys, while loadings for item M26 were .89 for girls and .78 for boys. A Multigroup CFA with relaxed equality parameters for these two items was performed. The chi-square difference test was again significant, although it approached non-significance (see model B-Invariance, Table 13). MI also indicated that item A43 cross-loaded on self-handicapping and disengagement for girls, whereas for boys it cross-loaded with mastery focus, persistence, failure avoidance, self-sabotage and disengagement. This cross-loading of item A43 on many other factors for boys compared to girls was considered next as a source of non-invariance. A Multigroup CFA was performed allowing item A43 to load on both self-handicapping and anxiety. Although showing a slightly improved fit, allowing this cross-loading alone did not result in a non-significant chi-square (see Model C-Invariance, Table 13). The final model for the Time 2 gender analysis included both adjustments, with the two mastery orientation indicators freed and A43 cross loading (Model D-Invariance, Table 13). This fourth model showed an acceptable fit and the chi-square difference test was non-significant, indicating measurement invariance between boys and girls at Time 2.

Table 13.

Fit of Time 2 Male-Female Multigroup CFA for 10-Factor Model

Model	χ^2	*df*	CFI	TLI	RMSEA	χ^2 *diff*
A-Males	182.87	67	.92	.96	.092	-
A-Females	260.85	83	.95	.98	.082	-
A-Both Genders	425.83	147	.94	.97	.085	-
A-Invariance	434.78	163	.95	.98	.08	$p < .05$
B-Invariance	430.28	162	.95	.98	.08	$p < .05$
C-Males	171.02	67	.93	.96	.087	-
C-Females	253.45	84	.95	.98	.08	-
C-Both Genders	405.53	148	.95	.97	.082	-
C-Invariance	408.89	163	.95	.98	.076	$p < .05$
D-Invariance	404.33	162	.95	.98	.076	$p > .10$

Note. A = Original invariance model; B = Model fit with items 25 and 26 freed between gender; C = Model fit with item A43 cross-loading on self-sabotage; D = Model fit with item A43 cross-loading on self-sabotage and parameters freed for items 25 and 26; Invariance = Both threshold and factor loadings constrained equal across gender.

As partial measurement invariance between boys and girls was found at Time 2, these modifications were considered in more detail to evaluate their importance and potential impact on the overall model. Firstly, the factor loading values of the non-invariant items were considered for both sexes before and after the parameters were freed. For girls, the loading value for item M25 remained at .87, whilst item M26's loading changed from .89 to .90 when these parameters were freed in the post-hoc model. For boys item M25 remained at .76, and item M26 changed from .78 to .77 when the parameters were freed. This change in factor loadings was minor and unlikely to influence factor scores or the relationships between the factors.

The other consideration arising in the tests of model fit and measurement invariance was the cross-loading of item A43 on self-handicapping. When this path was added to the Multigroup model it only loaded on self-handicapping at .23 for females and .27 for males. This is compared to loadings ranging from .52 to .84 for the other self-handicapping indicators for boys and girls. These values are consistent with the weak loading observed for item A43 on self-handicapping in the overall CFA for Time 2 (.21). Generally only indicators with loadings of at least .30 are included as factor indicators (Tabachnick & Fidel, 2001). Indicators with loadings less than this are considered to relate too weakly with the common factor linking other indicators and so they are removed. Although item A43 was identified in both the overall CFA and gender Multigroup CFA as cross-loading, the strength of these associations was weak.

Furthermore, allowing this cross loading in the individual gender CFAs and Multigroup CFA showed no substantial improvement in fit indices (see models A and C in Table 13). Although the cross-sectional tests of measurement invariance suggested some potential difference between boys and girls at Time 2, these were negligible and did not appear to substantially affect the overall model. Consequently, it was decided that rather than risk developing a non-replicable model driven by post-hoc MI adjustments, it would be more appropriate to maintain a model as consistent as possible with previous publications of the scale. Consequently, the final model for both time-points was the 10-factor model with 40 indicators without any cross-loadings or items freed across gender.

4.6 Measurement Invariance across Time

With an acceptable model fit established for each wave and gender, in the next step measurement invariance across time needed to be tested. Similar to group comparisons, this involves comparing a model with equalities against a baseline model without such constraints. However, instead of comparing different participants, equalities are held constant across data from different time-points. Consistent with measurement invariance between groups, for longitudinal categorical data a baseline model with thresholds and factor loadings free across time is compared against a constrained model with thresholds and factor loadings simultaneously held across time (Muthén & Muthén, 2007). For longitudinal comparisons, the constrained model also has factor means set to zero and scale factors set to one at Time 1 only (Guttmannova et al., 2008).

The baseline model to test measurement invariance between the two waves included the final models for Time 1 and Time 2 (see models 10-Factor B in Tables 6 and 7). This consisted of a 20-factor model with 80 items, with the recoded item V41 for both time-points and correlated item uniqueness across time. As shown in Table 14, this model showed an acceptable fit to the data and the chi-square difference test was non-significant ($p > .05$), indicating that applying the constraints did not significantly worsen the model fit.

The 10-factor model was then tested for invariance across time separately for each sex. The model for boys at both time-points without equality constraints showed an acceptable fit. Constraining factor and threshold loadings across time also resulted in an acceptable model fit with a non-significant chi-square difference test ($p > .05$). The 10-factor model with girls at both times also showed an acceptable fit without equality constraints and when equalities were applied the fit of this model was not significantly different from the unconstrained model ($p > .05$).

Table 14.
Fit of MES-HS Across Time and Sex

Model	χ^2	df	CFI	TLI	RMSEA	χ^2 *diff*
Both Waves	558.99	188	.94	.97	.062	-
Invariance	559.62	199	.94	.98	.059	p > .09
Male	195.19	96	.94	.96	.071	
Male Invariance	192.83	100	.94	.96	.067	p > .09
Female	338.91	128	.94	.97	.072	
Female Invariance	338.26	134	.94	.97	.07	p > .05

Note. Invariance = Both threshold and factor loadings constrained equal across time.

4.7 Similarity between the Final and Original Models.

The current results indicated that the hypothesised 11-factor and 10-factor models showed the best fit to the current data. However, the fit indices and MI indicated a degree of misfit and that some adjustments to the hypothesised model could be made to improve its reflection of the data. Guided by these suggestions the current study then removed four items from further analyses. As the 11-factor model experienced estimation difficulties because of a non positive definite correlation matrix, the 10-factor model was applied. Cautious of moving away from the original model, analyses were then performed to assess how similarly the final model related to the original model. Factor scores from the final model with 40 items were computed and then correlated with factors scores from the original 11 factor model with 44 indicators. Table 15 below shows the correlations between factor scores from the 11-factor model and the final model at Time 1 and Time 2, respectively. As shown, most factor scores showed perfect positive correlations between the two models and this was consistent for both time-points. The original planning and study management factors, also showed very strong correlations with new planning factor, all above *r* =

.96. The new anxiety factor also showed strong positive correlations with its original counterpart (*r* = .99 for both Time 1 and Time 2). This indicates that despite having removed some items and reduced the number of factors, the factor scores of the final model are comparable to those from the original model.

Table 15.
Correlations between 11-Factor Model and New Model Factor Scores (Time 1/Time 2)

11-Factor Model	New Factors	
	Time 1	Time 2
Self Efficacy	.99	1.0
Valuing	.99	.99
Mastery Orientation	1.0	1.0
Planning	.96	.97
Time Management	.99	.99
Persistence	1.0	1.0
Anxiety	.99	.99
Failure Avoidance	1.0	1.0
Uncertain Control	1.0	1.0
Self Handicapping	.99	.99
Disengagement	1.0	1.0

4.8 Summarising Tests of Model Fit and Measurement Invariance.

In summary, the tests of model fit found that the 11-factor and 10-factor models reflected the data relatively well. This was in comparison to alternative models suggesting a simplified factor structure. However, as the 10-factor model did not show a substantially better fit, the 11-factor model was initially selected to remain consistent with prior theory and research with the Wheel and MES-HS. Four items were removed because at both time-points they failed to adequately distinguish between factors. Although a good fit was observed for the 11-factor model, it showed a non positive definite latent variable covariance matrix. This was resolved when planning and study management were combined to form one factor and so all further analyses applied the 10-factor model.

The hypothesised four-factor second-order structure failed to show an acceptable fit to the data and alternative higher-order models also showed a poor fit. Consequently, the remaining analyses were performed without a second-order model structure. Overall the MES-HS showed measurement invariance across time for both boys and girls (see Appendix J for factor loadings by gender). As shown in Figures 2 and

3, all factor indicators were significant and loaded strongly on their hypothesised factors. In these figures adaptive constructs are presented in the upper half and maladaptive constructs in the lower half. The cognitions are located on the left side and behaviours on the right side of the figures. The ovals represent the latent constructs of maths motivation. Each latent construct has multiple indicators represented by boxes, which are the MES-HS items. Each indicator has a residual error which consists of error and any variance not explained by the latent construct.

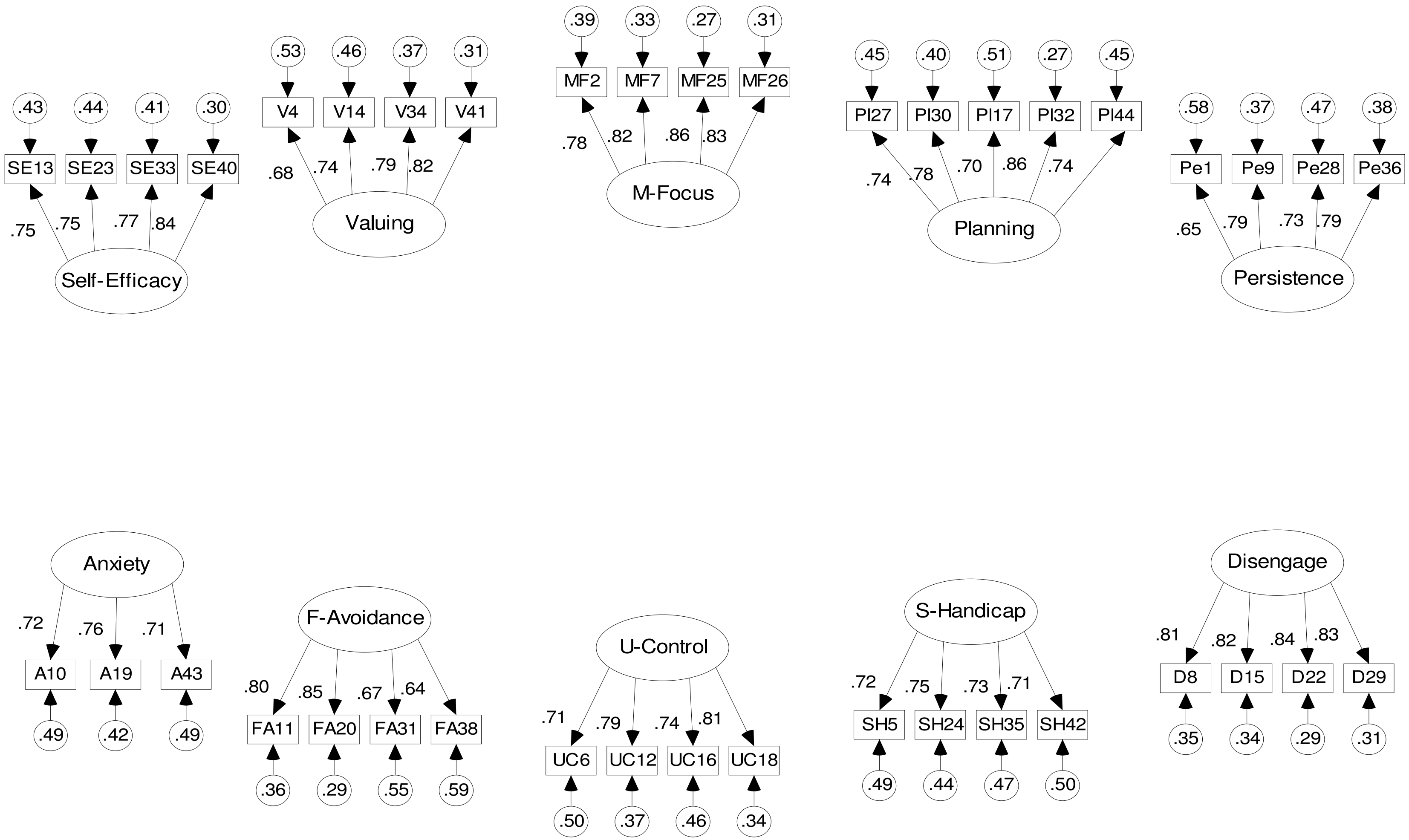


Figure 2. Time 1 factor loadings

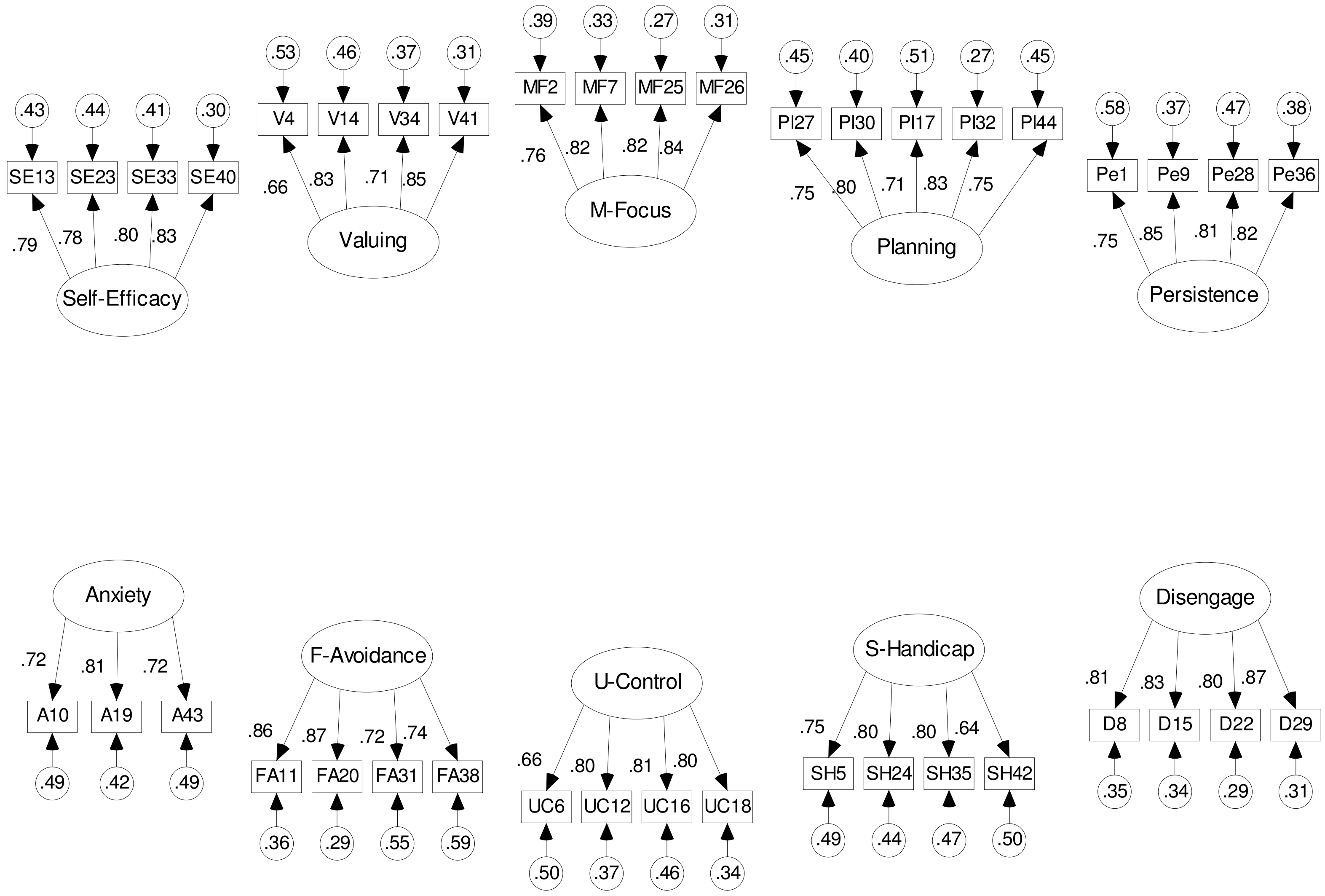


Figure 3. Time 2 factor loadings

4.9 Correlations Amongst Motivational Constructs

After the tests of factor structure and measurement invariance were complete, cross-sectional relationships between the factors were examined by exploring their bivariate correlations with each other. Tables 16 and 17 show the bivariate correlations for Time 1 and 2, respectively. See Appendix K for the correlations according to gender. As shown in Tables 16 and 17, the correlations between the factors were fairly consistent between time-points. Furthermore, most correlations amongst the factors were in the expected direction and of the expected strength, generally supporting the lower-order construct validity of the model. For both waves, the adaptive cognitions positively correlated very strongly with each other, ranging between r = .80 to .89. However, persistence also showed particularly strong positive relationships with these constructs, especially with self-efficacy (r = .87 and r = .83 at Time 1 and Time 2, respectively). The adaptive cognitions showed positive relationships with the adaptive behaviours and negative associations with the maladaptive behaviours. As suggested by Martin's (2007b, 2009) model, the adaptive behavioural constructs positively correlated with each other. However, persistence was associated with disengagement and the adaptive cognitions just as strongly as it was with study planning.

Consistent with expectations, the maladaptive cognitions tended to correlate most strongly with each other. Failure avoidance and uncertain control showed negative or non-significant relationships with all the adaptive constructs. However, anxiety showed significant positive associations with mastery and planning, while generally showing no significant correlation with the other adaptive constructs. As expected, the two maladaptive behaviours, self-handicapping and disengagement were positively correlated. Also as hypothesised, self-handicapping and disengagement were negatively associated with all the adaptive constructs and positively with the maladaptive constructs. However, in both waves, disengagement showed stronger associations with the adaptive cognitions and persistence, rather than self-handicapping.

Table 16.

Time 1 10-Factor Model Correlations between Motivation Factors

	SE	VS	MO	PLN	P	A	FA	UC	SH
SE	-								
VS	.83	-							
MO	.89	.85	-						
PLN	.59	.57	.59	-					
P	.87	.75	.80	.80	-				
A	-.08	.10	.19	.24	-.01	-			
FA	-.20	-.13	-.04	.17	-.14	.69	-		
UC	-.50	-.30	-.23	-.12	-.41	.68	.72	-	
SH	-.52	-.42	-.41	-.43	-.53	.25	.48	.63	-
D	-.76	-.79	-.68	-.55	-.78	.25	.40	.61	.70

Note. N = 519. SE = self-efficacy, VS = valuing, MO = mastery orientation, PLN = planning, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. Values above .09, p < .05.

Table 17.

Time 2 10-Factor Model Correlations between Motivation Factors

	SE	VS	MO	PLN	P	A	FA	UC	SH
SE	-								
VS	.87	-							
MO	.85	.80	-						
PLN	.48	.55	.54	-					
P	.83	.78	.75	.67	-				
A	.03	.07	.28	.32	.06	-			
FA	-.31	-.26	-.16	.04	-.23	.64	-		
UC	-.41	-.22	-.12	.00	-.35	.70	.67	-	
SH	-.46	-.38	-.38	-.28	-.55	.24	.53	.56	-
D	-.76	-.79	-.65	-.48	-.81	.16	.50	.45	.66

Note. N = 519. SE = self-efficacy, VS = valuing, MO = mastery orientation, PLN = planning, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. Values above .09, p < .05.

To demonstrate the complex nature of these cross-sectional relationships, Figures 4 and 5 visually present the correlations amongst constructs for Time 1 and Time 2, respectively. The adaptive constructs are presented in the upper half of the figures and maladaptive constructs in the lower half. The cognitions are located on the left side and behaviours on the right side of the figures. The ovals represent the latent constructs and for simplicity their indicators and residual errors are not included within these figures (refer to Figures 2 and 3 for measurement model details). As shown, most pairs of motivational constructs share significant correlations within each time point.

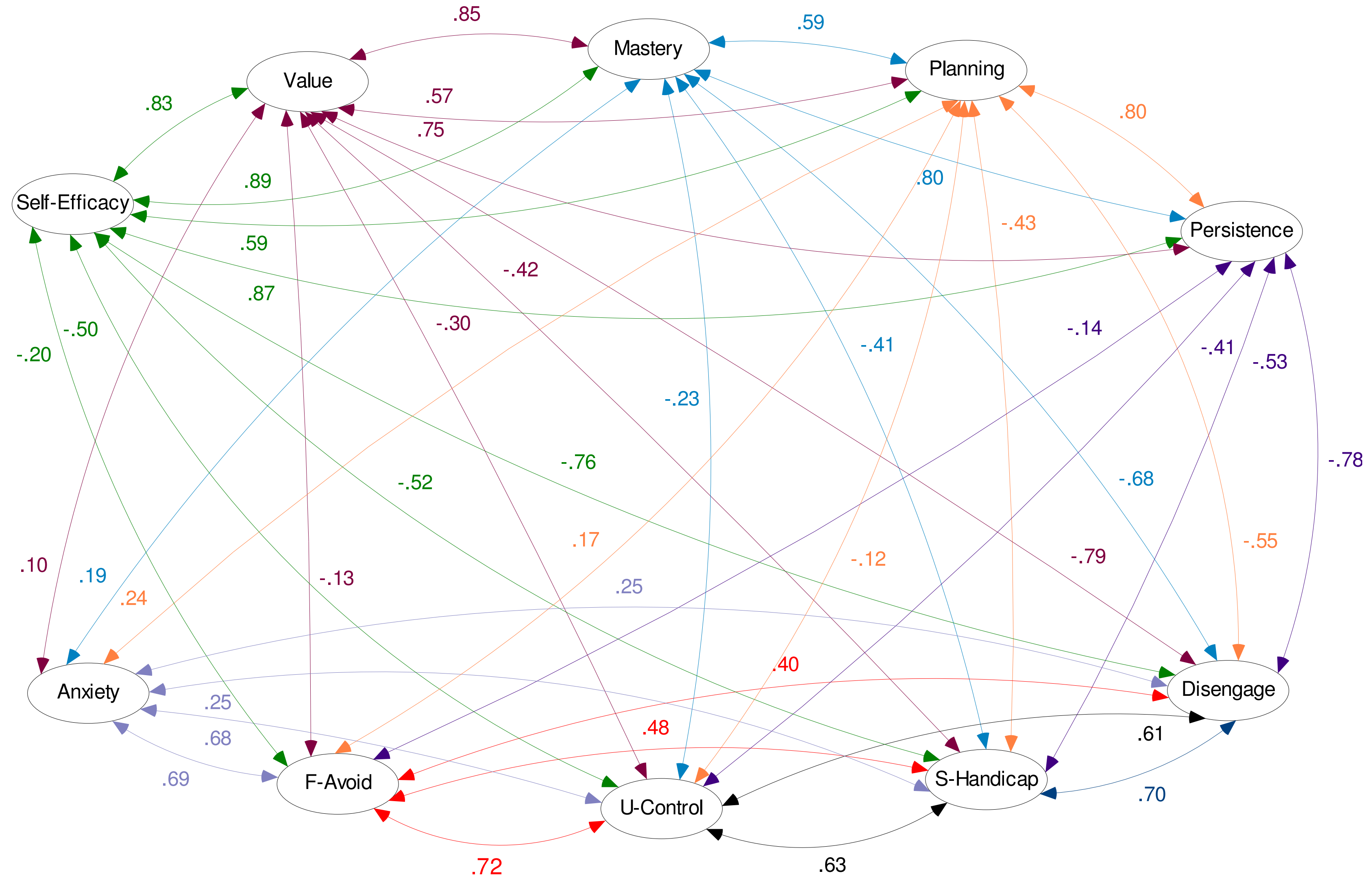


Figure 4. Time 1 latent factor correlations

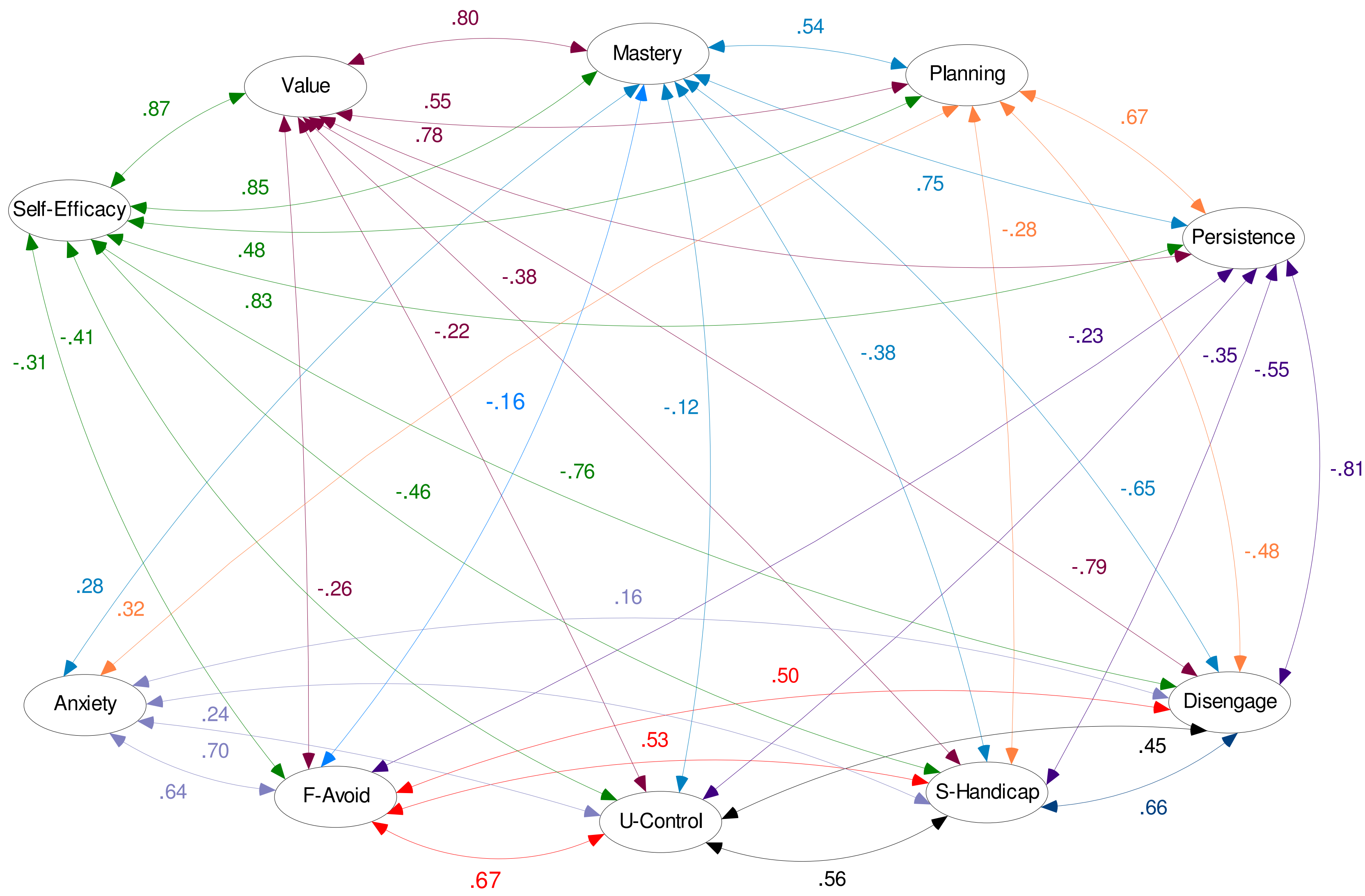


Figure 5. Time 2 latent factor correlations

4.10 Stability of Maths Motivation

With models established for each wave and their measurement invariance ascertained, the current study then explored the longitudinal nature of motivation and its many facets. A final model including both time-points was created to calculate the stability coefficients of the latent factors. This was done by setting the first factor loading for each factor to one and then regressing the Time 2 factor on its respective Time 1 factor. As expected, all stability coefficients were significant (χ^2 = 513.77, *df* = 187, $p < .05$; CFI = .95; TLI = .98; RMSEA = .058) and in a positive direction ($p < .001$), ranging from .52 to .66. Figure 6 presents the latent constructs in the oval shapes, with a regression path connecting Time 1 constructs to their Time 2 counterpart. Again, for simplicity the factor indicators and their residual errors have not been included (see Figures 2 and 3 for details on the measurement model). For the sake of clarity, the correlations between factors within each wave are also omitted in this figure. For these correlations refer to Tables 16 and 17, as well as Figures 4 and 5.

As shown in Figure 6, each facet of maths motivation showed a fair degree of stability in year-to-year attitudes and behaviours towards learning maths, with the stability values ranging from .55 to .68. Self-efficacy, mastery focus, persistence, as well as anxiety appeared relatively more stable, whereas planning, failure avoidance and uncertain control appeared showed the relatively lowest stability over the one year period. However, Table 18 presents the 95% confidence intervals for each stability path. The overlap of the confidence intervals reveals that the stability values of the motivational constructs were broadly in the same range.

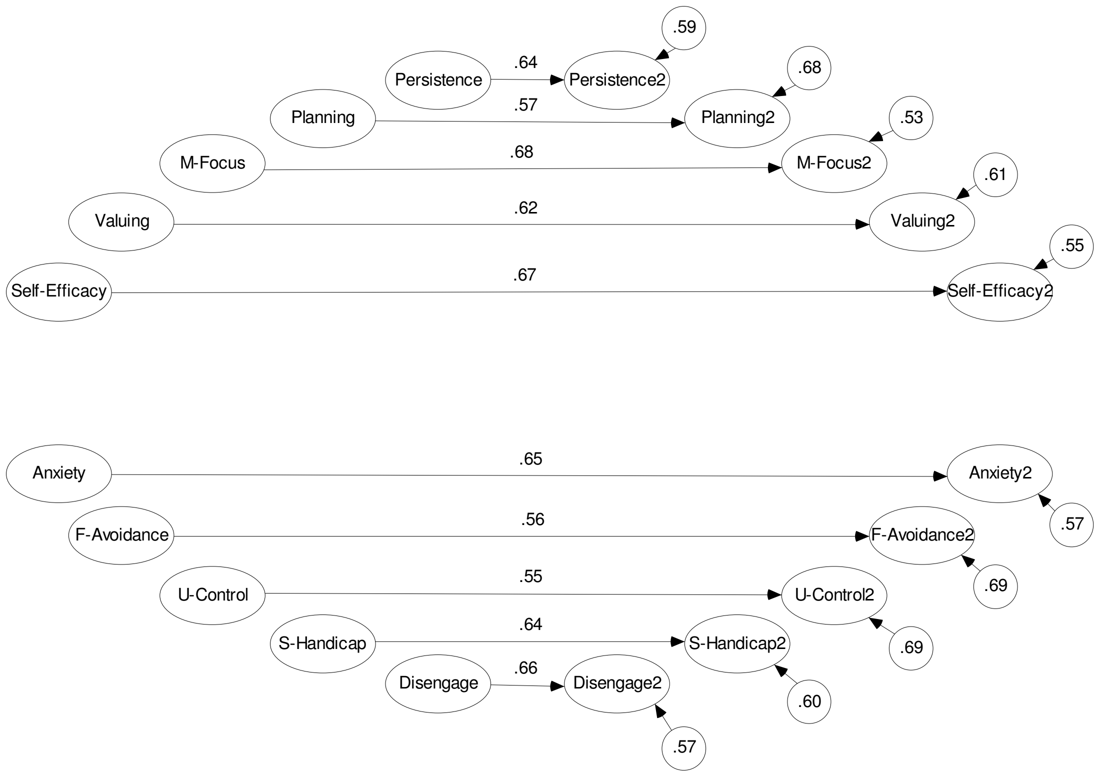


Figure 6. Stability coefficients of motivational constructs.

Table 18.

Confidence Intervals for the Stability Paths

Construct	µ
Self-Efficacy	.62 < .67 > .72
Valuing	.56 < .62 > .69
Mastery	.63 < .68 > .74
Planning	.49 < .57 > .65
Persistence	.59 < .64 > .70
Anxiety	.58 < .65 > .73
F-Avoidance	.48 < .56 > .64
U-Control	.48 < .55 > .63
S-Handicapping	.56 < .64 > .71
Disengagement	.60 < .66 > .72

Note. 95% confidence.

4.11 Relationships amongst Motivational Constructs across Time

Motivational theories tend to address concurrent influences amongst several of the constructs in this study and have left longitudinal relationships between different facets of academic motivation largely overlooked. Consequently, an exploratory analysis was performed that considered longitudinal relationships amongst constructs within Student Engagement and Motivation model. MI from the initial stability model with each Time 2 construct regressed on its Time 1 counterpart were considered for how the range of constructs may relate to each other longitudinally. All MI scoring above 10 were included and these suggested that failure avoidance at Time 2 was predicted by self-efficacy, valuing, mastery focus, study planning, management, persistence, uncertain control, self-handicapping and disengagement. These MI were relatively small, ranging from 12.84 to 15.82 and all were included in a post-hoc model. Many of the added paths were non-significant and so a backward elimination analysis was performed until only significant path coefficients were left. This model showed a good fit (χ^2 = 516.99, *df* = 192, *p* < .05; CFI = .95; TLI = .98; RMSEA = .057) and as shown in Figure 7, the final longitudinal model included Time 2 failure avoidance sharing significant paths with Time 1 valuing, mastery focus, as well as Time 1 failure avoidance. Time 1 valuing was a positive predictor, while mastery focus was a negative predictor. The stability coefficient decreased slightly for failure avoidance from .56 to .53 when these new paths were included in the model.

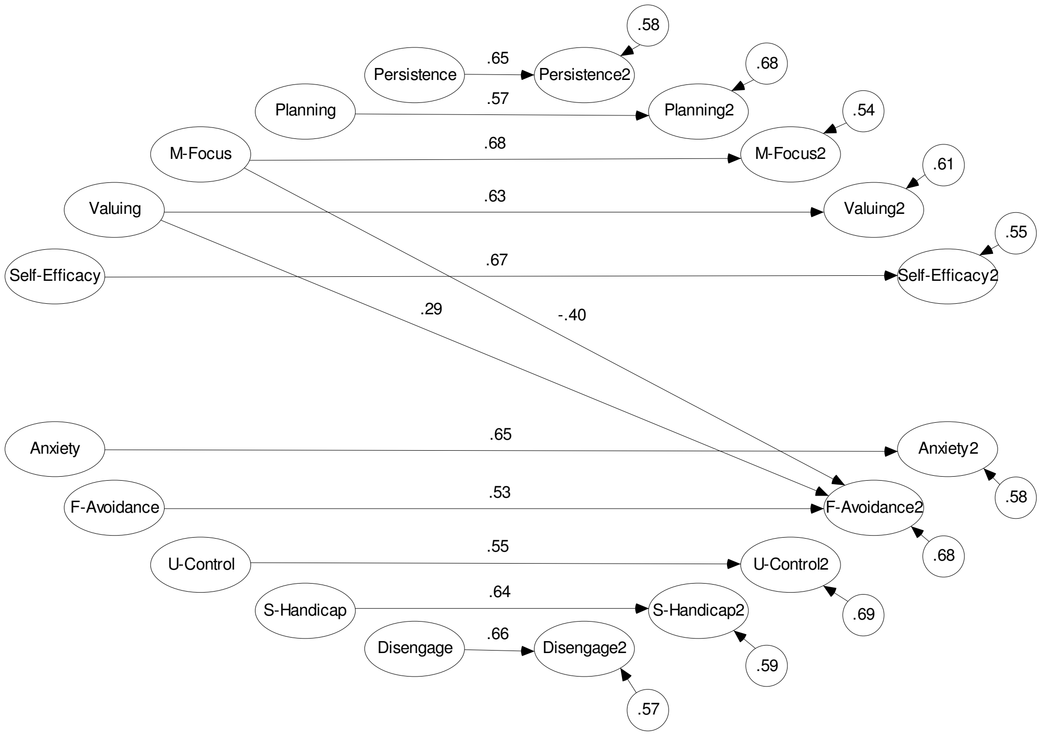


Figure 7. Post-hoc path analysis of motivational constructs.

4.12 Mean Level Changes and Gender Differences in Mathematics Motivation

A main question of the current study concerned how maths motivation changes for Australian high school students, and if the direction or rate of change varies according to gender and different grades. With the MES-HS factor structure and measurement invariance across time and gender clarified, these latent mean differences could then be compared (Levesque et al., 2004; Wu et al., 2009). To do this, the factor scores formed in Mplus were saved and converted to an SPSS file. Then 2 X 3 repeated-measures ANOVAs were performed with SPSS 16 for each motivational construct with sex and cohort (Grades 7, 8 and 9 at Time 1), as well as their interaction as independent variables. The ANOVA results for the adaptive constructs will firstly be presented and then the results for the maladaptive constructs will be presented.

As Figures 8a to 8g indicate, the time effects for all adaptive cognitions and behaviours were significant, indicating declines in these motivational constructs from Time 1 to Time 2. Self-efficacy and persistence showed no main effects for sex, cohort or their interaction. This indicates no overall differences in ratings between boys and girls or cohorts and that self-belief and persistence decreased at a similar rate for each group. There were significant main effects of gender for mastery orientation (η_p^2= .02) and planning (η_p^2= .02), with girls reporting more overall mastery (*M* = .02) and planning (*M* = .03) than boys (*M* = -.13, *M* = -.15, for mastery orientation and planning, respectively). Study planning also showed a significant main effect for cohort (η_p^2 = .02), with students in Grades 8 (*M* = -.13) and 9 (*M* = -.11) reporting lower rates of planning, than those in Grade 7 (*M* = .06). However ratings of planning decreased in a similar way for each cohort. The only construct to show an interaction with time was valuing, which showed a significant cohort X time interaction (η_p^2 = .01) indicating that students in grade 7 at Time 1 reported more utility valuing than grades 8 and 9, and this difference increased with the transition to Grades 9 and 10 showing a steeper decrease in valuing than the transition to Grade 8. Overall, although students from Grade 7 to Grade 8 showed the most adaptive maths motivation, ratings of all positive facets declined somewhat across time.

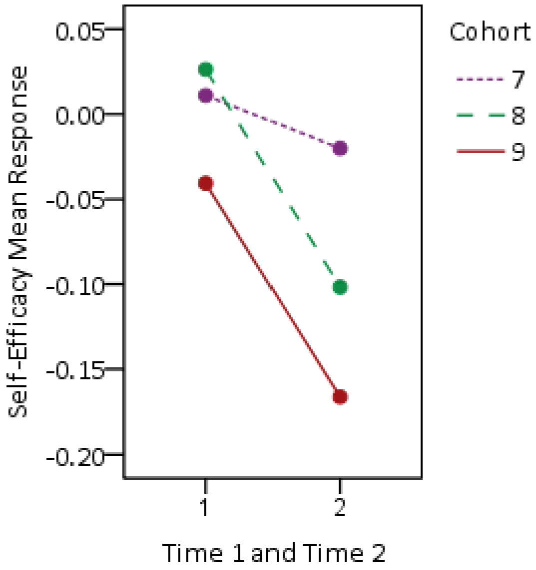


Figure 8a.
Changes in self-efficacy
*Time F (1, 513) = 14.80*** (η_p^2 = .03)*
Cohort F (2, 513) = .95
Gender F (1, 513) = .02
Time X Cohort F (1, 513) = 1.87
Cohort X Gender F (2, 513) = .62

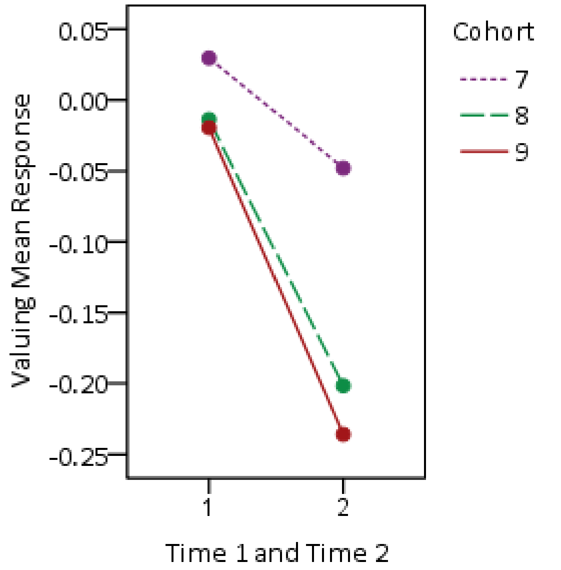


Figure 8b.
Changes in valuing
*Time F (1, 513) = 48.39*** (η_p^2= .09)*
Cohort F (2, 513) = 2.24
Gender F (1, 513) = .01
*Time X Cohort F (2, 513) = 3.62**
Cohort X Gender F (2, 513) = 1.09

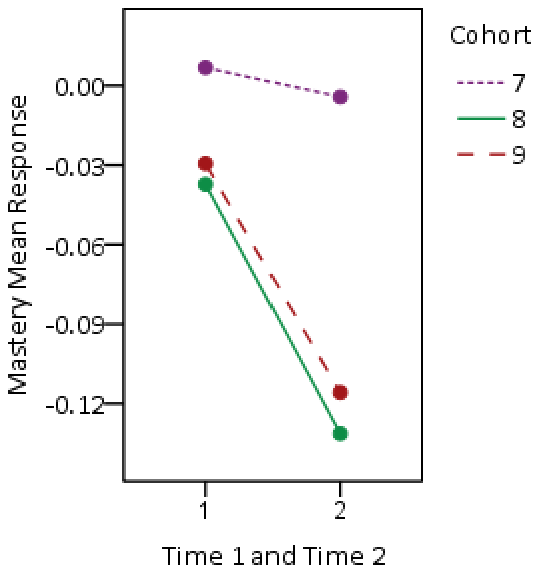


Figure 8c.
Changes in mastery orientation
Time F (1, 513) = 6.02 (η_p^2= .01)*
Cohort F (2, 513) = .93
*Gender F (1, 513) = 6.13**
Time X Cohort F (2, 513) = 1.16
Cohort X Gender F (2, 513) = .58

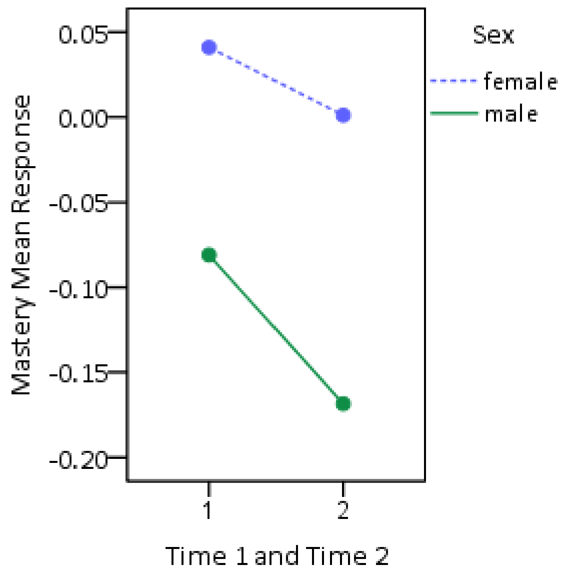
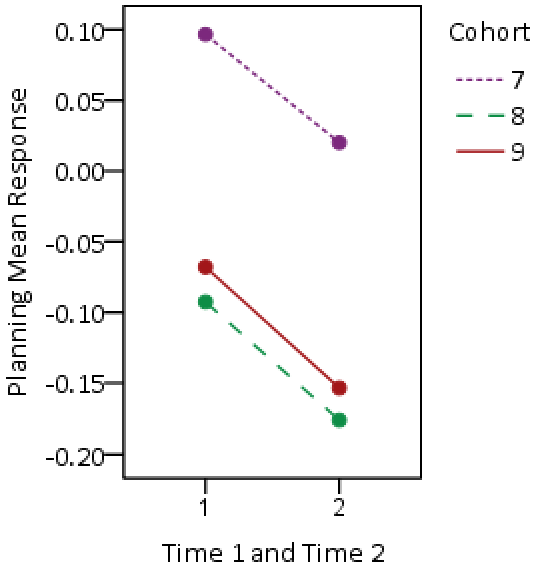


Figure 8d.
Gender effect in mastery



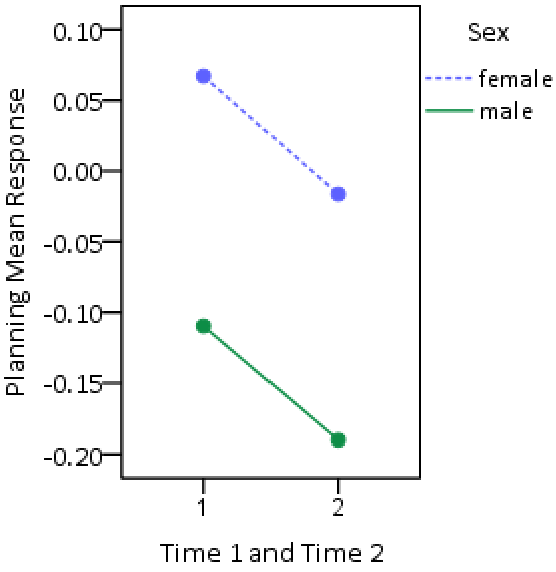


Figure 8e.
Changes in planning
*Time F (1, 513) = 9.36** (η_p^2= .02)*
*Cohort F (2, 513) = 5.53***
*Gender F (1, 513) = 10.28****
Time X Cohort F (2, 513) = .01
Cohort X Gender F (2, 513) = 1.40

Figure 8f.
Gender effect in planning

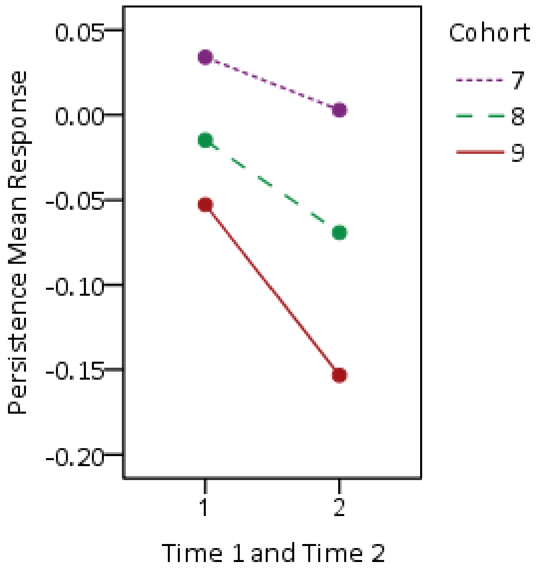


Figure 8g.
Changes in persistence
*Time F (1, 513) = 7.11** (η_p^2 = .01)*
Cohort F (2, 513) = 1.88
Gender F (1, 513) = 2.69
Time X Cohort F (2, 513) = .74
Cohort X Gender F (2, 513) = 1.44

In relation to the impeding dimensions, there were several main effects for gender. Girls reported significantly more Anxiety (η_p^2 = .08) (*M* = .16), Failure Avoidance (η_p^2 = .02) (*M* = .04) and Uncertain Control (η_p^2 = .05) (*M* = .09) than boys (Anxiety *M* = -.18, Failure Avoidance *M* = -.16 and Uncertain Control *M* = -.16). However, there were no significant changes in mean ratings overtime or cohort effects for the maladaptive cognitions. Of the maladaptive constructs, only disengagement showed a significant change across time, increasing from Time 1 to Time 2 in a similar way for each cohort and gender. Self-handicapping showed no significant main effect for time, gender, grade or their interaction

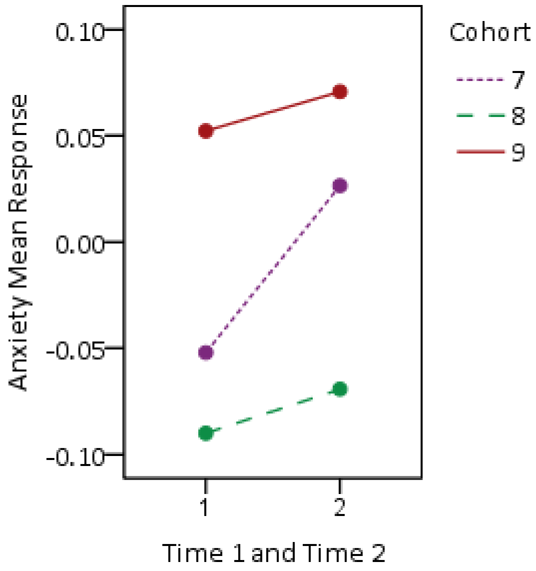


Figure 8h.
Changes in anxiety
Time F(1, 513) = 3.21
Cohort F (2, 513) = 2.31
*Gender F (1, 513) = 43.25****
Time X Cohort F (2, 513) = .89
Cohort X Gender F(2, 513) = 1.06

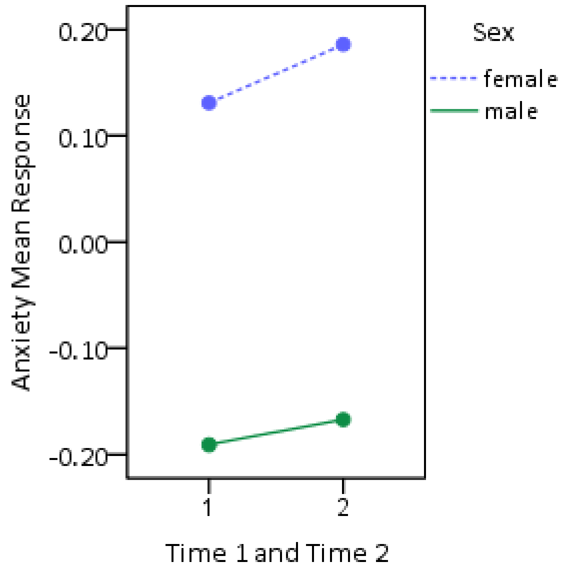


Figure 8i.
Gender effect in anxiety

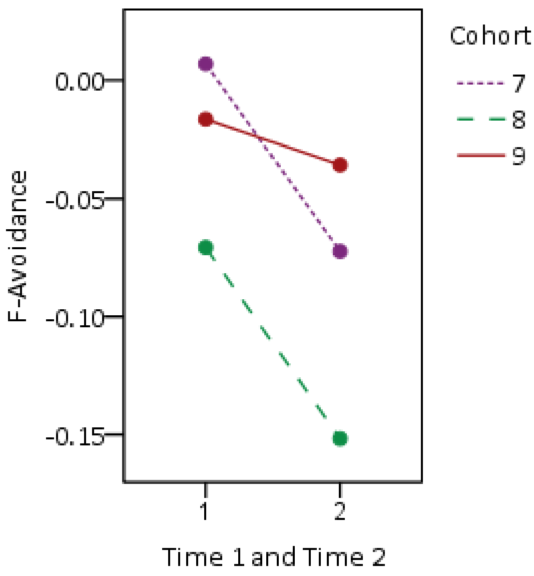


Figure 8j.
Changes in F-Avoidance
Time F(1, 513) = 2.96
Cohort F(2, 513) = .86
*Gender F(1, 513) = 11.55***
Time X Cohort F (2, 513) = .31
Cohort X Gender F (2, 513) = .28

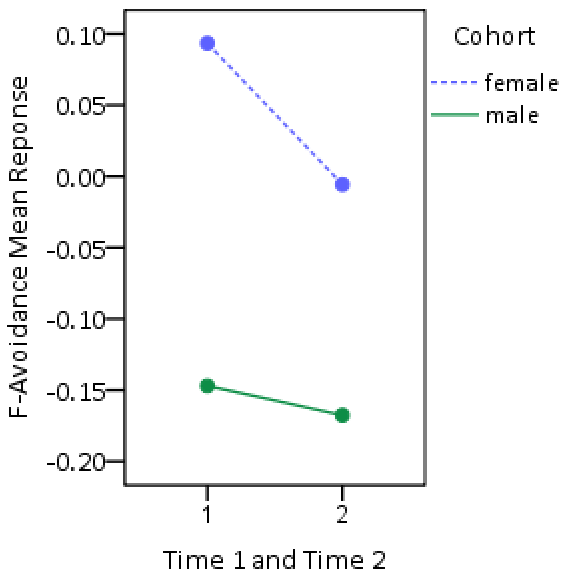


Figure 8k.
Gender effect in F-Avoidance

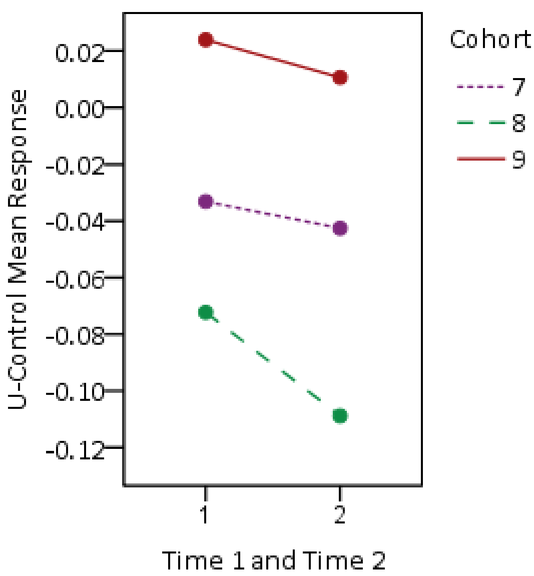


Figure 8l.
Changes in U-Control
Time F (1, 513) = .57
Cohort F (2, 513) = 1.36
*Gender F (1, 513) = 24.51****
Time X Cohort F (2, 513) = .11
Cohort X Gender = F (2, 513) = .28

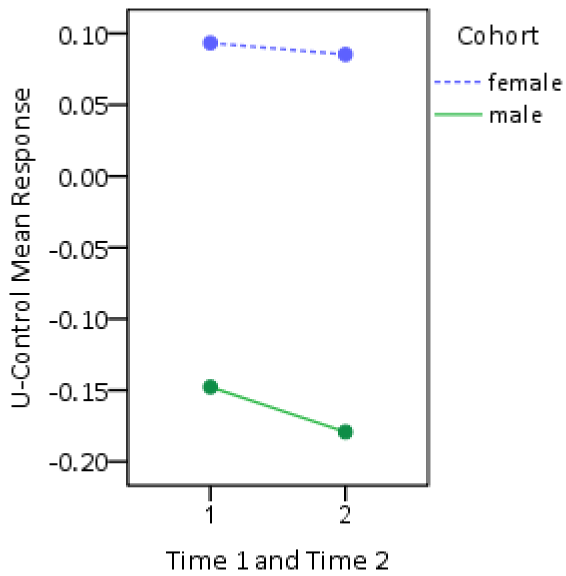


Figure 8m.
Gender effect in U-Control

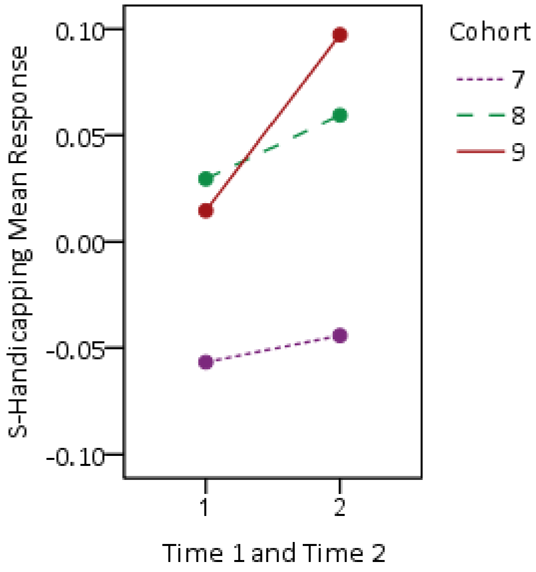


Figure 8n.
Changes in S-Handicapping
Time F(1, 513) = 2.96
Cohort F(2, 513) = 1.77
Gender F(1, 513) = .88
Time X Cohort F (2, 513) = .71
Cohort X Gender F(1, 513) = .70

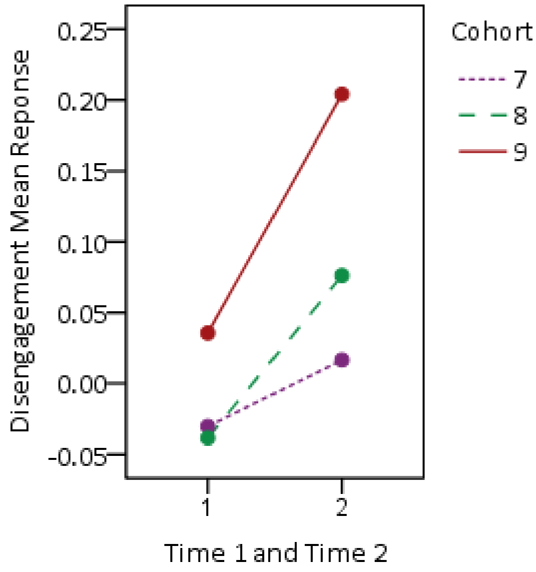


Figure 8o.
Changes in disengagement
*Time F(1, 513) = 15.75*** (η_p^2= .03)*
Cohort F(2, 513) = 1.40
Gender F(1, 513) = 2.21
Time X Cohort F (2, 513) = 1.64
Cohort X Gender F(2, 513) = 1.47

Chapter 5
Study 1 Discussion

5.1 Outline of Chapter 5

Chapter 5 will firstly review the main aims of Study 1. Then it will evaluate the findings from the measurement analyses and their implications in regard to theory and practice. Next, the associations of each construct with other facets within the Student Motivation and Engagement Wheel will be explored. This will evaluate the adequacy of current theories in explaining the network of relationships. Following this, the results for mean level changes and gender trends will be discussed. Finally, a summary with the limitations and conclusions for Study 1 are presented.

5.2 The Research Questions and Aims

The current study aimed to examine the multifaceted nature of maths motivation through a multi-cohort-multi-occasion design. The key research questions regarded the nature of maths motivation and how it develops throughout high school for Australian male and female students. The Motivation and Engagement Wheel was applied to maths as a comprehensive model of academic motivation that addresses a range of cognitions and behaviours stemming from pivotal theories of motivation. Firstly, the factor structure and measurement invariance of the measurement scale was tested across gender and time to ensure that all groups interpreted it as expected and shared a similar structure of maths motivation. Then the stability of maths motivation over a one-year period, as well as the concurrent and longitudinal relationships amongst motivational facets was examined. Finally, Study 1 assessed mean level gender and cohort differences, as well as year to year differences in ratings of motivation. This was to clarify if declines and gender trends observed in other populations are also found in Australian high school students from a rural background.

5.3 Measurement Analyses of the MES-HS

5.3a Factor Structure of Maths Motivation.

To the best knowledge of the author, the current study provides the first independent assessment of the factor structure of the MES-HS. It tested the fit of Martin's hypothesised 11-factor lower-order structure, as well as that of four alternative models. Although the 11-factor model was expected to show a strong fit to the data, it also considered if maths motivation could be conceptualised more succinctly.

The current study found that neither the 1, 2 or 4-factor models reflected the data well. However, Green et al. (2007) found that within a larger 3-factor model assessing science, English and maths where items for each discipline formed a factor, the MES-HS items for maths could reflect one-factor. When compared to motivation in other academic subjects, maths motivation may be distinguished as a global construct. However when only maths motivation was assessed, as done so in the current study this scale did not represent one-factor. Furthermore, although the scale is hypothesised to hold a 4-factor higher order structure, this did not work as an alternative lower order structure. After the scale was adjusted slightly through item deletion, the 11-factor model reflected a relatively acceptable fit to the data. This was partially consistent with the hypothesis and previous research finding a good model fit with the MES-HS (Green et al., 2007; Martin & Marsh, 2005). However as expected, the 10-factor model also fit the data, showing as close fit to the data as the 11-factor model.

Although Martin (2007a, 2007b, 2009) presents planning and study management as two separate constructs, the current study questioned the theoretical and practical distinction of these two factors. This was based on their theoretical and practical similarity, as well as the empirical evidence evaluated in this study. Examination of the GOF indices, the strength of the correlation between planning and study management and their parallel relationships with other factors suggested that they could be combined. A review of the self-regulation literature revealed that similar to criticisms of the broader motivational literature, definitions of self-regulation and its factor structure vary substantially between studies. Both planning and study management are based on self-regulation theory (Zimmerman, 1994) and the behaviours they refer to overlap somewhat both theoretically and practically. Planning aims to enhance personal regulation, while study management refers to a focus on improving the learning environment (Zimmerman, 1994). Planning relates more to cognitive and behavioural regulation, whereas study management relates more to organising one's environment to support learning. However, essentially both factors as measured by the MES-HS are concerned with how students organise their study.

Both the 10-factor and 11-factor models are useful in providing information about the extent of and type of effort students expend towards learning. On one hand, adjusting the Wheel to a 10-factor model retains the complexity of student engagement but also focuses on cognitions and behaviours that are readily distinguishable, permitting a more parsimonious model. On the other hand, retaining the 11-factor model with a distinction between planning and study management allows for more specific assessments of students' behavioural engagement and comparability with published research.

A different model was only considered necessary if it showed a substantially different degree of fit to the original factor structure and so the 11-factor model was initially selected for further analysis. This was to maintain theoretical and empirical consistency with previous research applying the Wheel and the MES-HS. However, the 11-factor model came across estimation problems based on linear dependency between the planning and study management factors. As a result, the final decision favoured the 10-factor model to be applied to assess maths motivation in this study. This finding does not invalidate the 11-factor model, as its factor-structure and measurement invariance were also supported to a fairly large extent. However, it may indicate that the indicators of planning and study management should be reviewed to capture more distinctive behaviours.

The poor fit of the 1, 2 and four-factor models indicate that academic motivation is multidimensional and that cognitions and behaviours should be assessed individually rather than summed together as global indicators. For example, research applying a valuing framework often pools intrinsic and utility values together (Fredricks & Eccles, 2002; Singh et al., 2002). However, the current results showed that while utility and mastery values were strongly associated with each other and showed similar relationships with other constructs, they did differ in the strength and direction of those relationships and as a result, should be assessed as unique cognitions. This was also the case for many facets within the Wheel, as maths motivation could not be reduced to a simpler factor structure. Although much research refers to 'effort' as a global construct (for example, Chouinard et al., 2007; Ntoumanis, 2001; Legault, Green-Demers, & Pelletier, 2006; Greene et al., 1999), the first-order CFAs showed that study planning, persistence, self-handicapping and disengagement were distinct constructs. Consequently, studies that combine constructs to form a global measure of motivation are at the risk of overlooking important subtleties in the relationships between motivational facets and other variables.

Unexpectedly the second-order structure of the MES-HS failed to show an acceptable fit to the data. This is contrast to previous research within general academic motivation that has supported the 4-factor higher-order structure (Martin, 2007b, 2009). An inspection of the strength of correlations between the constructs led to post-hoc second-order models being formed. However, these also showed a poor fit. There were very strong correlations between some constructs belonging to different quadrants of the Wheel. However, the relationships were complex and there was no clear pattern by which the constructs could be grouped. For example, although persistence and planning were very strongly associated, only persistence was strongly correlated with the adaptive cognitions. Reflecting the multidimensional nature of motivation, this indicates that maths motivation is best conceptualised at a lower-order level, rather than summarised within a more parsimonious second-order framework.

Whilst the 10 and 11-factor models showed an adequate fit to the current data, there was room for improvement in terms of the model fit. Although all indicators significantly loaded on their hypothesised factor, four items failed to adequately distinguish between the factors and a fifth item cross-loaded with the self-handicapping latent construct. However, prior research with the MES-HS has reported all items as performing adequately within both general academic and maths motivation (Greene et al., 2007; Martin, 2007b; Martin & Marsh, 2005). In both waves, the same four items showed cross-loadings, indicating consistency in their failure to adequately distinguish between factors. The planning items Pl21 and Pl39 assessed students' preparation for maths 'study' in general, whereas the remaining items concerned studying specifically for exams or assignments. Perhaps this difference in item specificity resulted in the factor cross-loadings, as more task general items were associated with other latent constructs, while task specific items tended to only load on their intended factor. The anxiety item (A37) that showed many cross-loadings was also theoretically distinguishable from the other anxiety indicators in terms of its specificity. It concerned general negative affect related to maths, whereas the remaining anxiety items specifically referred to feelings of worry. The item referred to "…*not feeling very good*", which can potentially involve a range of feelings, such as sadness, helplessness, exhaustion, physical sickness or worry. While negative affect and worry are similar constructs, for Australian rural students they appear to have different psychological implications. This is consistent with previous research suggesting that there are two dimensions comprising maths anxiety. According to Wigfield and Meece (1988), two forms of maths anxiety can be distinguished; cognitions involving thoughts of worry versus negative affect involving emotions and physiological experiences such as fear, nervousness and discomfort. Item A37 appeared to target the affective dimension of maths anxiety, while the remaining three anxiety items focused on the cognitive element of worry.

In relation to anxiety, the current results also showed that at Time 2, item A43 from this factor cross-loaded on self-sabotage. This item referred to '…*maths work*', whereas the other items addressed exams specifically. This cross-loading may represent a real difference between young and older high school students' coping strategies. The term *'maths work'* may refer to tasks in the classroom involving processes and outcomes readily observable by others, rather than exams or assignments which tend to be more privately experienced events. Considering that study pressures and self-consciousness increase during adolescence (De Fraine et al., 2007), perhaps a tendency to worry about general maths work is associated with a greater likelihood of protecting self-worth through performance avoidance for older rather than younger students. As younger students may perceive less pressure to achieve and meet others' expectations, their worries about doing maths work may not reflect their tendency to protect self-worth. On the other hand the cross-loading of item A43 on self-handicapping could also simply reflect sampling variability, rather than indicating a meaningful difference in the measurement model between the younger and older waves. When the cross-loading was permitted item A43 loaded weakly on self-handicapping and was unlikely to influence the overall model fit or how the constructs related to each other. Considering that no previous research has identified this relationship, the cross-loading was treated with caution and not included in the final model.

5.3b Measurement Invariance.

Direct comparisons of the mean differences between gender and time-points were a major focus of this research and so the current study tested if the MES-HS operates equivalently across these groups. The MES-HS demonstrated an acceptable fit for each wave and importantly, invariance across gender and time. This meant that the items were interpreted and functioned in a similar way for boys and girls, as well as between the first and second time-points. On occasion the chi-square difference test did approach significance because of gender differences in factor loadings. However, these were minor and were not considered as reflecting meaningful differences.

The gender multigroup CFA for Time 2 showed the anxiety indicator A43 as being a source of measurement non-invariance. Worrying about maths work was associated with self-handicapping for girls, while for boys this feeling extended to other aspects of mathematics motivation, including maladaptive cognitions as well as behaviours. This may reflect a tendency for girls' worries about maths work to be more focused and compartmentalised, whereas for boys such concerns may generalise to how they approach tasks and develop maladaptive coping strategies. This supports suggestions by Llabre and Suarez (1985) that boys' maths anxiety is more strongly related to general anxiety than for girls. However, when item A43 was freed to cross-load on self-handicapping, the factor loadings of other items did not change and its own loading was weak. Although this source of invariance was possible to consider on a theoretical basis, the empirical evidence indicated that it was negligible.

The main lesson from the assessments of model fit and invariance seems to be that factor indicators must be specific to their intended emotion, behaviour and context. Each of the five problematic MES-HS items diverged in this way from other indicators hypothesised to load on the same latent factor. Perhaps the wording of these indicators could be reviewed to target more specific content. Nevertheless, the current results support the Student Motivation and Engagement Wheel as a suitable model of motivation throughout high school and the MES-HS as a suitable measure. Previous research has reported the 11-factor model as showing invariance between different grades, as well as boys and girls (Martin, 2007b; 2009). However, this has addressed the MES-HS at a general academic level, rather than being subject specific. Therefore, the current study extends previous findings by demonstrating that within mathematics, the MES-HS reflects an equivalent 10-factor structure across gender and repeated testing occasions. This indicates that there is generality of the academic motivational framework to mathematics and that a multidimensional approach to maths motivation that incorporates a range of theoretical viewpoints is highly suitable to this area of study.

5.4 The Stability of Maths Motivation

The second main focus of Study 1 was how maths motivation develops across time. Major theories of academic motivation imply that attitudes and behaviours towards learning have a lasting effect and much research discusses the importance of tracking academic motivation across time. However, models of academic motivation tend to be concurrent, rather than longitudinal. This means that few have addressed the stability of motivation (Schunk, 2000) and that predictions about the relationships between motivational constructs generally address associations within the same time-frame. Consequently, the current study first tested the stability of each motivational facet across the one-year interval. Then due to the lack of established theory, an exploratory analysis was performed on the longitudinal relationships amongst constructs within the model.

As expected, all constructs were significantly and positively related to their Time 1 counterparts. Each of these paths reflected strong stability coefficients, suggesting that mathematics motivation tends to be stable, with fairly moderate year to year fluctuations. In contrast to Wigfield et al. (1997), the adaptive cognitions shared similar levels of stability. Although mastery orientation appeared more stable than utility value, this was not a substantial difference. Also in contrast to their findings regarding self-efficacy, the current study found similar stability for self-efficacy and intrinsic interest. This difference in findings may be because Wigfield et al.'s (1997) sample consisted of primary school students, while the current study involved high school students. The stability of both ability and value beliefs tends to increase with age (Eccles et al., 1984; Stipek & Mac Iver, 1989; Wigfield et al., 1997). Compared to primary school, by high school perhaps students are more consistent in which activities they enjoy and their self-perceptions of competence in specific contexts. According to Wigfield et al. (1997) slightly lower stability for utility values may be expected because students receive less consistent information about the relevance of maths from various sources including parents, teachers and peers throughout the year. However, more stable perceptions of competency and enjoyment may arise because students frequently receive explicit and implicit feedback about their performance.

Looking at other components in the model, the current study found stronger stability coefficients for anxiety than previous research has reported. For example, Ma and Xu (2004) tracked high school students from grades 7 to 12 and observed stability coefficients ranging from .39 to .57, which are lower than the current model's value. This difference in strength may be due to the dimension of anxiety focused on in the two studies. The current measure concerned the cognitive element of anxiety, whereas Ma and Xu (2004) had two items assessing negative affective reactions to maths. Rather than conflicting, when considered together these results may indicate that the tendency to worry about going well in maths is more stable across time than experiencing negative emotions such as fear or nervousness. Perhaps such worry is less context dependant and not always attributable to maths per se but is more associated with a student's personality tendencies.

The current pattern of stability coefficients did not support expectations based on previous findings addressing the subject-specificity of the MES-HS constructs. Green et al. (2007) found that ratings of anxiety, planning and task orientation were relatively strongly correlated across English, maths and science, while valuing and disengagement were more context-dependent. Although the current study found anxiety and mastery orientation had slightly higher stability over the one-year interval, planning did not. Furthermore, Green et al. found that uncertain control and failure avoidance showed fairly strong cross-domain generality, however these did show greater stability in the current study. This inconsistency between the stability results and cross-sectional research on domain generality reveal the nature of motivation. Although some facets of academic motivation may have similar concurrent ratings across disciplines, these same facets are not necessarily the most stable across time.

While the current study showed individual facets of motivation to be fairly consistent overtime and to share a similar level of stability, a second question also asked how different facets within the model relate to each other longitudinally. The exploratory analysis addressing this question showed only failure avoidance at Time 2 to be significantly predicted by previous motivational experiences. This is despite expectations that self-efficacy would play a major role in shaping future motivation, particularly of intrinsic, utility and anxiety beliefs (Meece et al., 1990). Social cognitive theory presents self-efficacy as a driving force influencing how students perceive and react to learning activities. However, the exploratory analysis conducted for this study showed no longitudinal evidence of this influence. Furthermore, although previous research has found that university students' persistence in maths predicts their mastery values and feeling of control one-year later (Martin et al., 2003), the current post hoc analysis did not support this trend either when the stability of all motivation factors was accounted for.

The additional paths to Time 2 failure avoidance derived from Time 1 valuing and mastery orientation. Failure avoidance was positively predicted by valuing, whereas it was negatively predicted by mastery focus. This indicates that students who believed learning maths was relevant to their future risked developing a work orientation centred on avoiding negative judgements from others. This may be because students pre-occupied with gaining an external reward use judgements from others as sources of reassurance. Consequently, although EVT presents utility values as a positive motivator, the current results demonstrate that its extrinsic nature has the potential to encourage maladaptive motivation in the long-term. However, students who enjoyed maths and gained satisfaction from it were less likely to develop a fearful orientation. This may be because their focus is on the intrinsic enjoyment they gain from learning. Students with a mastery orientation also tend to associate performance with effort rather than ability (Ames, 1992). This means that they are less likely to be concerned with others' judgements of their competence. Consequently, these results suggest that intrinsic interest can act as a buffer to potentially stressful evaluative events and judgements. This highlights the role of values in need achievement, self-worth and goal theories, as a fear of failure appeared to be influenced by which type of values students associated with a task.

The current results also indicated that the stability of failure avoidance varied somewhat year-to-year, particularly when students' prior values were taken into account. From a practical perspective this is good news for educators as a failure avoidant tendency may be fairly malleable compared to other constructs such as anxiety or self-efficacy. Perhaps enhancing students' feelings of interest and satisfaction from learning maths, with a balanced perspective of its usefulness may lead to less failure avoidance in the future.

Overall, the tests of stability indicated that there was some degree of consistency in students' experiences across time. Despite previous findings that the mean level of motivation tends to fluctuate within the school year (Chouinard & Roy, 2008; Mac Iver et al., 1991), particularly before stressful periods such as exams (Smith, 2004), the current study showed that longer term maths motivation was fairly stable. This means that a student's ranking in maths motivation relative to others was fairly consistent one-year later. The interpretation of this as positive or negative depends on the individual. If a student has stronger self-efficacy compared to other students, this is promising as they are likely to maintain a similar advantage one-year later. However if a student has comparatively weaker competency beliefs, the stability coefficients indicate that this relative difference is also likely to be fairly enduring. However, the stability values were not so high as to suggest there was not any individual movement within the group.

5.5 Theoretical Evaluation of Associations within the Student Motivation and Engagement Wheel

Another main goal of Study 1 was to address the nature of maths motivation in terms of the associations between motivational constructs and the adequacy of current theory to account for these relationships. Each facet in the final model will now be reviewed in relation to their development and relationships with other motivational constructs. This will draw on the correlational and longitudinal analyses, reiterating the findings and interpreting their practical implications. The usefulness of the core motivational theories in explaining these relationships will also be evaluated. Each facet will be discussed individually, with a brief summary presented for each quadrant of the Wheel. This section is valuable for the reader who wants a detailed examination of a specific facet of motivation. Subsequently, the discussion of grade and gender differences is taken up again in section 5.6 to develop a picture of how maths motivation develops for the average rural student in Australia.

5.5a Self-Efficacy

At both time-points, self-efficacy was most strongly related to valuing, mastery and persistence, as well as negatively correlated with disengagement (see Figures 4 and 5). Whilst all other maladaptive cognitions and behaviours showed moderate negative relationships, anxiety showed no significant correlation to self-efficacy. Self-efficacy also showed strong stability across time (see Figure 6), indicating that students tended to maintain a similar self-perception of their abilities one-year later. Consequently, maths self-efficacy was primarily related to previous self-efficacy perceptions, as well as concurrent values and perseverance.

The observation of self-efficacy as being most associated with students' value beliefs and previous perceptions of their maths ability supported predictions of EVT. These results highlight the inter-relatedness of maths competency beliefs with extrinsic and intrinsic values. While these were unique constructs, students with stronger self-efficacy tended to also have stronger value beliefs. Conversely, poor self-efficacy was highly likely to be associated with poorer attitudes regarding the usefulness and enjoyment of maths.

The concurrent correlations between the motivational constructs indicated that a decrease in self-efficacy would be problematic for students' engagement because self-belief was highly associated with behaviour within the same year. Students with lower maths self-efficacy were likely to report more disengagement and less effort, characterised by lower persistence. However, behaviours such as planning and self-handicapping were relatively less strongly associated with self-efficacy. Although they were associated in the expected direction, self-efficacy appeared to relate more to perseverance, rather than organising one's study or efforts to protect self-worth. This may be because students with strong self-efficacy believe they have a good chance of achieving and are less concerned with protecting self-worth because learning challenges are not threatening. The current results are consistent with Bandura's (1997) suggestion that students who believe they can do what it takes to achieve are more likely to put more effort in. Self-efficacy appeared to play an energising role in maths motivation, relating to whether students' perceive activities as worthwhile and their determination to complete a task.

Contrary to Bandura's (1997) suggestion that self-efficacy influences students' anxiety, the current study found no significant correlation in either wave. Instead, feelings of uncertain control were negatively associated with self-efficacy. This clarifies the distinction between maladaptive cognitions in social-cognitive theory. Students need a sense of control that they can regulate their behaviour to influence outcomes (Bandura, 1997). Consequently, self-efficacy was more likely when students felt confident about their ability to control events. A student may believe they are good at maths but they also need to know how to get a good mark on an upcoming exam. The current results show that it was specifically a sense of control that was directly relevant for students' self-efficacy, rather than worrying about performance. The negative association between self-efficacy and control beliefs is consistent with attribution theory (Weiner, 1985). Students with stronger self-belief tended to feel that they could influence outcomes more than those with lower competency beliefs.

Weiner (1985) suggests this is because competent feeling students attribute success to their abilities and failures to poor effort. However, those with low self-efficacy may attribute their failures to their ability and subsequently feel little control over how to improve their situation. Furthermore, perceptions of effort as a pointless endeavour will be perpetuated if such students also perceive their low ability as a stable rather than changeable quality.

In summary, self-efficacy appeared to be largely associated with how useful and interesting a student thinks maths is, as well as their tendency to persevere versus feel apathetic within the same year. Consequently, demonstrations of confidence in maths are reflective of students' value beliefs and tendencies to be behaviourally engaged. Students are unlikely to feel confident toward a task they believe is boring or pointless. The associations self-efficacy shared with other constructs were generally accounted for by the EVT, self-worth and social-cognitive theories. The current results suggest that rather than focusing on reducing worry or fears of failure to improve a students' self-efficacy, both types of values towards maths should be supported, as well as boosting a sense of control over achievement outcomes.

5.5b Utility Valuing

As shown in Figures 4 and 5, utility valuing was most strongly related to self-efficacy and mastery orientation, as well as persistence and disengagement. Although anxiety showed a slightly significant positive relationship with valuing at Time 1, the remaining maladaptive constructs showed weak to moderate negative relationships. Valuing at Time 2 showed a strong relationship with its Time 1 counterpart (see Figure 6). Overall, the likelihood of perceiving maths as useful was most related to previous ratings of this belief, as well as holding positive competency beliefs and an intrinsic interest towards maths.

Overall, utility valuing was more strongly directly related to adaptive constructs rather than anxiety or fearful facets. The more a student perceived maths as useful, the more likely they were to also perceive it as an interesting subject and themselves as being capable of achieving it in. Although utility values can be considered as an external motivator, they had positive associations with students' experiences of enjoyment and competency in maths. Alternatively, students who felt capable and interested in maths were more likely to consider it useful.

The nature of the correlations of valuing with mastery and competency beliefs may reflect the self-worth protective process of defensive pessimism. For a student to believe that maths is useful for their future, but also acknowledge that they find the discipline boring or that they feel incompetent can create feelings of distress and lowered self-value. Instead, to retain a sense of pride it is functional to discount the value of maths so that having a low interest or competence in this field does not matter anyway.

In terms of behavioural engagement, valuing maths was strongly associated with persistence and disengagement, as well as planning to a lesser extent. This has implications for EVT as little previous research has focused on the role of utility valuing in learning behaviour. Research has tended to focus on the usefulness of utility value in predicting more distal outcomes such as enrolment and career choices (Meece et al., 1990; Wigfield & Eccles, 1992). However, the current results highlight the importance of values in understanding self-regulation and apathy. They also challenge assumptions that external motivators are inherently negative and show that they can be a strength.

The correlations also demonstrate that utility values play a role in elements of social-cognitive theory. Although anxiety was not particularly associated with students' maths valuing, ratings of uncertain control were. As with self-efficacy, it appeared that it was feelings of control that were more relevant to usefulness beliefs than feelings of worry. Utility values tended to negatively correlate with feeling that outcomes were beyond one's control. This also reflects a self-worth motivated defence, as it is risky for students' wellbeing to believe that something is important if they cannot improve their chances of achieving it. Nevertheless, although social-cognitive theory does not explicitly address utility values, they appeared to be relevant to perceptions of control.

Generally, the relations of utility valuing with other facets within the model were accounted for by EVT. However, the current results also demonstrate how this type of incentive can be integrated in self-worth and social-cognitive theories. Overall a key finding was that the more a student believed maths was pointless, the less likely they were to have high confidence in it or enjoy the subject very much. Consequently, those wishing to target utility values should enhance students' confidence in maths, as well as the satisfaction they can gain from completing maths activities.

5.5c Mastery Orientation

Mastery orientation was most strongly positively related to self-efficacy, valuing and persistence and was also strongly negatively related to disengagement (see Figures 4 and 5). Mastery orientation generally shared moderate negative relationships with all other maladaptive constructs except anxiety, with which it showed a positive relationship. It also showed strong stability across the one-year interval. Consequently, the development of a mastery interest in maths appeared to be primarily related to previous experiences of this belief, as well as concurrent values, persistence and disengagement.

The strong correlations mastery shared with the adaptive facets within the model support the conceptualisation of intrinsic interest as central to adaptive behavioural engagement and achievement (Ames, 1992; Nichols, 1989). In support of those arguing for the multidimensionality of values, the current results indicated that rather than reflecting an overall construct, these were related but distinct beliefs. These results also highlight the relevance other values and competency beliefs may play in the development of a mastery approach. Students with an intrinsic interest in maths were more likely to feel greater confidence than those who tended to find maths boring. In support of the EVT framework then, students' perceptions of ability should be included in models of intrinsic interest.

The negative relationship mastery orientation shared with most maladaptive constructs confirms its importance as a core feature of adaptive motivation. A greater mastery orientation was likely when students felt a sense of control over their chances of success and less concern regarding others' judgements. Consequently, intrinsic interest may buffer against maladaptive coping strategies by supporting students' needs as identified by need achievement and control theory. Having a mastery approach towards maths may mean that students are likely to be more attuned to and have a greater understanding of what is required to achieve. Having an interest in the subject matter also appeared to help students regulate their affective processes to avoid feelings of 'panic' regarding performance evaluation.

Contrary to expectations, a mastery orientation was positively associated with anxiety within the same year. This may be interpreted as adaptive, as students who enjoy learning maths are likely to want to do well in it and so they may worry about their performance on assessment pieces. However, as the relationship between anxiety and mastery was fairly weak, there was no indication that the strength of this relationship would impede a mastery orientated student's achievement. It should be remembered that the current results refer to the cognitive aspect of anxiety, rather than the affective dimension. Perhaps it is the latter dimension that has negative implications for students' intrinsic interest. Nevertheless, none of the core motivational theories seemed able to explicitly address the processes underlying the observed link between mastery interest and anxiety.

Overall, the development of a mastery orientation was most strongly related to previous experiences of maths interest and satisfaction, as well as concurrent utility and self-efficacy beliefs. The current results suggest that if students enjoy a subject, although they may worry about doing well in it, they are unlikely to experience adverse emotional and behavioural reactions. In line with this, those wishing to increase students' intrinsic interest in maths should focus on boosting their competency perceptions and the personal relevance of the subject. Furthermore, there is a need for motivational theories to account for the relationship between mastery interest and anxiety.

5.5d Summary of Adaptive Cognitions

In summary of the adaptive cognitions, all were strongly influenced by their ratings one-year earlier. This indicates that adaptive cognitions tended to remain fairly stable although students' teachers, classes and classmates often vary year to year. For students with strong ratings this is good news because these beliefs may be resilient against negative contextual influences, such as peer pressure or poor student-teacher relationships. However, this presents a challenge for interventions because students with poor adaptive cognitions were also likely to maintain somewhat similar ratings of these attitudes across grades. Furthermore, all the adaptive cognitions were highly associated with behavioural engagement within the same academic year. This has important implications as students with poor competency and value beliefs were particularly at risk of poor perseverance, attention and effort in maths.

While being strongly associated with students' behaviour towards learning, these cognitions were also very highly intertwined. As a result, the ratings of one adaptive cognition were likely to also reflect the strength of the remaining two. For example, believing that maths was important appeared to be also expressive of a student's confidence and enjoyment in maths. The current results are consistent with EVT and other research arguing that competence beliefs, utility value and mastery-approach goals are closely related (Chouinard, 2008; Eccles et al., 1983; Greene et al., 1999; Jacobs et al., 2002; Mac Iver et al., 1991; Meece et al., 1990; Middleton et al., 2004). However, the current study also supports their distinction as unique constructs (Eccles & Wigfield, 1995). Consequently, a theory of motivation that addresses competency beliefs should also include values and vice-versa. It is likely that having perceptions of ability and values aligned is important for students' overall sense of worth and wellbeing (Harter, 1990). In this sense, the EVT approach is supported because it incorporates these three adaptive cognitions. However, self-efficacy and goal theories appear to be lacking a complete picture because they do not address the close relationship that ability and value beliefs share.

Although some studies find students do not distinguish between expectancy-value constructs (Cocks & Watt, 2004; Greene et al., 1999), the current results showed that their main relevance as distinct constructs was in relation to the darker side of motivation. The adaptive cognitions were more varied in how they related to maladaptive, rather than adaptive facets of motivation. For example, although valuing and mastery orientation positively related to anxiety, mastery showed a stronger association. Perhaps perceptions of maths as useful are not internalised to the same extent as an intrinsic interest because utility values are an externally rather than intrinsically based incentive. If this is the case, then because gaining satisfaction and enjoyment from maths is an internally-driven incentive, students are more genuinely concerned with performing well in it.

In relation to behavioural engagement, stronger adaptive cognitions were associated with greater effort and persistence, which supported the predictions of self-efficacy, goal orientation and expectancy-value theories. However, the correlational relationships showed that adaptive cognitions were also implicated in students' strategies to manage their self-worth and fear of failure. These relationships highlight the role of both competency and value beliefs in the self-worth, need for achievement and control theories. Although these theories address the importance of having strong competency beliefs, they largely ignore the role of values in influencing students' self-protective behaviours. The current results indicate that holding an incentive value towards learning maths may work with self-efficacy to act as a buffer to reduce the likelihood that students will be driven by preoccupations with avoiding failure and protecting their self-worth. Consequently, to fully understand the relationships amongst the adaptive cognitions with maladaptive coping strategies, an incorporation of social-cognitive and expectancy-value theories with need achievement and self-worth theories is needed.

5.5e Study Planning

As shown in Figures 4 and 5, planning was most strongly related to persistence. It also showed moderate positive correlations with the adaptive cognitions and a negative relationship with disengagement. While planning showed a moderate positive association with anxiety, its relationships with uncertain control and failure avoidance were inconsistent. Time 2 planning was moderately related to previous ratings of planning. Overall the development of planning was most associated with previous tendencies to engage in this behaviour, as well as concurrent persistence and adaptive cognitions.

The results showed that students who reported more study planning also tended to report stronger competency and value beliefs. This is consistent with social-cognitive (Bandura, 1997) and self-regulation theories (Zimmerman, 1989) that present self-efficacy as strongly linked with study efforts. The current results also followed theoretical predictions from EVT, that the more students believed they were capable and also that the task was worthwhile, the more effort they would exert. While consistent with expectations, the relationships planning shared with competency and value beliefs highlight the theoretical relevance of the range of adaptive cognitions in understanding self-regulatory behaviour. Although goal orientation emphasises the importance of an intrinsic interest to support study efforts, it does not address the role that utility values may play. On the other hand, while expectancy-value theory does consider these two unique incentive values, research often addresses them as global rather than unique constructs. Consequently, models of self-regulation wanting to capture processes of study planning should address students' perceptions of ability, as well as their interest in maths and its relevance for their future.

Unexpectedly, anxiety was positively associated with planning, revealing that students who organised their study environment and timetable were more likely to be concerned about their results on exams and assignments. Conversely, this also means that students who put less effort into studying were less likely to worry about the outcomes of assessment pieces. Rather than reflecting common assumptions that anxiety has a debilitating effect, this demonstrates a possible energising function of maths anxiety. A student may be driven to organise their study timetable based on worries about doing well on maths exams because it is useful for their future, or they get a sense of satisfaction from learning or a combination of these factors. In this sense, perhaps the link between anxiety and planning is better understood when students' adaptive cognitions are also considered. Social-cognitive theory presents self-efficacy as shaping how people perceive challenges and develop coping strategies (Bandura, 1986, 1993, 1997). Although this is stretching the theoretical application of the theory somewhat, having a strong sense of self-efficacy may help students to address worries and values in a proactive manner through organising.

The other maladaptive cognitions reflecting low control and working to avoid negative judgements were inconsistently related to students' study planning. This is in contrast to expectations from need achievement and control theories. According to need achievement theory students are driven to experience success (Atkinson, 1957). This could lead to a prediction that those working to avoid negative judgements from others would also put more effort into their study. Furthermore, control and attribution theories argue that students who feel ineffective in influencing outcomes are less likely to bother putting in any effort (Connell, 1985; Weiner, 1979), leading to a negative relationship expected between uncertain control and planning. However, the current results showed that a fear of failure and a sense of control over outcomes were largely unrelated to whether a student organised their study timetable and environment.

Previous research (Martin, 2003y, 2007b, 2009) on general academic motivation with the MES-HS has also found inconsistent relationships between failure avoidance and uncertain control with planning and study management. Martin (2003y) found no significant correlation between uncertain control with planning and study management, while Martin (2009) observed negative correlations. This inconsistency may reflect students' own variation in the frequency of these behaviours. Some have suggested that self-regulation is sensitive to contextual factors (see Wolters & Pintrich, 1998). Consistent with this idea, in the current study planning showed relatively weaker stability together with failure avoidance and uncertain control. Consequently, if these three types of experiences tend to fluctuate, their relationships with each other can be expected to be unclear.

In summary, planning was most related to concurrent persistence, as well as competency and value beliefs. A student demonstrating poor planning and organising of their maths study may be expressing disengagement due to low competency or value beliefs. Nevertheless, compared to other facets within the model planning may be relatively susceptible to change. It may be encouraged by supporting students' adaptive cognitions and a belief that their perseverance will pay off during challenging tasks. Generally, social-cognitive, self-regulation and EVT theories were most appropriate in explaining the relations of planning with other facets of motivation.

However, there appears to be an absence of suitable theory to address its relationship with maladaptive cognitions, particularly anxiety.

5.5f Persistence

Persistence at Time 1 was most strongly related to concurrent adaptive cognitions, planning and disengagement (see Figures 4 and 5). It was moderately negatively related to the maladaptive constructs, except anxiety with which it showed no significant relationship. Persistence showed strong stability across time. Overall, the development of persistence was most associated with ratings of this tendency one-year earlier, as well as all the adaptive constructs and apathetic behaviour.

A student's tendency to persist when challenged in maths appeared to be strongly associated with both competency and value based beliefs. This is partially consistent with Zimmerman (1989) who presents self-regulation as particularly driven by self-efficacy. Although the current study found competency beliefs were strongly associated with students' tendency to persist, their subjective values were also very relevant. This meant that it was unlikely a student would persist on a difficult task unless they also felt confident in their abilities, believed the outcome was important or tended to enjoy the learning experience. Consequently, models of self-regulation should include the range of adaptive cognitions to understand what may underlie a student's perseverance.

The strong correlations persistence shared with the adaptive cognitions and disengagement highlights its value as a core indicator of behavioural and cognitive engagement. These relationships support the predictions of expectancy-value and goal theories that students who felt competent and believed that a task was worthwhile would be less discouraged by challenges than those without these adaptive cognitions. This relationship may also be understood from the need achievement and self-worth perspectives (Atkinson, 1957; Covington, 1992). According to these, if the task holds some kind of incentive value for a student, they will want to either achieve success or avoid failure in it. When self-efficacy is included in the picture, self-worth theory suggests that students who are confident in their abilities will invest effort because the context is not perceived as threatening their self-worth.

In relation to maladaptive cognitions, students were less likely to persist if they felt ineffective in improving their chances of success or were preoccupied with others' negative judgements of their ability. This is consistent with expectations drawn from attribution and control theories (Connell, 1985; Weiner, 1979). According to Connell (1985) and Weiner (1979), low persistence may stem from poor perceptions of control and attribution. Students were unlikely to persevere during a challenging task if they felt their efforts to succeed were futile. Consequently, the negative relationship of persistence at both time-points with uncertain control and disengagement supported the predictions of attribution and control theory (Connell, 1985; Weiner, 1979). This is concerning because a student who gives up quickly during challenging tasks is susceptible to developing a hopeless orientation towards learning maths, which is perpetuated by a greater likelihood of experiencing failure.

On the other hand, persistence and the maladaptive cognitions can also be understood from a need achievement (Atkinson, 1957) and self-worth perspective (Covington, 1992). According to Covington (1992) persisting demonstrates an effort on the student's part to succeed or complete a task. However, if a student wants to gain favourable judgements from others, this extrinsic incentive can make them pre-occupied with seeking reassurance based on their performance. Consequently, if students feel that others will perceive them negatively if they fail despite trying, they can protect their self-worth by avoiding effort. Although need achievement theory (Atkinson, 1975) may initially suggest that a fear of failure leads to persistence to enhance the chance of success, the current results indicate that the opposite occurred. Instead, when students are challenged, a greater fear of failure may mean they may lack the psychological resources needed to maintain their persistence, which may involve adaptive values and competency beliefs. This may be particularly relevant for adolescents, as this period is associated with increased self-consciousness with concerns about others' judgements of themselves.

5.5g Summary of Adaptive Behaviours

In summary of the adaptive behaviours, both planning and persistence were primarily related to students' concurrent competency and value beliefs, as well as disengagement. Although Martin (2007a, 2007b, 2009) presents planning and study management as primarily operationalising a mastery orientation, the current study showed that these behaviours were also related to self-efficacy and utility values, which are emphasised as important in the social-cognitive and expectancy-value theories.

Interestingly, persistence was more strongly associated with the adaptive cognitions than planning. The difference in the strength of correlational relationships for these two types of self-regulatory behaviours with other facets in the model demonstrates that they should not be combined to form a global measure of 'effort' or 'self-regulation', as sometimes occurs. Perhaps these differences in the strengths of associations reflect students' inclination to inconsistently engage in planning, whereas persistence may be a more stable tendency. To engage in observable and effortful behaviour such as persistence, students may need strong competency and value beliefs to sustain their focus and coping skills. However, planning requires less psychological commitment and so may be less reliant upon having strong incentive values or ability beliefs. In this sense, persistence appears to be a stronger reflection of adaptive engagement than study planning.

The current results indicate that the development of self-regulatory behaviour is complex. Each theory of motivation was useful in explaining different relationships between the adaptive behaviours and other facets within the Wheel. Overall, the results indicate that to increase adaptive behaviours a particular focus should be made on developing students' self-efficacy and value beliefs. Longitudinally, persistence appeared more stable than planning. While this means that a decrease in study organising may be less reflective of a long-term trend than a tendency to give up, it also suggests that planning may be more susceptible to outside interventions. The associations of adaptive behaviours with the maladaptive dimensions of motivation were multifaceted. Although self-worth, attribution and control theories were useful in understanding most of these relationships, they did not address the role of anxiety in self-regulation.

5.5h Anxiety

Time 1 anxiety was most strongly related to feelings of failure avoidance and uncertain control (see Figures 4 and 5). It also showed weak positive correlations with both of the maladaptive behaviours. In relation to the adaptive constructs, it shared significant positive correlations with mastery and planning, whilst generally showing weak or non significant associations with self-efficacy, valuing and persistence. Longitudinally, anxiety showed strong stability across the one-year interval (see Figure 6). Overall, the development of anxiety appeared to be most strongly related to prior experiences of anxiety one year earlier, as well as concurrent feelings of poor control and a fear of failure.

Despite being located in the maladaptive section of the model, the current measure of maths anxiety did not show inherently negative relationships with other facets of motivation. These results indicate that some concern regarding doing well in maths assessments was likely for those who enjoy maths. However, feelings of worry were largely unrelated to students' self-efficacy or utility values. This is partially consistent with Wigfield and Meece (1988) who found maths worry positively correlated with interest and usefulness beliefs and negatively correlated with ability perceptions. The current results may highlight the degree of internalization for mastery versus extrinsic values. Utility valuing is an extrinsic motivator and so although students may recognise the usefulness of maths, concerns about achieving in it are not necessarily internalised to the same extent as when an intrinsic interest is held. Nevertheless, it appears that amongst the adaptive cognitions, it was feelings of enjoyment from maths that were most associated with worrying about doing well.

The current results also demonstrate the multifaceted nature of the associations maths anxiety shares with self-regulatory behaviour. Anxiety was relevant to organising one's study routine but was not significantly associated with perseverance. This may be because organising is a proactive behaviour that helps alleviate students' feelings of worry. However when students are faced with a challenge, determination and willpower are more relevant than worrying about doing well. The weak relationship with persistence may be because the nature of this relationship depends on students' experiences of other motivational constructs. If students hold strong competency and value beliefs, while also worrying about doing well in maths, EVT, self-efficacy and self-regulation theories would expect greater perseverance. However as suggested by control, need achievement and self-worth theories, if students are primarily driven by feelings of low control or fearing failure, they are also likely to worry about doing well in maths but would have lower ratings of persistence due to their lack of coping resources.

The weak associations anxiety shared with the maladaptive behaviours only partially confirmed predictions based on self-worth theory, as these relationships were expected to be stronger. This may be because anxiety works indirectly through other more specific cognitions such as uncertain control (Bandura, 1997) or a fear of failure (Atkinson, 1957) to produce maladaptive behaviours. Another suggestion for the weak relationships observed between anxiety and the maladaptive behaviours is that maths anxiety leads to an avoidance of maths (Llabre & Suarez, 1985). The current study included students attending class and completing the questionnaire at two time-points, which would have excluded those with attendance problems. Consequently, maths anxiety may not be so relevant to the maladaptive behaviours of those in the current sample because they were less likely to avoid maths than other students.

The direction and strength of the relationships anxiety shared with other motivational constructs demonstrates that maths anxiety measures should clarify exactly which particular dimension they are assessing. Although maths anxiety was associated with maladaptive cognitions, it was also positively associated with greater mastery orientation and planning. This positive relationship with both maladaptive and adaptive constructs may be because the current study applied the worry dimension, rather than negative affect. Worrying about doing well appears to have some adaptive value. However, anxiety that is experienced as physical or emotional reactions may reflect more problematic elements and internal distress (Wigfield & Meece, 1988). The current study also tested linear relationships, which may have overlooked curvilinear trends. As Anderson (1990) suggests, a moderate amount of arousal can be adaptive and energizing, while excessive amounts impede an individual's performance and coping mechanisms. Consequently, more attention should be given to the cognitive versus affective elements of anxiety and their potential curvilinear relationships with other constructs.

Despite its positive associations with mastery interest and planning, maths anxiety is concerning because it may signal the development of maladaptive coping strategies. Rather than being directly associated with behaviour, experiences of anxiety appeared to be more strongly related to perceptions of control and avoiding failure, which in turn may encourage amotivation and self-sabotage. As a result, those wishing to improve students' anxiety levels should focus on reducing the negative implications of failure and empowering students to understand what is needed to gain desired outcomes.

5.5i Failure Avoidance

Failure avoidance was most positively related to anxiety and uncertain control and was moderately positively associated with self-handicapping and disengagement (see Figures 4 and 5). Failure avoidance also showed negative correlations with self-efficacy, valuing and persistence, while showing inconsistent relationships with planning and task orientation. It also showed somewhat lower stability compared to the other motivational constructs. Nevertheless, failure avoidance was primarily related to worrying about success on maths tasks and perceiving a sense of control over outcomes.

These results are consistent with goal and self-worth theories suggesting that students who are concerned with receiving favourable judgements will be more focused on the outcomes rather than the learning process. As a result, they are likely to be anxious of their performance level because it determines their sense of worth (Covington, 1992). Control theory is also useful in explaining the association between failure avoidance and uncertain control. From this perspective they are positively associated because the development of intrinsic interest is impeded when students fail to attribute themselves to their success and so students must rely on extrinsic sources to evaluate their performance (Connell, 1985).

However, the results showed that the development of failure avoidance was also related somewhat to the values students held towards maths one-year earlier. However, no theoretical approach links a fear of failure with incentive values. Consequently, EVT, need for achievement and self-worth theories could be incorporated to account for how values contribute to the development of a fear of failure.

Failure avoidance also showed moderate positive correlations with self-handicapping and disengagement. This indicates that approach and avoidant goal orientations are not mutually exclusive. Students with a strong fear of failure may initially put in effort to avoid negative judgements from others. However, they may then be likely to self-sabotage or give up when they feel pressured or perceive success as unlikely. Although each of these approaches functions to protect students' self-worth, which one is implemented is likely to depend on other motivational facets, such as self-efficacy.

Overall, the current results reveal that failure avoidance was particularly multifaceted in how it related to other motivational constructs. It is common for parents and teachers to use social comparison and communicate high expectations when reminding students of the importance of maths. However, a preoccupation with pleasing others appeared to generally have negative associations with adaptive motivation and engagement. Although students may initially attempt a challenging task, those driven by a fear of failure may be less likely to engage or persevere when it is really needed. Consequently, adults who focus on the learning process, encourage students' effort rather than achievement and provide the tools to achieve will discourage failure avoidance and the likelihood of self-handicapping or disengaging. Furthermore, failure avoidance was relatively susceptible to fluctuations and so it may be sensitive to contextual factors, which is good news for those wanting to reduce this tendency.

5.5j Uncertain Control

As shown in Figures 4 and 5, uncertain control was most positively associated with anxiety and failure avoidance. It also showed moderate to strong positive correlations with self-handicapping and disengagement, while generally negatively relating to all adaptive constructs. Overall, uncertain control was most associated with prior ratings, as well as cognitions of worry and failure avoidance.

Although uncertain control was negatively associated with the adaptive cognitions, it showed the strongest association with self-efficacy. This is consistent with social cognitive theory (Bandura, 1997), which argues that students will doubt their ability to achieve an outcome when they are unsure of how to influence their likelihood of success. The relationships of control with self-efficacy and anxiety also support Bandura's suggestion, that uncertain control relates to perceptions of one's ability, as well the degree that students will fret over their performance. However, the current study also demonstrates the importance of value beliefs in perceptions of control, which is not accounted for by current theory. Students were likely to feel a greater sense of control when they perceived maths as relevant and interesting. Although social-cognitive and control theory involve perceptions of control they do not address the incentive values associated with a task or goal. Consequently, models and theories of students' attributions should address incentive values, as well as competency beliefs.

In relation to the adaptive behaviours, uncertain control was negatively related to persistence but generally unrelated to planning. Rather than influencing students' organising behaviours, feelings of control were more relevant in encouraging perseverance. These relationships show the function of control in self-regulatory behaviours. They also demonstrate a potential link between the self-regulatory, control and self-worth theories. Compared to planning, persistence involves a greater risk to one's self-worth because it is readily observable by others and can demand a greater investment of time and energy. Consequently in terms of self-regulatory behaviour, a poor locus of control was primarily associated with the effort students would exert in attempting to complete maths tasks, rather than how well they organised their study.

The nature of relationships between uncertain control and the maladaptive facets within the Wheel are also consistent with theory. As expected according to attribution, control and self-worth, low control was positively associated with anxiety, disengagement and self-handicapping. This suggests that a student with low perceptions of control may initially engage in learning because they fear negative perceptions from others but if they feel uncertain about success their anxieties may increase to then prompt options such as self-handicapping or withdrawal to protect self-worth.

The main observations for uncertain control were that those who believed they could influence outcomes were likely to feel more positive about tasks and themselves than those who tended to feel ineffective. Consequently, control is a particularly important facet of motivation because perceptions of low control may leave students susceptible to a helpless and apathetic approach to learning maths. This may eventually translate to negative consequences for attendance, enrolment decisions, as well as achievement.

5.5k Summary of Maladaptive Cognitions

Overall, the maladaptive cognitions were highly interrelated with each other and showed multiple relationships with other facets within the model. The nature of these associations suggest that supporting students' sense of control and reducing the negative implications of failure may encourage worries about succeeding in maths to be expressed in a more adaptive and proactive manner, rather than through self-handicapping or disengagement.

The theories of social-cognition, control, need achievement and self-worth were most useful in explaining associations of the maladaptive cognitions with other facets within the model. However, the correlations also revealed associations with self-regulatory behaviours and values that current theory did not account for.

Furthermore, some predictions of social-cognitive theory were not supported. Unexpectedly, maths anxiety was largely unrelated to self-efficacy, utility values and behavioural engagement, whereas feelings of control were. Researchers often refer to 'anxiety' or 'distress', however these two conceptualisations had different associations with other aspects of cognitive and behavioural engagement. The current results highlight the distinction between maths worry and uncertain control and reveal it is specifically perceptions of control that are pivotal in adaptive motivation rather than avoiding feelings of worry.

5.5l Self-Handicapping

As shown in Figures 4 and 5, self-handicapping was most strongly positively correlated with disengagement and uncertain control. Failure avoidance was moderately positively associated with self-handicapping, as was anxiety to a lesser extent. Self-handicapping showed negative relationships with all adaptive constructs, particularly persistence. At Time 2 (see Figure 6) self-handicapping was strongly predicted by ratings of this behaviour one-year earlier.

The relationship self-handicapping shared with control and failure avoidance supported the predictions of the self-worth, need achievement and attribution theories. Self worth and need achievement theories argue that self-handicapping is based on strategies to cope when fearing failure. However, attribution and control theory extend this by suggesting that this strategy is likely to develop when students feel success is beyond their control. Unexpectedly for self-worth, need achievement and control theories, anxiety was fairly weakly associated with self-handicapping. Again, this finding clarifies the role of control, rather than worry in protecting self-worth. It appeared to be the sense that outcomes were unmanageable, rather than agonising about doing well that was associated with avoidant behaviours.

In relation to self-handicapping and the adaptive cognitions, the current results also suggest that elements of EVT and social-cognitive theory should be incorporated into self-worth theory. The more students felt confident in their ability to achieve, thought maths was useful and interesting, the less likely they were to sabotage their chance of success. In support of social-cognitive theory's premise that self-efficacy drives other motivational beliefs and behaviours, this was the adaptive cognition most strongly associated with self-handicapping. Bandura (1997) suggests that a sense of self-efficacy influences the type and amount of effort students exert towards learning. Self-efficacy may buffer against negative cognitions to protect students from developing an avoidant coping style. Holding a belief that maths is useful for one's future or enjoying it also appeared to protect against failure acceptance. These incentive values may encourage students to approach their maths work in a proactive manner, helping overcome any fears regarding failure and uncertainty about success that may otherwise lead to self-handicapping. Research and theory addressing values has largely focused on their implications for students' achievement, enrolment and self-regulatory behaviours. However, the current results show that incentive values are also very important in understanding students' resilience to self-worth threats.

The results also differentiate the behavioural implications of self-handicapping. While students with an avoidant fear of failure and sensitive self-worth were less likely to report self-regulatory behaviours, this concern was more impeding for persistence, rather than study planning. Self-handicapping was also strongly positively related to a helpless attitude toward learning maths, as represented by disengagement. This may be because the failure accepting nature of self-handicapping leads students who repeatedly avoid trying in maths to experience little success. This may perpetuate their low confidence in this subject, while their sense of poor control and fear of negative judgements increase because they have not engaged and subsequently learnt how to cope with challenges.

Overall, the development of self-handicapping primarily related to amotivation, as well as beliefs stemming from students' need to experience success and protect their self-worth. Those wanting to reduce failure accepting tendencies should support students' understanding of what is needed to achieve in assessment pieces, while reducing the emphasis on social comparison and public evaluation of their performance. Although self-worth, need achievement and attribution theories were useful in explaining most relationships self-handicapping shared, they seemed less useful in explaining its associations with anxiety and value beliefs.

5.5m Disengagement

Disengagement strongly negatively correlated with all adaptive cognitions, as well as persistence. Furthermore, the strength of its associations with these adaptive constructs were similar to the strength of its positive correlation with self-handicapping. Disengagement also showed moderate correlations with the maladaptive constructs. Overall, disengagement was most strongly related to prior ratings of this tendency as well as concurrent persistence, perceptions of competency and utility valuing.

Students who tended to believe they were less capable of achieving in maths and perceive it as useless and boring were more likely to feel disconnected from the learning process. Consequently, disengaged students are likely to need boosting in all facets comprising the adaptive cognitions. These relationships highlight disengagement as a relevant outcome for EVT. Often research applying this theoretical model has addressed outcomes such as enrolment choices or achievement. However the current study shows that EVT is directly relevant in how amotivation develops. It appears that self-belief and both types of incentives serve a protective function against feelings of indifference or helplessness.

The harmful implications of amotivation were demonstrated by its consistently negative associations with the adaptive behavioural constructs. In comparison to study planning it was particularly negatively related to persistence. This clarifies the relationship between learned helplessness (Seligman, 1978) and self-regulation. Although students who felt apathetic towards learning were less likely to organise their study schedule and environment, they were much less likely to try when feeling challenged. Conversely, students who were enthusiastic about learning maths were also likely to persevere and to a lesser extent, plan and organise their study.

At both time-points disengagement showed weak to moderate positive relationships with the maladaptive cognitions. However, anxiety was associated with disengagement to a lesser extent than failure avoidance and uncertain control. The weak relationship with anxiety is partially in contrast to predictions based on disengagement as stemming from need achievement and self-worth theories (Martin, 2009). An explanation for this could be that a student who is already disengaged has accepted failure as an option for themselves and as a result does not worry about their performance anymore. However, having a fear of failure and perceiving little control over outcomes can be associated with students' concurrent self-protective coping strategy to disengage from challenging situations.

The current results indicate that disengagement was not primarily related to anxiety-based concerns but was more associated with constructs of expectancy-value and self-regulation theory. Consequently, students who apply very little incentive value to maths and feel unconfident in their abilities may be at risk of amotivation because learning no longer holds any personal meaning for them. Those wanting to boost students' behavioural engagement should focus on their self-efficacy and value beliefs, which should be reflected in greater persistence during challenges.

5.5n Summary of Relationships within the Student Motivation and Engagement Wheel

The patterns of relationships within the Wheel were largely consistent between the two waves. This supports the soundness of the model and the consistency with which motivational experiences are related to each other. Most facets of motivation were associated with other concurrent experiences, although some constructs were more interconnected than others. This pattern of correlations demonstrates the complex nature of maths motivation.

The ability of each core theory of motivation to explain this network of associations was evaluated. A key finding was that incentive values were relevant to understanding maladaptive aspects of motivation, as well as self-regulatory behaviours. Similar to self-efficacy, concurrent values appeared to play a buffering role, protecting students from developing self-worth protective strategies. Unexpectedly, many predictions from social-cognitive and self-worth theories involving anxiety were not supported. It is likely that worrying about doing well is not overly relevant to theories of self-worth or social-cognition. Instead it may be the negative affective dimension of maths anxiety that impedes students' maths motivation by triggering self-doubt and self-protective strategies. Although each theory was useful, the combination of EVT, self-worth and need achievement theories was used most in providing a multidimensional theoretical understanding of students' learning experiences.

5.6 Mean Level Changes in Maths Motivation

A third research question the current study addressed was how the maths motivation of various cohorts of Australian high school students changes across time. While each facet of motivation showed fairly strong stability across the one-year interval, these findings provide information about relative rankings and do not tell us about the level of motivation students experienced. Therefore, tests of mean differences between the two time-points, as well as cohort and gender differences in mean ratings were required to gain a fuller picture of motivation across the two years. This was to explore if Australian high school students on average experience an increasingly maladaptive orientation towards maths and to examine the nature of any differences between boys and girls. The ANOVA analyses showed that students' maths motivation generally became more negative, with ratings of all adaptive constructs decreasing across the year interval, while disengagement increased. They also revealed that girls tended to experience greater maladaptive cognitions, despite reporting more mastery orientation and study planning. However, most of the effect sizes represented by partial eta-squared were small according to Cohen's (1988) recommendations. Only the time trend for valuing and the gender effect for anxiety and uncertain control showed moderate effect sizes. Consequently, interpretation of these results must take into account the effect sizes to keep the results in perspective.

The current results are consistent with research applying an EVT and goal-orientation approach that report decreases in students' competency beliefs (Jacobs et al., 2002; Wigifield et al., 1991), values (Fredricks & Eccles, 2002; Gottfried et al., 2001; Ma & Cartwright, 2003; Watt, 2004) and mastery goals (Chouinard & Roy, 2008) during high school. However in contrast to some (Fredricks & Eccles, 2002; Marsh, 1989), the current study found no evidence of a curvilinear trend during later grades, as ratings of adaptive constructs decreased steadily for all cohorts. The absence of a later recovery in adaptive motivation may be due to the range of grades sampled in the current study. Previous studies reporting curvilinear trends for adaptive cognitions have included all the secondary year levels (Fredricks & Eccles, 2002; Marsh, 1989; Watt, 2004). Therefore it is unclear if students' ratings would have continued to decline or begin to increase during their senior grades. Nevertheless, in the current study adaptive cognitions and behaviours decreased steadily from Grade 7 to Grade 10.

Some have suggested developmental vulnerabilities in academic motivation (Watt, 2004). However, maths motivation generally changed in a similar way for each of the three cohorts. Only utility valuing showed a different rate of change between the cohorts, with older students' ratings decreasing more steeply than the youngest cohort. This is consistent with Watt (2004), as well as Chouinard and Roy (2008) who observed metropolitan Australian and Canadian students' maths utility values to become increasingly negative after Year 7. Consequently, the decrease in perceptions of maths as useful appears to accelerate during the middle grades of high school for Australian rural students as well.

The decrease in utility value and intrinsic interest could reflect the natural progression of students' interests developing and becoming more specific as their sense of self establishes with age. Unfortunately for maths, other disciplines may hold a greater importance, while also appearing less abstract (Watt, 2004) and difficult (Anderman & Midgley, 1997) as students progress through high school. Alternatively, considering the strong associations amongst self-efficacy and value beliefs (Deci & Ryan, 1985; Eccles 1983), if students feel decreasingly competent, their subjective values and behavioural engagement are likely to show a similar trend. This could reflect a self-worth protective strategy, as having ability and value beliefs aligned maintains students' sense of worth (Harter, 1990), whereas feeling incapable but recognising maths is important can create feelings of distress.

Although adaptive behaviours may be expected to follow the trend of adaptive cognitions, no other study has empirically tested this assumption. The current results showed that decreases in mean ratings of adaptive cognitions also extended to adaptive behaviours representing self-regulation. This is noteworthy because students' are expected to do more independent learning and study as they progress through secondary school. This decrease in effortful behaviour is concerning because it is contradictory to the learning demands of school during this period.

The current study also looked at how maladaptive constructs change across high school. Unexpectedly, no significant changes in ratings of anxiety, uncertain control, failure avoidance or self-handicapping were observed. This is in contrast to others who have found ratings of maths anxiety to increase during high school, particularly in grade 9 and towards the senior grades (Ma & Cartwright, 2003; Smith, 2004; Wigfield & Meece, 1988). Although the current study found a positive trend for anxiety, this was not significant. Consequently, there was no evidence to suggest that students experienced more cognitive stress and worry about their performance in maths as they progressed towards the senior grades. This apparent lack of increasing stress however, did not reflect the development of a more autonomous self across time (see Allen et al., 1989). When autonomy increases, students' self-worth becomes more independent of others' judgements regarding their abilities. In this sense, ratings of failure avoidance and self-handicapping should decrease with the development of autonomy. However, the current results showed that mean ratings of failure avoidance and self-handicapping remained steady.

There was also no increase in students' feelings of control across time. This may indicate that the extent to which students understand the feedback they receive from their teachers that shape their perceptions of control is maintained throughout high school. Ideally however, students' sense of control over their performance outcomes would increase with time as they learn from accumulated experience and feedback. Smith (2004) provides an alternative explanation by applying social-cognitive theory to link students' perceptions of uncertainty with their expectations. From this perspective, anxiety and distress arise when students feel a poor sense of control and uncertainty about future events (Bandura, 1986, 1997). It is possible that by the end of their first year of high school students have received feedback about their performance, which allows them to form an understanding of their maths ability and what to expect in terms of their performance. For some students this may be a positive experience as their first year of high school leaves them satisfied with their understanding of how to influence outcomes, whereas others may feel bewildered and in a failure accepting manner, develop a low concern regarding their maths achievement. Regardless of whether an individual student perceives low or high control, this could explain why overall mean ratings of uncertain control did not change across time.

In contrast to suggestions that students disengage from maths because they experience increasing academic pressure and stress as they move towards senior high school (Smith, 2004), these demands were not reflected in the current ratings of maladaptive constructs. It is possible that changes in these constructs may not be particularly relevant during junior and middle high school. Pressures on students to achieve may become more explicit during the senior grades (Watt, 2004), which would make developmental differences in anxiety-based constructs more observable in these later grades. An alternate interpretation of the nonsignificant time effect for the maladaptive cognitions and self-handicapping is that they demonstrate students' indifference towards maths. This level of amotivation may already be present from the end of Grade 7. Furthermore, ratings of disengagement mirrored those of the adaptive constructs, to increase across time. While ratings of anxiety-based beliefs and behaviours remained stable, feelings of detachment and amotivation increased. This may indicate a growing apathy towards learning maths as students progress through high school. Nevertheless, the finding that maladaptive cognitions behaved in a similar way across time as each other is consistent with control and need achievement perspectives that suggest these constructs are highly inter-related.

Although the significant changes in mean ratings were somewhat weak, they are concerning because they indicate that throughout high school students' adaptive attitudes towards maths become more negative, as do their effortful behaviours. It appears that these students developed amotivation rather than a self-protective response to increased stress and external pressures. Consequently, declining behavioural engagement and participation in maths may be related to declining adaptive attitudes, rather than increasing maladaptive cognitions. The changes in adaptive constructs, particularly in utility valuing, are a concern because in NSW Year

10 is the last year of compulsory maths enrolment. At the end of Grade 10 students make important decisions that will influence their post-school opportunities, such as electing the subjects and level of difficulty they want for senior high school. It is unlikely that a student experiencing a long-term decrease in adaptive maths motivation will voluntarily choose to study maths thereafter, particularly at an advanced level.

5.7 Why the Decline in Adaptive Maths Motivation?

There have been suggestions that a decline in maths competency beliefs may be reality based and inevitable. Younger children often have unrealistically optimistic self-concepts (Marsh, 1989; Wigfield et al., 1997). However, by around age 10 students are less optimistic and there is a stronger relationship between their self-concept and actual ability. As children become older they begin to integrate more external information into their self-concepts, such as their relative abilities, social comparison and teacher feedback (Marsh, 1989; Stipek & Daniels, 1988). Furthermore, their skills tend to improve less rapidly than before (Eccles, 1999). This means that during early adolescence, ability perceptions decrease in a lot of areas for many students (Dweck & Elliott, 1983; Marsh, 1989; Stipek & Mac Iver, 1989). As suggested by social-cognitive, self-worth and self-efficacy theories, ability beliefs are important cognitions that underlie many other beliefs and behaviours, such as school values, planning and persistence (Bandura, 1997, Bleeker & Jacobs, 2004; Jacobs et al., 2002; Mac Iver et al., 1991). Consequently, the current results may support the ability belief hypothesis, that perceptions of competency naturally decrease and so adolescents who doubt they can succeed are less likely to value or engage in a task (Urdan & Schoenfelder, 2006).

The ability-beliefs hypothesis tends to consider declines in adaptive constructs as part of a natural progression. However, an alternative perspective argues that developmental declines in academic motivation are not inevitable. The Stage-Environment Fit model considers contextual influences within the school environment that may either facilitate or prevent a decline in motivation (Eccles, Midgley, Wigfield, Buchanan, Reuman, Flanagan, & Mac Iver, 1993). Eccles and her colleagues suggest that declines in expectancy and value beliefs during early adolescence relate to a conflict between the needs of adolescents and the high school social environment (see Eccles et al., 1993). Early adolescence is characterised by an increased need for independence, peer orientation and self-consciousness (Eccles et al., 1993). However, in contrast, high schools tend promote a greater emphasis on social comparison and reduce choices (Anderman & Midgley, 1997; Lepper et al., 2005; Stipek & Daniels, 1988), have stricter grading and behavioural standards and poorer teacher-student relationships than primary schools (Wigfield et al., 1991). This conflict between students' needs and the opportunities in their social environment is suggested by the stage-environment fit model to encourage disengagement.

Although the Stage-Environment Fit model is a broad explanation with many potential factors, it does highlight the importance of the social context in generating adaptive engagement. Consequently, if maladaptive maths motivation is context specific and preventable, a closer examination is needed of which environmental and social factors may be influencing declines in adaptive constructs and increasing disengagement.

5.8 Gender Differences in Maths Motivation

The final research question Study 1 addressed was that of gender differences in mean ratings of maths motivation and how these change with time. In terms of adaptive cognitions it was unclear if significant differences would arise. However if they did, they were likely to be gender stereotypical with boys showing more confidence and values but girls reporting more effort, as well as maladaptive cognitions.

The only significant gender differences found for the adaptive facets were that girls reported more mastery focus and study planning than boys. In the past it was common for boys to provide higher ratings of adaptive cognitions. However the current results suggest that gender differences traditionally found in competency and value beliefs are becoming less common. Although maths is traditionally a male-dominated field, girls reported more satisfaction from learning it and putting more effort into studying it. This challenges the common assumption that girls are disadvantaged in their maths competency and value beliefs. Instead the current results indicate that boys may be disadvantaged in relation to their mastery orientation and study organisation. The current results also extend previous research by addressing gender differences in adaptive behaviours. They indicate that across high school, girls tend to put more effort into organising their learning environment and study timetable. However, this did not translate to a greater tendency than boys of persevering when faced with a challenge. As with the developmental findings however, the gender differences in the adaptive constructs showed weak effect sizes.

Nevertheless, these results support those previously reporting girls as having a stronger intrinsic and mastery orientation in maths than boys (Chouinard & Roy, 2008; Chouinard et al., 2007; Kenny-Benson et al., 2006). However, they are in contrast to those who have found boys report more intrinsic interest (Watt, 2004), competency (Meece et al., 1990; Pajares & Miller, 1994; Watt, 2004; Wigfield et al., 1991; Wolters & Pintrich, 1988) and usefulness beliefs (Forgasz, 1995; Perl, 1982). The current sample of Australian high school girls and boys shared comparable levels of maths self-efficacy and utility valuing, which is consistent with some research from Northern-America (Jacobs et al., 2002; Kenney-Benson et al., 2006; Meece et al., 1990; Skaalvik, 1990;).

In relation to maladaptive constructs, the current study found consistent gender differences favouring boys. Although mean ratings remained steady across high school, girls consistently had higher ratings of anxiety, failure avoidance and uncertain control than boys. Furthermore, the effect sizes for anxiety and uncertain control were the strongest gender effects. This corresponds with previous research on maths anxiety reporting that females in primary and secondary school, as well as university tend to experience more anxiety than boys (Betz, 1978; Meece et al., 1990; Pomerantz et al., 2002; Wolters & Pintrich, 1998). In contrast, a few studies such as Ma and Xu (2004) have observed no gender differences in students' maths anxiety. However, Ma and Xu's (2004) items referred to affective elements of maths anxiety, such as feeling fearful and upset. As the current study addressed the worry component of maths anxiety rather than negative affect, the conflicting results may relate to differences in the conceptual focus between the current study and that of Ma and Xu (2004). The current results are consistent with previous research addressing the cognitive dimension of maths anxiety and indicate that anxiety is a main factor differentiating the maths learning experiences of girls and boys. The results also extend previous research by showing that perceptions of control in maths are also particularly relevant to gender.

Despite the gender differences found for the maladaptive cognitions, the current study found no gender effect for self-handicapping and disengagement. Although Smith (2004) found boys reported greater self self-handicapping, this was with a sample of Australian senior high school students and Study 1 did not include students from these upper year levels. Perhaps boys' self-handicapping tendencies become more prominent during the final years of high school when they may feel their performance is under more scrutiny from others than previously. Nevertheless, despite suggestions that boys are more protective in demonstrating their ability (Martin, 2002a), the current results indicated that boys and girls shared similar ratings of maths self-handicapping and disengagement from Grade 7 to Grade 10.

This is the first Australian study to look at gender differences in a range of adaptive and maladaptive motivational constructs across time. Surprisingly, the current study found no differences in the way boys' and girls' maths motivation changed. This is in contrast to those suggesting that boys' motivation decreases more than girls (Chouinard & Roy, 2008; Fredricks & Eccles, 2002; Jacobs et al., 2002), as well as those finding it is girls' maths motivation that becomes more disadvantaged during high school (Eccles et al., 1985; Meece et al., 1982; Pintrich & De Groot, 1990; Watt, 2004). Furthermore, there was no support for Ma and Cartwright (2003) who found girls' maths anxiety to increase faster than boys' maths anxiety during high school. Although girls and boys differed in mean ratings of their maladaptive cognitions, their motivational trajectories were similar across grades 7 to 10.

The most noteworthy gender effect was the mean difference observed between boys and girls in their ratings of maladaptive cognitions. While this supports previous research showing that females tend to experience more maths anxiety than boys, it also extends it by demonstrating that this gender difference also relates to lower perceptions of control and a greater concern with avoiding negative judgements from others. This is consistent with suggestions that girls tend to experience greater academic emotional distress (Pomerantz et al., 2002; Smith, 2004) and internalise failure in maths more than boys (see Stipek & Gralinski, 1991). Pomerantz et al. (2002) suggest that this orientation may develop from gender stereotypes that often portray females as helpless and dependent, which corresponds to the development of stronger maladaptive cognitions in girls, while protecting boys from such distress.

Girls may be particularly concerned with having a sense control and with public judgements of themselves and their effort because compared to boys, failure tends to bring about greater feelings of hopelessness and shame for girls (Frenzel et al., 2007; Stpiek & Gralinski, 1991). Some have suggested that this susceptibility of girls is particularly prevalent in situations involving evaluations of performance (Baloğlu & Koçak, 2006). The current results support this suggestion, as the indicators of maths anxiety and uncertain control referred to performance in exams and assignments, which are evaluative contexts. Consequently, potentially negative feedback may leave girls more stressed about how to improve their performance because they place more personal weight on such information.

Previous research has also found girls to experience a greater need for achievement in the sense that they are more concerned with pleasing others than boys (Greene et al., 1999; Higgins, 1991; Miller et al., 1996; Pomerantz & Ruble, 1998). Rather than approval stemming from a demonstration of ability, for girls it may be more based on complying with expectations (Pomerantz & Ruble, 1998; Pomerantz et al., 2002). Although this concern may increase effort to some extent, it may also cause girls to experience distress over the possibility of failure because they will disappoint others (Pomerantz et al., 2002). According to Ryan and Deci (2000b), avoiding negative judgements is an external motivator and so it is unlikely to lead to enduring adaptive behaviours. Furthermore, anxiety-based beliefs impede the coping resources students need to persist when challenged. This may explain why girls reported more planning than boys but there was no gender difference in ratings of persistence. If boys tend to distance themselves emotionally from failure they would be more resilient to such negative experiences in maths.

Overall, the current results suggest that the tendency girls have towards avoiding maths participation may stem more from maladaptive anxiety-based beliefs, rather than a relative deficit in their competency or value beliefs (Wolters & Pintrich, 1998). Although boys may feel less satisfaction from maths and put less effort into learning it, the range of negative affect girls experience during high school and the implications for their self-worth may lead them to actively avoid post-high school maths, or at least avoid seeking out challenging maths courses. As a result, to understand gender differences in maths motivation and participation it seems necessary to apply control, need achievement and self-worth frameworks.

5.9 Limitations of Study 1

Although the current study provided a valuable insight into the nature and development of Australian high school students' maths motivation, there were some limitations that will now be discussed. These related primarily to the students included in the final sample and the length of the study.

The final sample was comprised of students who fully completed the questionnaires at both time-points. Unfortunately this excluded students who were absent on the day of testing. Although additional time was provided and the researcher was present to assist any students with reading difficulties, the final sample only included students who completed the majority of the items. Students with attendance problems or those who experience difficulty in completing work were unlikely to be included. This means that the final sample probably included a greater proportion of students with good attendance, literacy and concentration rates compared to the broader student population. As a result, the factor structure, nature of associations between constructs, developmental changes and gender differences were applicable to a somewhat engaged and capable student group. Therefore, the results are not necessarily reflective of students who attend maths class irregularly or who have concentration, reading or writing difficulties. This is unfortunate because it is these students especially whose maths motivation needs supporting. It would be ideal to track both students who attend class and those who regularly skip class. This would gain a more accurate picture of how maladaptive motivation develops, as the current results may underestimate declines in adaptive motivation of the wider student population. Tracking both student groups would also identify potential differences in the nature of associations amongst constructs between the student groups, as well as gender differences that may more salient for less engaged students.

Secondly, in the ANOVA analyses, multiple comparisons were performed on each factor of maths motivation. When hypothesis testing, there is a risk that multiple comparisons can increase the chance of making a Type I error. The ANOVA analyses were partly hypothesis testing but also partly exploratory because prior research was lacking. This meant that a Bonferroni adjustment was not seen as fully applicable. Rather than solely using the significance level of the results, interpretation was guided by the assessment of effect sizes, as represented by partial eta squared. These were found to be quite small in a number of cases. This ensured that the role of the independent variables was not overemphasised. Although applying a Bonferroni adjustment can decrease the risk of Type I error, on the other hand this technique also increases the risk of Type II error, failing to reject a null hypothesis. As this is the first study to consider such a range of motivation constructs longitudinally with a sample of Australian rural high school maths students, it was considered appropriate to recognise all significant findings at the conventional critical value ($p < .05$).

Another limitation of Study 1 was that it did not address maths motivation during the senior grades of high school. Although the current study intended to examine motivation across both junior and senior high school, it was not viable within the context of the participating schools' timetables and the workload of the senior students. In NSW schools, grades 11 and 12 comprise the senior grades. Both grades were a busy and important time because these results contributed towards students' final High School Certificate (the HSC) and score for admission to university. During the period of data collection senior students were preparing for their exams. Although not an ideal time of year, this was when the three schools had requested to participate. Due to consideration of the students' workload and the need for maths classes to cover revision before the exams, it was inappropriate and impractical to invite Year 11 and 12 students to participate. However, the trajectory of maths motivation during these final two years is of great interest to those wanting a more complete understanding of its development. These grades are when students may feel under increasing pressure to achieve and also when they make greater choices about the careers or study disciplines what they will and will not pursue post-high school. Perhaps these conditions make self-worth and fear of failure processes more salient than during previous grades. Tracking Australian high school students during this time would help us understand their experiences in more detail and potentially shed some more light on declining maths enrolments in senior grades and tertiary courses.

Although Study 1 covered two time-points, allowing motivation to be tracked across two academic years, a longer analysis of its trajectory with the same students was not possible. This means that only linear changes in maths motivation could be analysed between the two years. However, it is possible that some facets of maths motivation follow a non-linear trajectory, as the rate of change may increase, decrease, plateau or show a curvilinear trend across multiple years. At least three time-points are needed to identify the nonlinear curve in these types of changes. The current study tried to account for this by including multiple cohorts and testing differences in their rates of change. Apart from utility valuing there were no other indications of nonlinear trends. Nevertheless, following the same group of students across several years would delineate cohort versus longitudinal differences more accurately. A longer study that tracked students into their senior grades would also permit an analysis of potential nonlinear trends that arise during the crucial senior grades.

5.10 Summary of Study 1 and Conclusion

Study 1 explored the multifaceted nature of maths motivation and its development during secondary school. In a sample of Australian high school students, a comprehensive model of academic motivation was presented and its psychometric properties were tested within maths in a multi-cohort-multi-occasion design.

The results showed that a general framework of academic motivation was applicable to maths. Although motivational theories are largely developed at a general academic level, the cognitive, affective and behavioural experiences they refer to are relevant to learning maths. It was also found that a 10-factor model can be applied to the MES-HS, which supports a parsimonious and practical approach to conceptualising motivation, while still retaining the valuable multidimensionality of this scale. Although a few items in the MES-HS may need revising for specificity, further testing with other populations in mathematics will consider the possibility that these items were falsely identified because of sampling variability. Overall, the Student Motivation and Engagement Wheel is a useful framework by which to comprehensively and longitudinally assess the maths motivation of both boys and girls and its measure, the MES-HS is a suitable scale with which to do so.

It is also concluded that a singular theoretical approach does not adequately conceptualise the complex nature of maths motivation. Instead, a combination of pivotal theoretical frameworks was needed to explain the associations of facets within the Wheel. Of particular significance was the complementary role EVT played in understanding constructs stemming from need achievement, self-worth and control theories. The current analysis also identified the distinctive relationships that different self-regulatory behaviours share with other facets of motivation, particularly the relevance of need for achievement theory and a fear of failure to models of self-regulation. A key finding regarding the nature of motivation was the unexpected weak relationships for anxiety with both adaptive and maladaptive dimensions of motivation. Future research should clarify which aspect of anxiety is being assessed as it appears that perceptions of control are more indicative of a negative motivational orientation than feelings of worry. It is possible that the affective dimension of anxiety (Wigfield & Meece, 1988) holds clearer relationships with other facets of motivation. If so, the model could be reviewed to include this construct because its potential to impede adaptive motivation and perpetuate a maladaptive orientation may be more serious than the cognitive component of anxiety currently included.

Supporting a multidimensional approach, the current results revealed which facets of motivation were most strongly related, as well as those that were less so. Although ratings in one facet of maths motivation were largely related to concurrent attitudes and behaviours towards learning maths, the extent of these relationships depended on the construct in question as they each showed unique inter-relations.

This is useful for educators and parents because understanding which cognitions and behaviours are likely to be entwined means that interventions can be targeted appropriately.

Study 1 also replicated and extended previous research on changes in maths motivation during high school. Adaptive motivation appeared to decrease across grades 7 to 10, while disengagement increased. However, these trends were not met with an increase in all maladaptive constructs. The expectancy-value, self-efficacy and goal orientation theories were most relevant in understanding developmental trends in maths motivation. Rather than focusing on students' anxieties and self-consciousness, developmental trends in maths may be more effectively addressed by enhancing students' competency and value beliefs, particularly the perceived practical relevance of maths. Students' self-regulatory skills to study effectively and maintain effort towards learning maths should also be supported throughout high school. Furthermore, as the rates of change were similar in each cohort, an emphasis on promoting maths should be maintained for the duration of high school, rather than only during the transition to high school or entry to the senior grades.

The current results also clarify issues in maths motivation relevant to gender. The primary gender difference observed was that compared to boys, girls reported stronger maladaptive cognitions stemming from control and worry concerns. To a lesser degree they also expressed more concerns with a need to achieve and reported more interest and effort in maths than boys. However, it was unclear if girls' stronger ratings of planning were adaptive because they were driven by a greater intrinsic interest or if they perhaps stemmed from a preoccupation with pleasing others. The need achievement, self-worth and control theories appeared most useful in explaining gender differences in maths motivation. Consequently, those interested in understanding boys and girls' participation in maths may overlook important psychological processes if they neglect these constructs, as issues of shame and control seem central to distinguishing the maths experiences of girls and boys.

Chapter 6
Contextualising Maths Motivation; Affiliation With Significant Others

6.1 Outline of Chapter 6

Having established a model of maths motivation and explored its multifaceted nature throughout high school, the next section of this thesis will address antecedents to academic motivation. The social environment is presented as an antecedent of academic motivation that helps us understand how different approaches to learning maths develop. Chapter 6 firstly introduces the centrality of belongingness to wellbeing and then links this to academic motivation within the theoretical frameworks of school belonging and Self Determination Theory (SDT). Interpersonal relationships with parents, teachers and peers are then considered as core sources of affiliation during adolescence and past research examining their influence on academic motivation is reviewed. Given gender trends in maths participation and engagement, the potentially unique function of affiliation for boys and girls is discussed. Finally, a summary is made highlighting the main points and stating research questions that need addressing.

6.2 Understanding Academic Motivation within the Relational Context

Students' orientation towards school and learning can be considered in relation to the social context. From this perspective, relationships can either promote or impede students' motivation, depending on whether they meet the needs of adolescents (Eccles et al., 1993). Although students have a range of needs, such as self-esteem, autonomy and independence, during adolescence a particularly salient need is that of social acceptance and supportive relationships. Between the ages to 6 to 14 the importance of having trusting relationships becomes central, along with other important psychological developments such as self-awareness and self-esteem (Eccles, 1999).

Having a sense of relatedness with others predicts positive emotions such as happiness, confidence and enjoyment and is negatively related to negative affect such as worry, frustration and depression (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000). Adolescents reporting high quality relationships also tend to experience greater wellbeing, in terms of more friends, greater family cohesiveness, as well as lower drug use than those perceiving poor relationships (Field, Diego, & Sanders, 2002). Considering the significance of relationships to general wellbeing, their role during adolescence seems relevant to students' functioning at school. This is reflected in the significance that students place on relationships in determining their satisfaction with school. A supportive social environment is frequently associated with students who have positive perceptions of school, whereas poor relations, alienation and low school identification are often linked with disengagement and school withdrawal (Anderman, 2003; Finn, 1989; Dowson & McInerney, 2003; Goodenow & Grady, 1993; Hughs & Zhang, 2006; Knesting & Waldron, 2006; Murdock, 1999; Nichols, 2008; Osterman, 2000).

6.3 Conceptualising Affiliation within Mathematics Motivation

The importance of a welcoming environment in the learning context has been conceptualised as school belonging. This approach is based on the idea that humans have a psychological need to belong (Baumeister & Leary, 1995). School belonging is generally understood as the extent to which students feel personally welcomed, respected and supported by others (Goodenow & Grady, 1993) and feel positive towards their school (Hill & Werner, 2006). This approach stems from Maslow's (1962) Theory of Motivation, suggesting that the need for belonging is an essential requirement for higher needs such as seeking knowledge. Baumeister and Leary (1995) argue that this fundamental motivation affects emotions, cognitions, health and wellbeing. A sense of belonging gives students a secure emotional base from which they can develop without evaluative concerns, such as self-consciousness or worrying about failure (Roeser, Midgley, & Urdan, 1996). Consequently, feeling accepted leads to positive emotions such as happiness and calmness, while rejection can lead to maladaptive responses such as anxiety and depression (see Baumeister & Leary, 1995). If students feel supported and respected at school, they are more likely to experience greater self-confidence in their abilities (Goodenow & Grady, 1993; Pajares, 1996). Furthermore, identifying with a school community has a secondary effect of encouraging students to internalise its educational values (Catalano, Haggerty, Oesterle, Flemming & Hawkins, 2004).

School belonging is useful in understanding students' experiences within a broader group or a community. However, as it mainly concerns the nature of one's relationships with groups of others (Nichols, 2008), the role of different interpersonal relationships in motivation is overlooked. Self-Determination Theory (SDT) however, argues that interpersonal relationships play a crucial role in the level and style of motivation that individuals develop and maintain (Ryan & Powelson, 1991). Similar to school belonging, SDT is based on the assumption that humans have a need for affiliation, however it is more focused on interpersonal attachments. SDT identifies three psychological needs of competency, autonomy and relatedness, which must be satisfied to facilitate intrinsic motivation, self-regulation and wellbeing (Ryan & Deci, 2000a, 2000b). The need for relatedness is of interest to the current research and refers to the need to feel accepted, cared for and securely connected with significant others (Connell & Wellborn, 1991; Legault et al., 2006; Ryan & Deci, 2000a, 2000b). Relatedness is as an emotional connection between people in which the self is experienced as worthy of respect (Ryan & Powelson, 1991). It stems from Bowlby's (1979) findings that exploratory behaviour in infants is more likely when the infant is securely attached to the mother. Attachment theory suggests that secure attachment promotes identity development and trust in others, providing a secure psychological base from which to explore the physical and social environment (Furrer & Skinner, 2003). This sense of security and exploration develops adaptive responses to challenges through greater perceptions of self competence and control (see Catalano et al., 2004; Ryan, Stiller, & Lynch, 1994). Consequently, the quality of attachments are represented in the way students' perceive events, themselves and their chosen courses of action.

Connell and Wellborn (1991) and Ryan and Deci (2000a) argue that intrinsic motivation and self-esteem are more likely in contexts of security. Relatedness (also termed affiliation) plays an important role in the transmission of values, as values and desirable behaviours are likely to be prompted by those whom students feel psychologically connected with (Ryan & Deci, 2000a, 2000b; Ryan & Powelson, 1991). Relatedness may be particularly relevant to maths because it is a context in which the tasks are often not inherently intrinsically motivating. The attitudes and behaviours needed to learn maths must be initially prompted, valued or modeled by another, such as a teacher or parent. SDT argues that relatedness encourages behavioural engagement in domain-specific pursuits by activating positive affect, whereas alienation and amotivation may develop when this psychological need is not supported (Connell & Wellborn, 1990; Ryan & Deci, 2000b).

Consistent with theory, students with a stronger sense of relatedness tend to demonstrate stronger coping resources, stronger intrinsic interest and adaptive problem solving and perceive themselves as more competent than those with weaker affiliation with others (Andermann & Andermann, 1999; Connell & Wellborn, 1991). They also tend to develop a stronger sense of identity than those with less affiliation, while regulating their behaviour in the classroom more consistently with social norms (see Osterman, 2000). As a result, students perceiving affiliation with others tend to have more positive attitudes towards school and invest more effort in learning (Osterman, 2000). In contrast, students who feel disconnected from social partners may become more easily bored, anxious, and disengaged (Buhs, Ladd, & Herald, 2006; Furrer & Skinner, 2003; Knesting & Waldron, 2006; Legault et al., 2006; Murdock. 1999). Consequently, disengagement in learning may reflect unmet interpersonal affiliative needs (Legault et al., 2006).

6.4 Academic Motivation and Affiliation with Parents, Teachers and Peers

Although affiliation is associated with more positive school functioning, the function and existence of varying interpersonal relationships within learning processes needs more attention. Although students simultaneously encounter messages from many social partners (Bouchey & Harter, 2005), teachers, parents and peers are the three most commonly identified as primary socialisers of adolescent behaviour (Catalano et al., 2004). Consequently, affiliation with these three potential sources of influence will now be discussed in relation to the implications for academic motivation.

Research addressing socialisation has largely focused on the significance of parents in shaping their children's attitudes and expectations of the world. Until early adolescence, students are likely to have more frequent interactions and more intimate relationships with their parents compared to others. Consequently, there are often similarities between children and their parents' attitudes and the strength of this relationship may be very strong (Bleeker & Jacobs, 2004; Cole, 1991; Jacobs, 1991; Klassen, 2004). Children with strong parent relatedness tend to have higher self-esteem and be more engaged at school (Avery & Ryan, 1987; DEST, 2005; Ryan et al., 1994). However, the association parent affiliation shares with the range of specific cognitive and behavioural facets of academic motivation are not particularly well understood.

While parents are the main socialisers during the early years of development, as students enter school teachers become another, almost daily adult influence. Teachers play many roles, as educators, role models and as potential attachment figures. Consequently, they have many opportunities to guide students' beliefs and behaviours, particularly if students are lacking in parental support (Furrer & Skinner, 2003). Demonstrating the importance of teachers, teacher affiliation is associated with greater intrinsic interest and competency beliefs (Goodenow, 1992; Patrick et al., 2007; Wentzel, 1998), as well as self-regulation (Klem & Connell, 2004; Knesting & Waldron, 2006). Furthermore, declines in motivation across high school have been associated with lower ratings of teacher relatedness (Feldlaufer, Midgley, & Eccles, 1988; Midgley, Feldlaufer, & Eccles, 1989; Speering & Rennie, 1996). In relation to mathematics, Midgley et al. (1989) found that students who came from primary schools with low supportive teachers to supportive high school teachers showed an increase in their intrinsic valuing of maths. Conversely, students who changed to a less supportive teacher after the transition to high school reported a decline in their maths intrinsic interest, importance and usefulness beliefs. Consequently, the quality of teacher-student relationships can be associated with motivational outcomes.

Most research on the socialisation of academic motivation has focused on parents and teachers (Altermatt & Pomerantz, 2003; Floyd & South, 1972; Gest, Domitrovich, & Welsh, 2005). Although friends are likely to frequently engage in conversation involving advice giving and evaluative discourse (Altermatt, Pomerantz, Ruble, Frey, & Greulich, 2002), the research focus on adult influence has not been fully extended to that of peers (Furrer & Skinner, 2003; Mounts & Steinberg, 1995). However, the importance that adolescents place on peer acceptance calls for the peer relational context to be considered as a source of academic motivation, as well as parents and teachers (Murdock, 1999).

Positive and supportive friendships are a distinct concern during early adolescence because they assist in defining a sense of self and promoting wellbeing (Berndt, 1999). Being accepted by peers gives adolescents a confirmation of their abilities and self-worth while forming relationships that shape their attitudes and behaviours (Cheng, 1997; Syngollitou & Daskalou, 2004; Tedesco & Gaier, 1988; Wentzel, 1998). Friends have been recognised as an important source of adolescent delinquency (Altermatt & Pomerantz, 2003; Bates, 2004; Urberg, Degirmencioglu, Tolson, & Halliday-Scher, 1995) and most research has focused on negative attributes of friend influence. This is despite observations that those who lack friends are more likely to disengage from school (Furrer & Skinner, 2003) and that students are usually more willing to conform to prosocial activities than antisocial ones (Berndt, 1979; Brown, Clasen & Eicher, 1986). Consequently, friend influence is not necessarily negative and considering that friends are central to students' interpersonal life, they may be especially relevant to academic motivation through processes of relatedness (Legault et al., 2006).

Although the link between peer relatedness and academic motivation appears less consistent than adult affiliation, feeling respected and accepted by friends tends to be positively associated with adaptive, rather than maladaptive orientations towards school. Peer relatedness is positively associated with greater mastery goals and competency beliefs (Cocks & Watt, 2004; Levy-Tossman, Kaplan, & Assor, 2006). Positive peer relationships also seem to be particularly relevant in preventing academic anxiety (Mounts, Valentiner, Anderson, & Boswell, 2006; Osterman, 2000; Wentzel, 1998). Osterman (2000) suggests this is because low peer relatedness may increase students' evaluative concerns and tendency to avoid taking risks in their learning, such as speaking up in class and asking for help. However, feeling supported and respected by peers may mean that evaluative concerns are less likely to be triggered.

Others however, report friendships as not directly related to academic motivation (Ryan et al., 1994; Wentzel, 1998). Ryan and his colleagues (1994) observed that junior high school students' relationships with teachers and parents were positively associated with their school satisfaction, effort, positive coping, self-regulation and perceived control. In contrast, relationships with friends were generally unrelated to these outcomes and instead were predictive of general self-esteem. Furthermore, although relationships with teachers and parents were positively correlated, friends were not significantly related to the quality of either type of adult relationship. Although some find that friends do not contribute to academic factors, Wentzel (1998) highlighted their potential indirect role through anxiety regulation. Wentzel (1998) found that although peer support was not directly related to school interest and performance, it showed an indirect effect by negatively predicting emotional distress.

In summary, parents, teachers and peers are important figures in adolescents' lives, as they are each associated with students' emotional and behavioural development. However, the role of peers in student motivation and achievement has received less attention than that of parents and teachers. Some have found peers to be relevant, whereas others suggest they are associated with non-academic outcomes, such as general self-esteem.

6.5 The Relative Influence of Parents, Teachers and Peers in Academic Motivation

With these inconsistencies in mind, some research has considered the relative influence of parents, teachers and peers in academic motivation. Generally, perceiving a positive relationship with teachers has been more predictive of achievement (O'Connor, 2007), school interest (Wentzel, 1994, 1997, 1998), competency and value beliefs and effort (Connell & Wellborn, 1991) than relationships with peers or parents. However, other research (Furrer & Skinner, 2003; Patrick et al., 2007) finds that relatedness to each social group is beneficial and that parents, peers and teachers may play unique roles in shaping specific facets of motivation. There have also been suggestions of a potential compensatory role for different relationships in building resilience to protect students' wellbeing and engagement (Benner & Minstry, 2007; Furrer & Skinner, 2003; Wentzel, 1998).

There is some evidence that parents may be most relevant in broader beliefs and attitudes, with friends and teachers primarily influencing contextual facets of motivation (see Cauce, Hannan, & Sargeant, 1992; Connell & Wellborn, 1991). For example, Steinberg, Dornbush and Brown (1992) found that parents are particularly salient in long-term educational plans and goals. Furthermore, within mathematics Chouinard et al. (2007) found that parent relatedness was most strongly related to utility and mastery values, whereas teacher relatedness was most associated with students' competency beliefs. Consistent with the differentiated roles of adults, friends have been observed as more relevant than adults in daily and observable indicators of engagement, such as classroom conduct and persistence (Hardre, Chen, Huang, Chiang, Jen & Warden, 2006; Legault et al., 2006; Steinberg et al., 1992).

The enduring influence of relatedness was evidenced by Furrer and Skinner (2003) who found that relatedness with teachers, parents and peers positively predicted elementary students' academic engagement later within the same school year. The authors measured behavioural engagement as students' effort, attention and persistence during class, and emotional engagement as interest, anger and frustration. Behavioural engagement was most strongly predicted by parent, then teacher and peer relatedness, while emotional engagement was most strongly predicted by teachers, peers and then parents. However, importantly both types of engagement were predicted by relatedness with each social group, indicating they play additional, rather than supplementary roles in the development of academic motivation.

Applying a SDT framework and focusing on maladaptive academic motivation, Legault et al. (2006) tested the relative influence of relatedness, competency and autonomy support from teachers, parents and friends on high school students' academic amotivation. In support of the transmission of values (Ryan & Deci, 2000b), poor academic values were negatively predicted by affiliation with each social group. Furthermore, affiliation with parents and friends negatively predicted all indicators of amotivation, including low values, competency beliefs, task characteristics (perceiving learning as boring) and effort beliefs. However, teacher affiliation was only significantly associated with students' utility values. Consistent with prior suggestions, affiliation with parents showed a greater influence than friends in more long-term beliefs, such as valuing and ability beliefs, while friend affiliation was a stronger predictor of task characteristics and apathy beliefs than parent relatedness. Overall, these results suggest that individuals have unique roles in shaping maladaptive motivation and that amotivation may stem from inadequate social support.

More recently, the Student Motivation and Engagement Wheel has been considered within the context of relationships. This an important development because previous research has tended to apply a subset of motivational constructs, whereas this is a more comprehensive model. Martin, Marsh, McInerney, Green and Dowson (2007) tested the influence of relationship quality with parents and teachers on the four higher-order factors of the model. Both teacher and parent relationships positively correlated with adaptive cognitions and behaviours, and negatively with maladaptive cognitions and behaviours. Martin et al. (2007) then performed a path analysis controlling for gender and grade effects. Although both types of relationships were significant, teachers were more strongly predictive of the four higher-order constructs of academic motivation than parents.

Martin et al.'s (2007) study is noteworthy because they demonstrated the importance of teacher and parent relationships in a broader range of academic constructs than done so by previous research. However, they applied the higher-order structure of the Wheel, which overlooks potentially meaningful differences in the socialisation of specific facets of motivation. Furthermore, only the role of adults but not peers was considered. More recently, Martin, Marsh, McInerney and Green, (2009) applied the multifaceted lower-order 11-factor structure to explore the role of relatedness with teachers, parents and peers. They found that with the exception of anxiety and failure avoidance, each construct most strongly correlated with teacher relatedness, then parents and then peers. Interestingly, anxiety and failure avoidance were most strongly negatively associated with same-sex peers. Although Martin et al. (2009) observed a significant relationship between peer affiliation and academic motivation, partially consistent with previous research peers were more strongly associated with non-academic variables, such as physical ability and appearance self-concepts rather than academic motivation. Please note that the Martin et al. (2009) paper was published after the data for the current study had already been collected in the participating rural schools and therefore could only be considered posthoc.

6.6 Gender and Affiliation in Maths Motivation

Also central to understanding how the social environment contributes to maths motivation is the context of gender. As gender differences in maths motivation and interpersonal relationships arise, it is important to consider how these processes may be associated. Direct gender effects on maths achievement are weaker when social-cognitive variables such as parents' expectancies are controlled for (Byrnes & Miller, 2007). Consequently, experiences of relationships may contribute to the observed gender differences in maths motivation and participation.

Compared to boys, girls tend to exhibit a stronger relational orientation and report greater interpersonal and school belonging (Anderman & Anderman, 1999; Field et al., 2002; Furrer & Skinner, 2003; Goodenow & Grady, 1993; Hardre et al., 2006; Hill & Werner, 2006; Nichols, 2008). As discussed in Chapter 5.8, there are suggestions that girls tend to feel more compelled to meet external standards because their self-worth is more aligned with pleasing others than that of boys (Ruble, Greulich, Pomerantz, & Gochberg, 1993). This may be why girls tend to have more intense emotional responses than boys to evaluative feedback and negative reactions from others (see Creasey et al., 1997). This gender difference in relational orientation may cause feelings of security and affiliation to feature more prominently in shaping girls', rather than boys' academic motivation (Altermatt et al., 2002). This also suggests that girls would report more anxiety-based beliefs and effort than boys in maths. Although boys traditionally receive more encouragement from significant others to engage in maths, perhaps then social support is particularly important for girls' maths motivation because it encourages them to participate in a male stereotyped field (Lopez et al., 1997). Consistent with this suggestion, Martin et al. (2007) found that teacher affiliation negatively predicted girls' maladaptive cognitions and behaviours more strongly than that of boys. Furthermore, both teacher and peer support have been more strongly associated with girls' values and expectancy beliefs than boys' (Goodenow, 1993; Ntoumanis, 2001).

In contrast, others have found that although boys report less intimacy in relationships, affiliation is more predictive of their emotional and behavioural development (Goodenow, 1993; Moore & Boldero, 1991). For example, Furrer and Skinner (2003) found that elementary boys' emotional and behavioural engagement was more influenced by teacher-student relationships than that of girls. Furthermore, Fullarton et al. (2003) found that perceptions of school and class belonging were more predictive of boys' engagement than for girls. If boys generally feel less psychologically connected to others within their learning environment, then perhaps the implications of affiliation are greater because this source of support and encouragement is lacking. From this perspective, having a supportive social environment may be particularly helpful for boys during high school compared to girls.

6.7 Summary of Chapter 6 and Issues that Need More Attention

Students' social experiences are relevant to academic motivation and examining them can provide an understanding of their likelihood of developing a positive orientation towards learning (Lynch & Cicchetti, 1997). Although one of the most important characteristics of relationships during adolescence is trust and respect (Levy-Tossman et al., 2007), most research has concentrated on other aspects such as expectancies, or autonomy and competency support (Patrick, Mantzicopoulos, Samarapungavan, & French, 2008). Considering the centrality of acceptance to adolescents' wellbeing and school adjustment, gaining a better understanding of how affiliation promotes adaptive maths motivation is warranted.

However, research on interpersonal affiliation in maths is difficult to interpret because few studies have simultaneously investigated the role of different social partners at a subject specific level. Parents, teachers and peers are three major groups with whom students may develop relationships characterised by support and warmth versus distrust and detachment. The nature of each of these connections may have significant implications for students' orientation towards learning and so the relative influence of these social partners should be tested. Furthermore, research tends to assess general academic motivation rather than being subject specific (such as Goodenow & Gardy, 1993; Legault et al., 2006 Martin et al., 2007, 2009; Roeser et al., 1996). This means that students in these studies of general motivation must generalise their learning experiences and relationships across school, rather than focusing on specific contexts (such as maths) and this makes the influence of specific relationships unclear. Considering that measures of motivational constructs tend to have greater explanatory and predictive power when they are contextualized (Bandura, 1997; Pajares, 1996), to understand the role of affiliation within maths these relationships should be studied at the subject specific level.

Research has also generally focused on global measures or a subset of motivation constructs, which overlooks the multifaceted nature of maths motivation and the potential influence of affiliation on specific facets. Although expectancy and value beliefs have received some attention, the role of affiliation in maladaptive facets of motivation has been largely ignored. Given the theoretical emphasis of relatedness in building students' resilience and coping resources, the role of relationships within a comprehensive model including the darker side of motivation is needed.

There is also a need to gain more understanding of how maths motivation and relatedness interact across time. Research tends to be cross-sectional, or only follow students across the transition to high school. However as motivation involves sustained behaviour, a longitudinal study would capture social and motivational dynamics more accurately and usefully (Furrer & Skinner, 2003). Furthermore, despite widespread attention regarding gender trends in maths participation and motivation, comparatively little research has considered which relationships are most salient to boys and girls. Therefore, more understanding is needed regarding how these social experiences may have different implications for the maths motivation of boys and girls.

In summary, there is a limited understanding of the bearing that relationships have on maths motivation during adolescence. More research is needed to identify the interpersonal processes underlying students' motivation and delineate the role of affiliation (Schunk, 2000). Consequently, a longitudinal exploration of the relationships between a range of motivation constructs and affiliation with multiple social partners during high school is needed (Wentzel, 1998).

Chapter 7
Study 2; The Role of Affiliation in Maths Motivation

7.1 Study 2 Aims and Hypotheses

The present study seeks to gain a more comprehensive understanding of the relationship between affiliation and maths motivation. The premise is that relationships underpin students' academic motivation and engagement and relatedness is presented as a motivational resource. If students perceive a supportive environment they can direct their resources towards coping with academic challenges. As a result, positive interpersonal relationships characterised by affiliation are fundamental to adaptive maths engagement, whereas a lack of relatedness can undermine motivation.

The current study will apply an adaption of the Student Motivation and Engagement Wheel as a multidimensional model of maths motivation to examine the conceptual and predictive value of relatedness in maths motivation. Over two years, high school students' perceptions of affiliation with their parents, maths teacher and peers will be assessed along with their maths motivation and engagement. See Figure 9 for the hypothesised structural model.

Study 2 extends previous work by considering the relative salience of three key relationships (maths teacher, parents and peers) in a comprehensive range of cognitive and behavioural facets of motivation. It is also distinctive because it considers the nature of these associations with adaptive and maladaptive constructs across time and gender. As previous maths achievement predicts motivation (Klassen, 2004), the analyses will take the influence of maths attainment into account when assessing the role of affiliation.

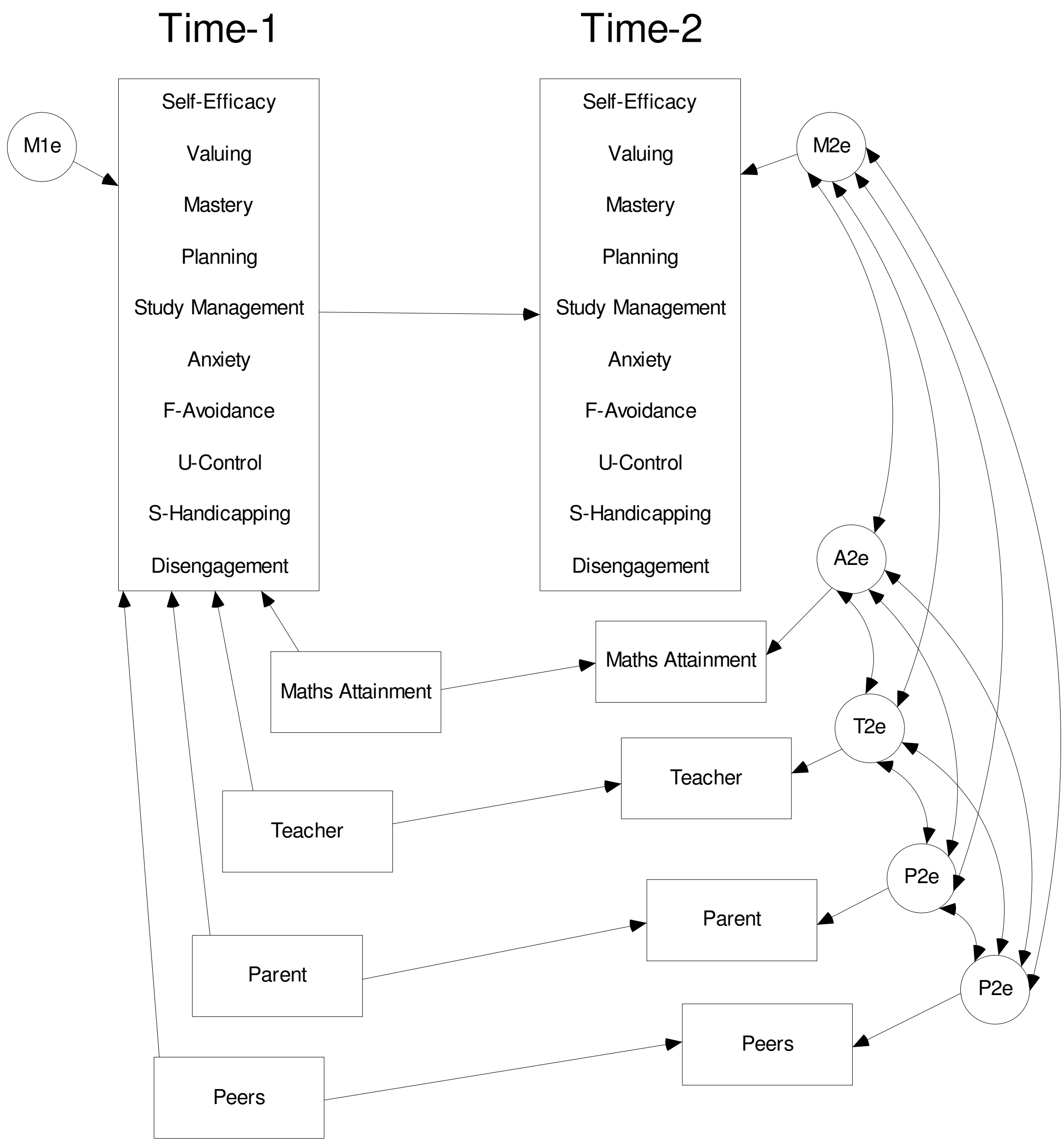


Figure 9. Hypothesised structural model of affiliation and maths motivation

The first section of the analyses will assess the fit and factor structure of the affiliation and attainment scales. It will consider how we can understand relatedness as perceived by students. In support of a multidimensional approach to social influence, students' perceptions of relatedness are expected to positively correlate with each other but reflect unique constructs. Preliminary analyses will also test the invariance of the relatedness and attainment measures across gender and time. This measurement model is expected to be equivalent for boys and girls and across the one-year interval.

Study 2 will then consider how relatedness and motivation develop and interact concurrently and longitudinally. The path diagram of the hypothesised relationships is shown in Figure 9. Importantly, the current study will explore the multidimensional nature of motivation by asking what the predictors are for each facet of motivation and the relative predictive strength of relatedness with different social partners. Relatedness is expected to positively predict adaptive constructs and negatively predict maladaptive constructs. However, it is uncertain which source of affiliation will show the strongest relationship with motivation. Previous research has identified teachers as most consistently linked with students' school orientation, however little research has been conducted within the context of affiliation or with a range of specific maths motivational constructs. As parents and peers are most prominent in a student's personal life it is possible that their relevance through relatedness may actually be stronger than that of teachers for some facets of motivation. However, due to their role in providing feedback, teachers may be most relevant for self-efficacy and considering the relevance of peer relationships in building students' coping resources, peers may be particularly relevant for maladaptive cognitions.

In terms of the longitudinal design, relatedness is primarily expected to predict concurrent rather than future motivation. Maths motivation and relatedness are expected to show strong stability across the one-year interval. This will indicate the relative consistency of individuals' orientation towards school and perceptions of relationships across time compared to other students.

The final analyses will consider the role of gender within the model. The moderating role of gender will be assessed through multigroup path analyses comparing the strength of path coefficients between boys and girls. This will ask if the relationship between affiliation and motivation and their development across time differs for boys and girls. No gender difference is expected in the stability of motivation and affiliation. However due to girls' greater relational orientation and desire to please others, the influence of affiliation is expected to be stronger for girls than boys.

7.2 Method

7.2a Participants

The participants were the same students who participated in Study 1. This included a total of 519 students from the three regional New South Wales (NSW) high schools. In the first wave there were 315 females, and 204 males in the seventh (*N* = 200), eighth (*N* = 176) and ninth grades (*N* = 143). As the study is a multicohort-longitudinal design, the first wave included students in Grades 7, 8, and 9 who then responded to the same questions again one-year later in Grades 8, 9 and 10, respectively.

7.2b Materials

Maths Motivation and Engagement. The adaptation of Martin's (2007a) Motivation and Engagement Scale-High School (MES-HS) from Study 1 was used to assess cognitive motivation and behavioural engagement in mathematics (see Appendix A). The model included modifications detailed in Study 1 relevant to factor structure and model fit. Because of this the scale consisted of 40 items measuring 10 dimensions of academic motivation and engagement. These dimensions include three adaptive cognitive (self-efficacy, valuing and mastery orientation) and two adaptive behavioural components (study planning and persistence), three impeding cognitive components (anxiety, failure avoidance and uncertain control) and two maladaptive behavioural components (self-handicapping and disengagement). Students rated themselves on a Likert scale of 1 (strongly disagree) to 7 (strongly agree) for each item.

Relatedness. Items measuring students' perception of relatedness with their parents, maths teacher and peers were based on theories of relatedness and belonging (Baumeister & Leary, 1995; Connell & Wellborn, 1991; Goodenow & Grady, 1993; Ryan & Powelson, 1991). These items assessed the quality of relationships with each social partner as characterised by experiences of affiliation, acceptance, friendliness and fairness.

The relatedness scale for students' maths teacher consisted of six items describing the quality of their relationship and liking of their maths teacher. For example, "*I like my maths teacher*". Students rated themselves from 1 (strongly disagree) to 5 (strongly agree), with a response of three indicating "uncertain". See Appendix L for all item listings.

Relatedness with peers was measured by the Identity subscale of the Quality of School Life Questionnaire (QSL) (Ainley & Bourke, 1992). Students rated to which degree six statements reflected their school experience. An example statement is, "*Other students are very friendly*". The ratings ranged from 1 (certainly false) to 5 (certainly true), with a response of three indicating "uncertain". See Appendix L for all item listings.

Relatedness with parents was assessed by the Parent subscale of the Self Description Questionnaire (SDQ) (Marsh, Ellis, Parada, Richards, & Heubeck, 2005). This measure includes 4 items in which students report the quality of their relationship and liking of their parents from 1 (false) to 6 (true). For example, "*I get along well with my parents*". The items refer to 'parents', rather than a specific guardian and have previously been shown to be internally reliable with α = .84 (Marsh et al., 2005). See Appendix L for all item listings.

Maths Attainment. The current study asks whether perceived relatedness predicts motivation above and beyond the contributions of maths attainment. To do this, maths achievement was assessed by the maths subscale of the Self Description Questionnaire (SDQ) (Marsh et al., 2005). This measure includes 4 items in which students report their self-perceived achievement in maths on a Likert scale from 1 (false) to 6 (true). An example item is "*Mathematics is one of my best subjects*". See Appendix L for all item listings.

7.2c Procedure

The consent process and procedure were the same as for Study 1 (see section 3.2c). The relevant ethical bodies, principals, maths teachers and parents provided their consent. Then all participants provided their written consent before commencing the study. See appendix B for ethics approvals and appendix C for information and consent forms. Those students not participating either failed to gain parental consent, were absent on testing days or declined the invitation to participate.

The students were told that the purpose of the research was to learn more about their academic motivation, especially their feelings and attitudes regarding maths. They were assured that their answers would be treated as confidential and encouraged to be honest in their responses. Students were instructed to work by themselves, completing the questionnaire at their own pace and that there were no right or wrong answers. The researcher was present throughout testing to assist students with any queries or reading difficulties and collected questionnaires when they had finished. Questionnaires took approximately 40 minutes to complete. The researcher administered the questionnaire to Year 7, 8 and 9 maths classes during normal lesson time in second semester (spring) of the school year. Then during the second semester of the following year, these cohorts completed the questionnaire again.

Chapter 8
Study 2 Results

8.1 Statistical Calculations

Confirmatory Factor Analysis (CFA) and Structural equation modeling (SEM) in Mplus (Version 5; Muthén & Muthén, 2007) were used to assess the model fit, measurement invariance of the affiliation and maths attainment scales and their predictive paths with the maths motivation constructs. A categorical framework was applied in the analyses because the responses for the affiliation and maths attainment items were based on Likert scales. As discussed in Chapter 4, a weighted least squares estimation is recommended for ordinal data (Flora & Curran, 2004; McIntosh, 2007) and the Mplus WLSMV estimator was used for tests of model fit and measurement invariance. The tests of model fit remained the same as those in Study 1, with the chi-square test statistic, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI) and the root-mean-square error of approximation (RMSEA) used to judge model fit. The structural invariance between nested models was assessed through Mplus with the chi-square difference test for the WLSMV estimator (Muthén & Muthén, 2007). Also consistent with Study 1, the current study included correlated item uniqueness across Time 1 and Time 2 in baseline and constrained models while testing affiliation and maths attainment measurement invariance.

8.2 Measurement Analysis of Affiliation and Maths Attainment Scales

All items measuring affiliation with parents, teacher and peers and maths attainment were included in a 4-factor CFA, with unique factors for parent, teacher and peer relatedness and maths attainment expected. Although these models showed a reasonable fit for each time-point (Time 1; χ^2 = 84.85 *df* = 56, $p < .05$; CFI = 1.00; TLI = 1.00; RMSEA = .032, Time 2; χ^2 = 147.80 *df* = 59, $p < .05$; CFI = .98; TLI = .99; RMSEA = .054) there was room for improvement.

At both time-points, two items (Pe1 and Pe3) from the peer affiliation scale showed relatively low loadings and correlations with the other indicators. See Appendix L for the wording of these indicators. For example, at Time 1 the factor loading for Pe1 was .26 and .53 for Pe3, while the other factor loadings of the other peer affiliation indicators ranged between .66-.79. An inspection of the item wording showed that Pe1 and Pe3 were conceptually different from the other peer items, which addressed perceptions of peer friendliness and acceptance more specifically than Pe1 and Pe3.

Two items from the teacher affiliation scale (MT2 and MT4) also showed relatively weaker correlations with the other teacher relatedness indicators. They also showed weak factor loadings on the latent construct, .65 and .64 for MT2 and MT4, respectively, compared to loadings ranging between .83-.91 of the other indicators. See Appendix L for the wording of these indicators. These two items assessed perceptions of attention and fair treatment from the teacher, whereas the remaining items focused more on students' perceptions of the quality of the relationship and the degree to which they liked their teacher. Based on this conceptual focus, these two indicators, as well as the two indicators from the peer affiliation scale were removed from further analysis.

The final 4-factor model of affiliation and maths attainment included 4 items for the maths teacher, 4 items for peers, 4 items for parent and 4 items for maths attainment. This model showed a good fit at each wave, as well as gender invariance within both waves (see Tables 20 and 21). The factor loadings for each time-point are presented in Figures 10 and 11 (see Appendix M for the factor loadings by gender).

Table 20.
Time 1 Final Model Fit and Gender Invariance for Affiliation and Maths Attainment

Model	χ^2	*df*	CFI	TLI	RMSEA	χ^2diff
Wave 1	61.19	40	1.00	1.00	.032	-
Females	55.26	36	1.00	1.00	.041	-
Males	42.55	35	1.00	1.00	.033	-
Both Genders	100.48	75	1.00	1.00	.036	-
Gender Invariance	119.71	91	1.00	1.00	.035	$p > .19$

Table 21.
Time 2 Final Model Fit and Gender Invariance for Affiliation and Maths Attainment

Model	χ^2	*df*	CFI	TLI	RMSEA	χ^2 diff
Wave 2	95.66	43	.99	1.00	.049	-
Females	61.69	37	.99	1.00	.046	-
Males	64.48	37	.98	.99	.060	-
Both Genders	135.87	79	.99	1.00	.053	-
Gender Invariance	151.96	95	.99	1.00	.048	$p > .26$

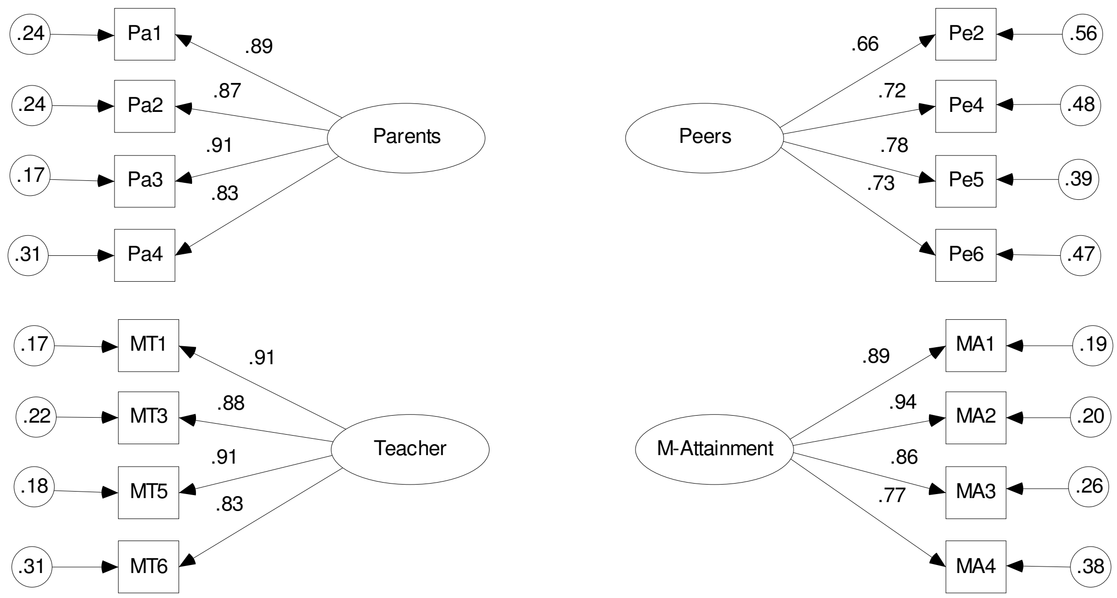


Figure 10. Time 1 factor loadings for affiliation and maths attainment latent factors

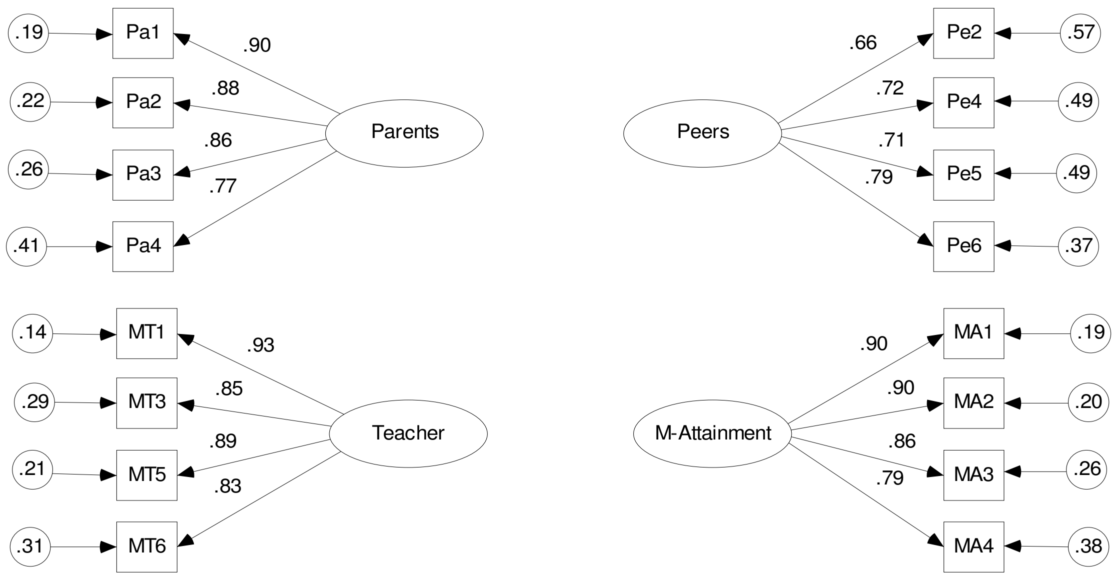


Figure 11. Time 2 factor loadings for affiliation and maths attainment latent factors

The affiliation model was then tested for measurement invariance across time (see Table 22) and showed overall invariance across time and for boys. The chi-square difference test was significant for girls (p = .04). However, as no substantial source of invariance could be identified and there were no change in fit indices, which still showed a very good fit, this effect was considered negligible for practical purposes. As a result, measures of affiliation and maths attainment were formed based on almost equivalent factor structure across gender and at multiple time-points.

Table 22.
Measurement Invariance of Affiliation and Maths Attainment across Time

Model	χ^2	*Df*	CFI	TLI	RMSEA	χ^2diff
Both Waves	199.81	110	.99	1.00	.040	
Invariance	219.64	125	.99	1.00	.038	$p > .06$
Female	126.08	88	.99	1.00	.037	
Female Invariance	141.78	99	.99	1.00	.037	$p < .05$
Male	115.52	76	.98	.99	.050	
Male Invariance	118.79	83	.98	.99	.046	$p > .74$

As shown in Table 23, all constructs positively correlated with each other. Peer affiliation showed the strongest correlations amongst the affiliation constructs, while maths attainment shared the strongest correlation with teacher affiliation. Unexpectedly, teacher and parent affiliation were relatively weakly associated with each other. The nature and strength of the correlations were similar in both waves.

Table 23.
Factor Correlations of Affiliation and Maths Attainment Time 1 and Time 2

	Parent-1	Teach-1	Peer-1	Math-1	Parents-2	Teach-2	Peer-2
Parent-1	-						
Teach-1	.12	-					
Peer-1	.43	.28	-				
Math-1	.16	.48	.25	-			
Parent-2	.68	.09	.27	.15	-		
Teach-2	.13	.34	.21	.32	.16	-	
Peer-2	.34	.09	.63	.17	.36	.28	
Math-2	.14	.33	.18	.76	.23	.49	.24

Note. Parent-1 = Parent Affiliation Time 1; Teach-1 = Teacher Affiliation Time 1; Peer-1 = Peer Affiliation Time 1; Math = Math Attainment Time 1; Parent- 2 = Parent Affiliation Time 2; Teach-2 = Teacher Affiliation Time 2; Peer-2 = Peer Affiliation Time 2; Math-2 = Math Attainment Time 2.

8.3 Path Analyses of Affiliation and Maths Motivation

To explore the role of significant others in maths motivation, path analyses were performed with the factors scores of affiliation, maths attainment and maths motivation from both time-points. These were included in a model to test how affiliation predicts motivation cross-sectionally and across time while accounting for the influence of maths attainment. To explore the cross-sectional predictive value of affiliation, it was expected that Time 1 affiliation would predict Time 1 motivation. However, it was uncertain which source of affiliation would show the strongest relationship with each motivational facet. Longitudinally, it was expected that motivation, affiliation and maths attainment would predict their Time 2 counterparts (see Figure 9). However, it was uncertain if the affiliation, motivation and attainment variables would relate to each other longitudinally. For simplicity Figure 9 presents only the structural model and omits the measurement structure (which has can be seen in Figures 2, 3, 10 and 11). For ease, it also presents the motivation constructs within the same rectangle. However these represent 10 unique constructs, with shared covariance between each latent factor within each time point.

The full model was very large and consisted of 28 latent factors (including the 20 motivation, 6 affiliation and 2 maths attainment constructs) with approximately 4 indicators each and at least 116 paths. Although it would have been desirable to have a full model, the need for clarity suggested that the model be broken down to manageable sections. Importantly, the relationships amongst all 10 motivational constructs have already been thoroughly examined in Study 1. As Study 2 aims to understand how each facet of motivation is influenced by affiliation, the level of analysis chosen was to perform the path analyses separately for each facet of motivation. This still allowed a detailed analysis of the relationship between each motivation construct with maths attainment and three different types of affiliation but allowed a clear presentation and discussion of the findings of this thesis.

8.3a Single Group Path Analyses

Ten single group path analyses were performed for each facet of motivation to identify the best fitting model for the overall sample. The initial models were a simplified version of Figure 9, with only one construct of motivation included in each analysis. Maths attainment and each source of affiliation at Time 1 predicting maths motivation and stability paths were the only a priori paths included. However, additional paths were added if suggested by the modification indices. The post-hoc additions were considered cautiously to avoid over-fitting based on sampling variability (Goffin, 2007; MacCallum et al., 1992) and all adjustments made were theoretically guided. Furthermore, non-significant paths in each model were removed if they did not significantly change other estimates until only significant paths remained.

As shown in Table 24, the final models for each facet of motivation showed acceptable model fit. Although the chi-squares are significant, the chi-square to degree of freedom ratios are within the recommended range of less than 4 (Ntoumanis, 2001; Tabachnick & Fidel, 2001). Acceptability of model fit was also judged using the GOF indices CFI, TLI and RMSEA and their recommended values as detailed in Chapter 4.

Table 24.
Model Fit for Final Path Models

Model	χ^2	*df*	CFI	TLI	RMSEA
Self-Efficacy	62.45	18	.98	.96	.069
Value	67.67	18	.98	.96	.073
Mastery	60.25	18	.98	.96	.067
Planning	57.73	19	.98	.97	.063
Persistence	51.72	17	.99	97	.063
Anxiety	63.07	21	.98	.97	.062
F-Avoidance	69.34	21	.98	.96	.067
U-Control	61.03	20	.98	.96	.063
S-Sabotage	58.20	19	.98	.97	.063
Disengagement	62.83	17	.98	.96	.072

The coefficients for these models are presented in Figures 12a to 12j. Each figure shows how affiliation and maths attainment influence motivation at Time 1. They also show the stability paths for each construct across the one-year interval. At Time 2 the associations amongst maths motivation, affiliation and attainment are represented through the covariance paths. Finally, the figures include any longitudinal paths added to the model. The results for each model will now be presented in more detail. However, because of the similarity of the findings, the descriptions are grouped according to the quadrants of the Wheel, with the adaptive cognitions presented first, then adaptive behaviours, then maladaptive cognitions and finally the maladaptive behaviours.

As shown in Figures 12a-c, the adaptive cognitions were each positively predicted by affiliation. In these, teachers appear to be a relatively strong source of support for adaptive cognitions. However, the paths for parent, peer and teacher affiliation did not significantly differ from each other, indicating that each source of affiliation shared a similar degree of influence. Maths attainment was the strongest predictor of the Time 1 adaptive cognitions. Longitudinally, each construct significantly predicted its Time 2 counterpart showing strong stability across the one-year interval. Maths attainment showed the greatest stability, while affiliation with parents and peers were relatively more stable than teacher affiliation. Additional paths were added with Time 1 maths attainment positively predicting Time 2 self-efficacy, valuing and teacher affiliation. Furthermore, Time 1 mastery orientation also predicted Time 2 teacher affiliation.

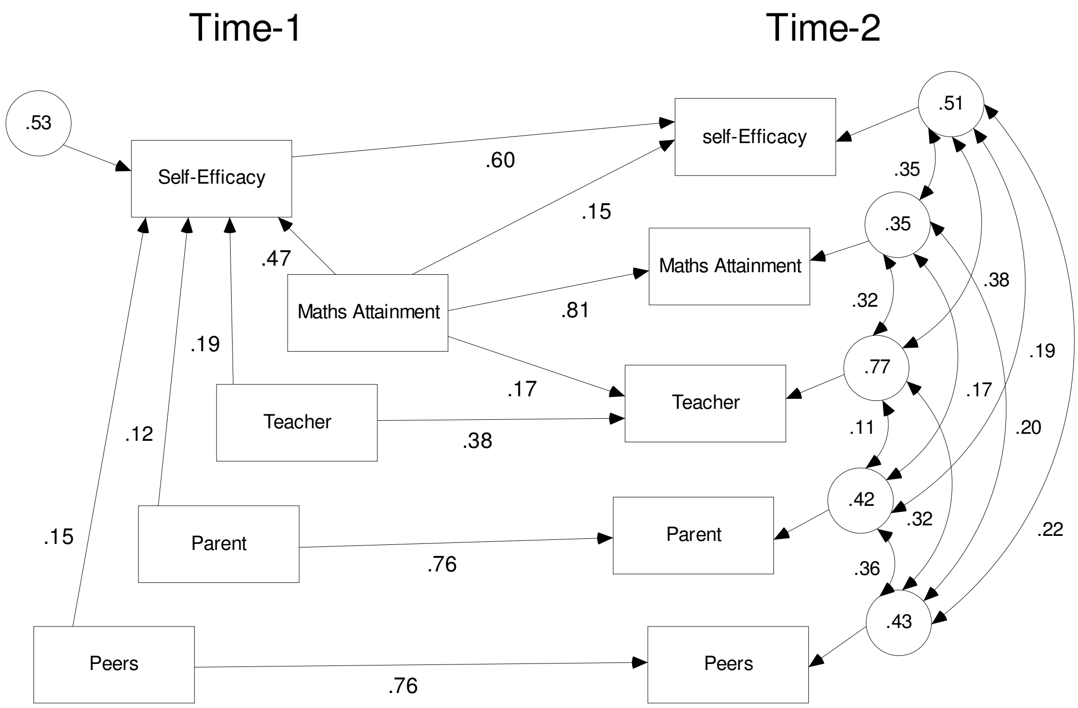


Figure 12a. Final structural equation model for self-efficacy

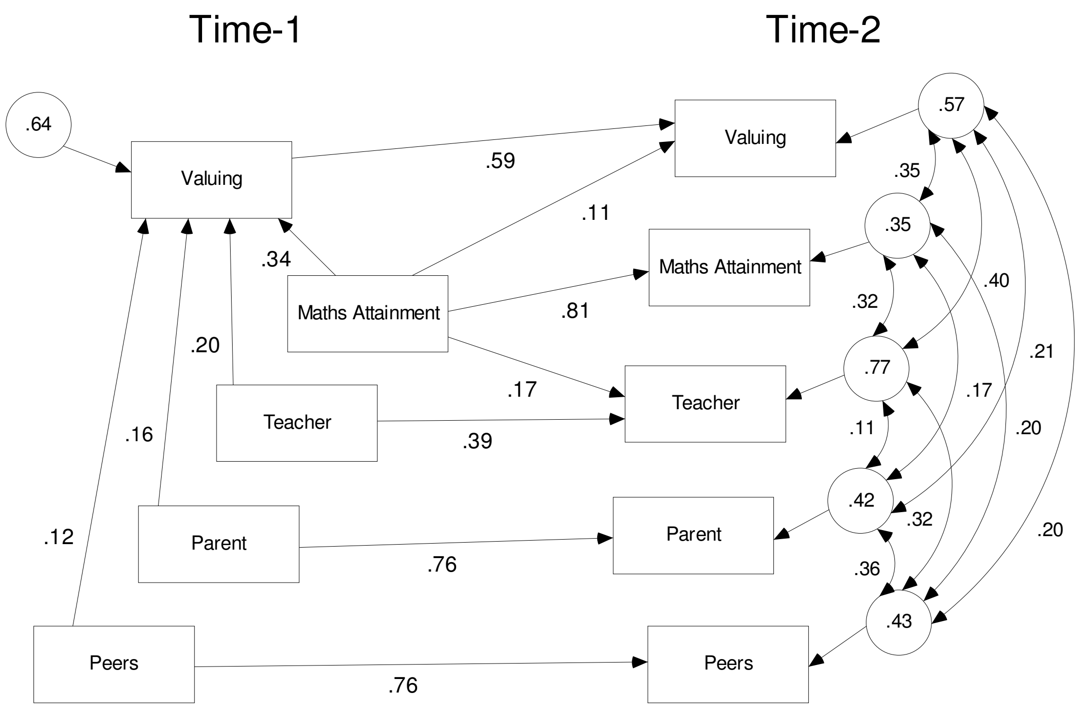


Figure 12b. Final structural equation model for valuing

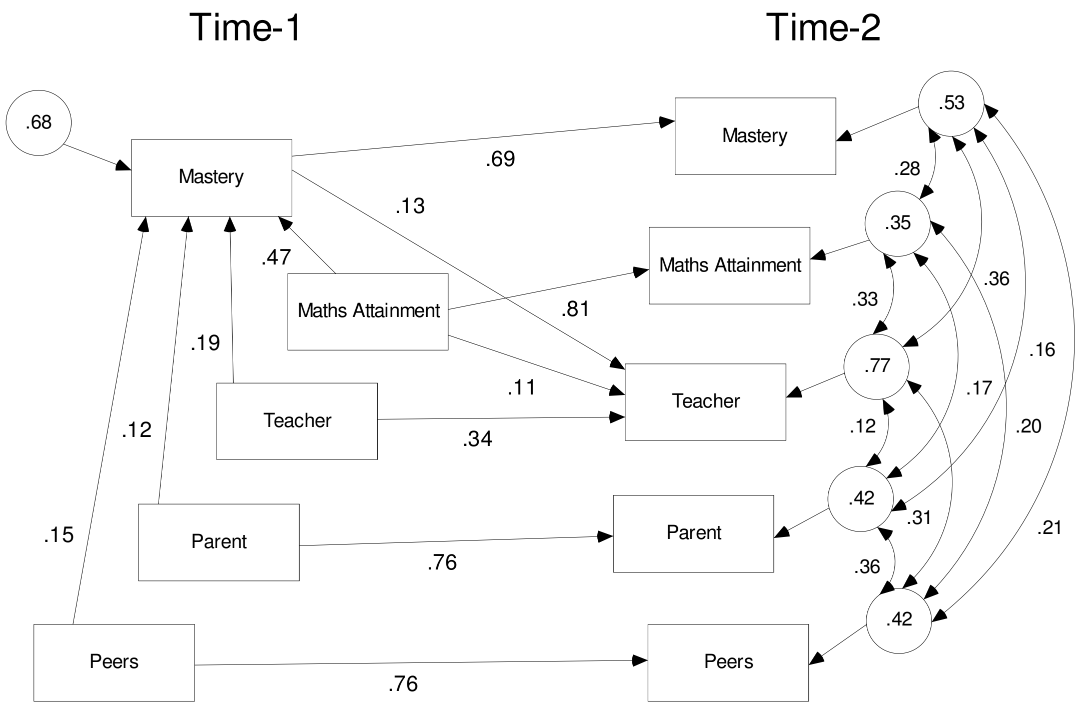


Figure 12c. Final structural equation model for mastery orientation

As shown in Figures 12d and 12e, both of the Time 1 adaptive behaviours also showed significant positive relationships with Time 1 social influence. Although peer affiliation appears to have the strongest influence, again the paths from the different social partners paths did not significantly differ in strength. Furthermore, maths attainment positively predicted planning to the same degree as affiliation did. Maths attainment was a significantly stronger predictor of persistence than parent and teacher affiliation but not friend affiliation. Furthermore, Time 1 maths attainment positively predicted Time 2 persistence, while persistence at Time 1 positively predicting future teacher affiliation.

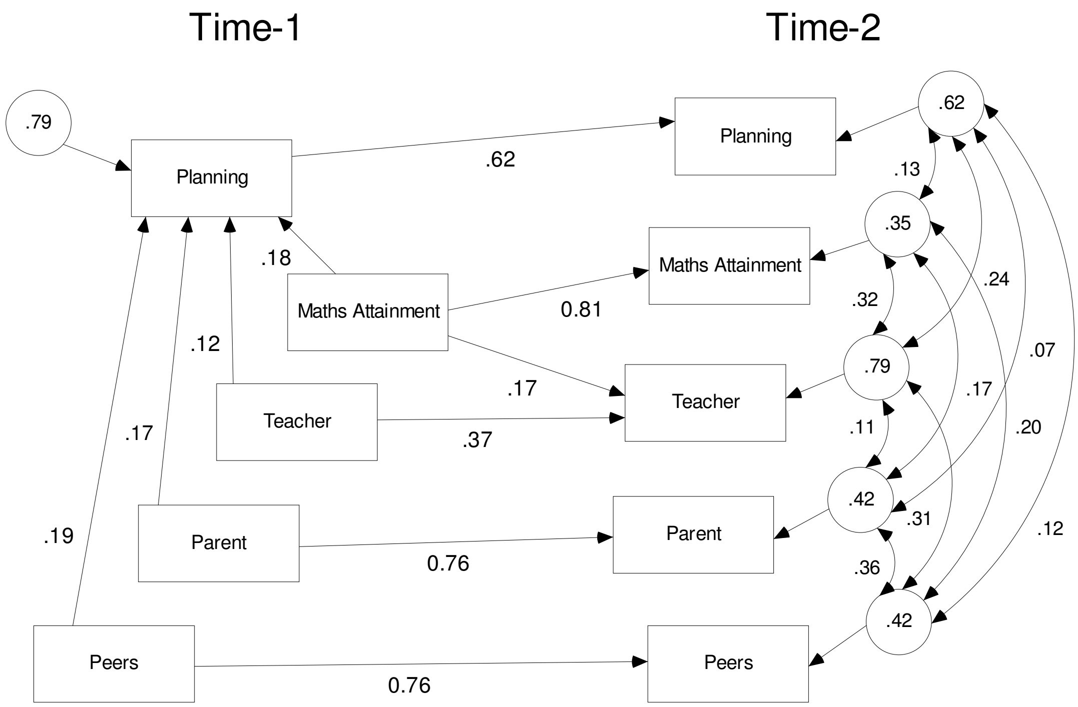


Figure 12d. Final structural equation model for planning

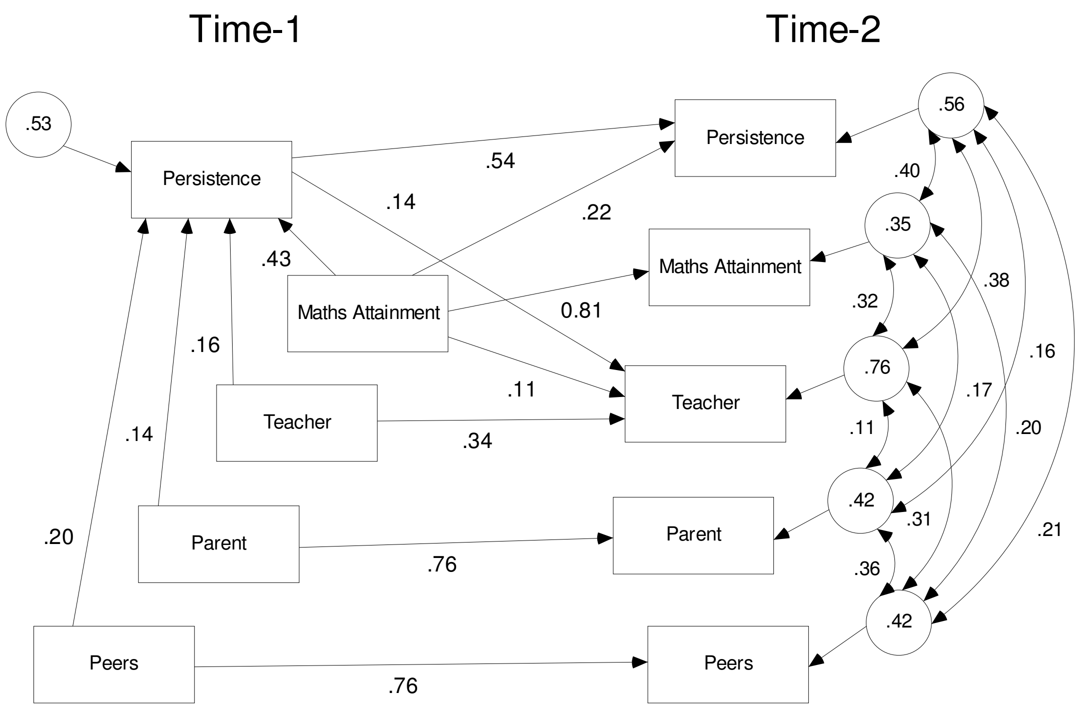


Figure 12e. Final structural equation model for Persistence

The maladaptive cognitions showed few significant paths with relatedness compared to the other motivation constructs (see Figures 12f to12h). Anxiety was positively predicted by teacher affiliation, while peer affiliation negatively predicted failure avoidance and uncertain control. Maths attainment was the strongest predictor of anxiety and uncertain control, showing a negative relationship. Maths attainment also predicted failure-avoidance but to a lesser extent and it was comparable to the effect of peer affiliation on failure-avoidance. Longitudinally the maladaptive cognitions each showed moderate to strong stability, with anxiety appearing the most consistent. Time 1 maths attainment negatively predicted Time 2 uncertain control. No other paths needed to be added to the models after examining MIs.

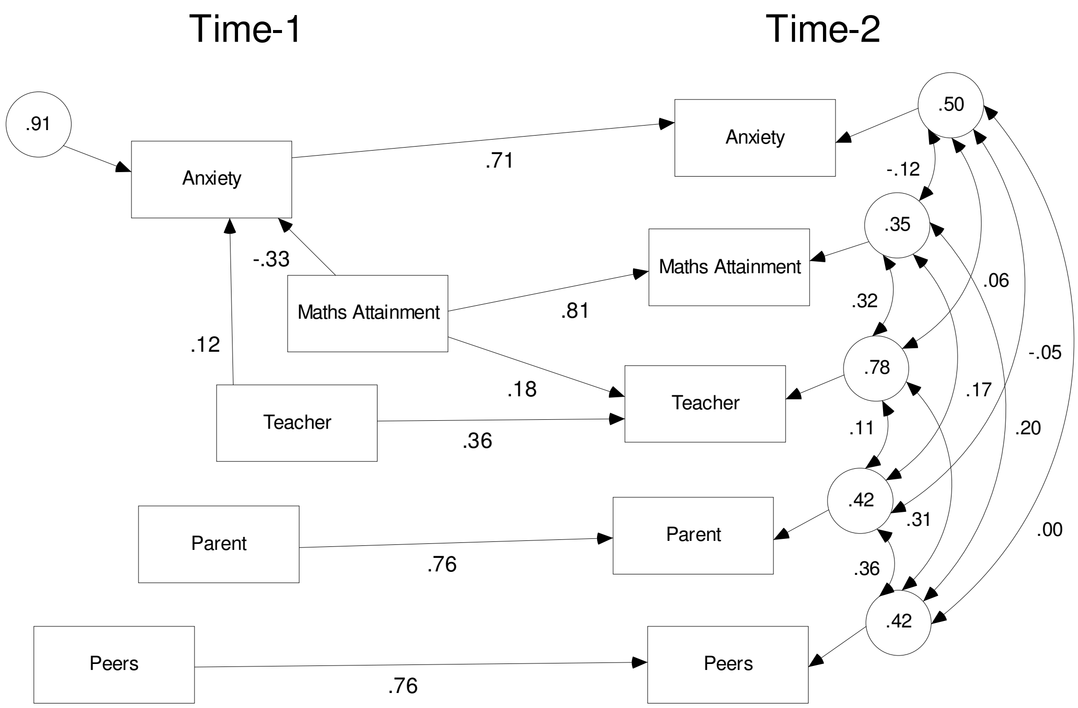


Figure 12f. Final structural equation model for anxiety

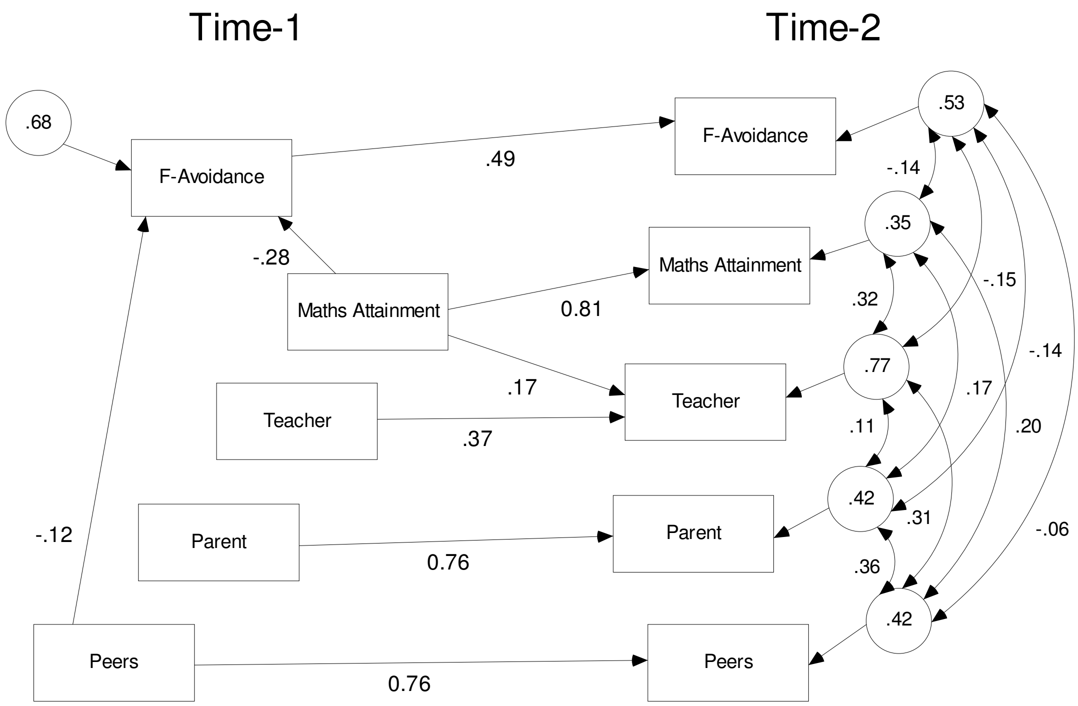


Figure 12g. Final structural equation model for failure avoidance

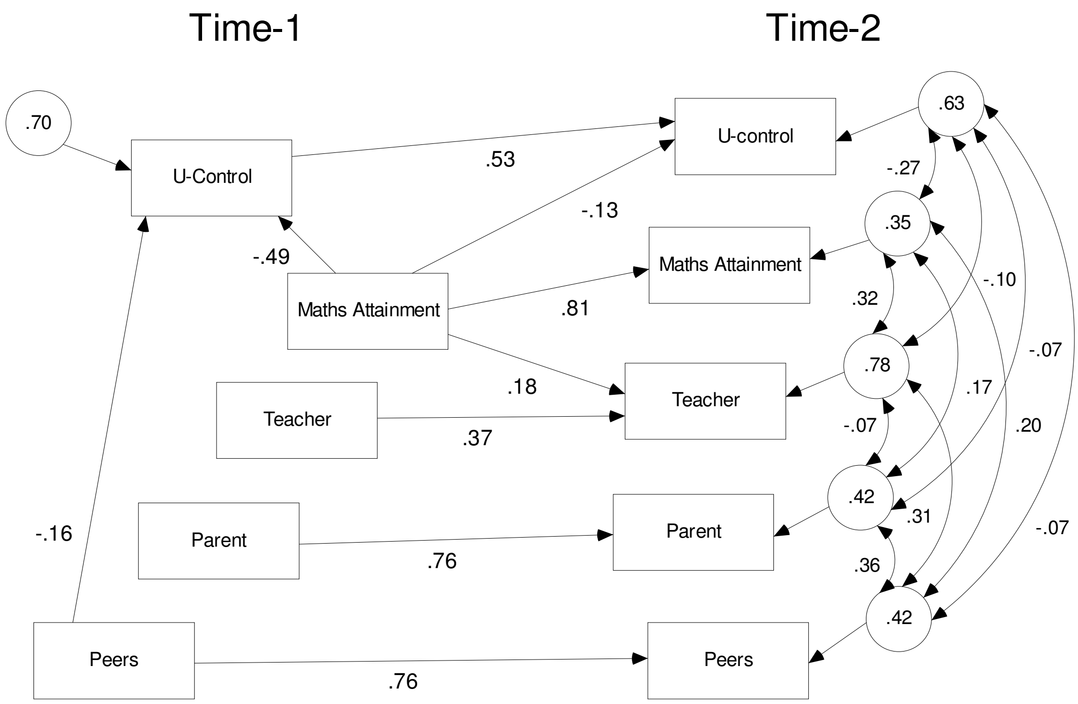


Figure 12h. Final structural equation model for uncertain control

The maladaptive behaviours were both negatively predicted by affiliation with parents, teachers and peers, whose path coefficients did not significantly differ from each other in strength. Maths attainment negatively predicted both behaviours. However maths attainment was a stronger predictor of self-handicapping than teacher and parent affiliation, and was the strongest predictor of disengagement. Self-handicapping did not show any longitudinal paths with other constructs. Disengagement at Time 2 however, was negatively predicted by previous maths attainment and parent relatedness, while Time 1 disengagement negatively predicted Time 2 teacher affiliation.

Overall, affiliation with significant others predicted many facets of maths motivation at Time 1. However, the strength of these relationships differed between each model. Although there were a few longitudinal paths between different constructs, the nature of these relationships also differed according to the facet of motivation. However, maths attainment at Time 1 was consistently related to Time 2 teacher affiliation. Maths attainment was also generally the strongest predictor of each motivational construct.

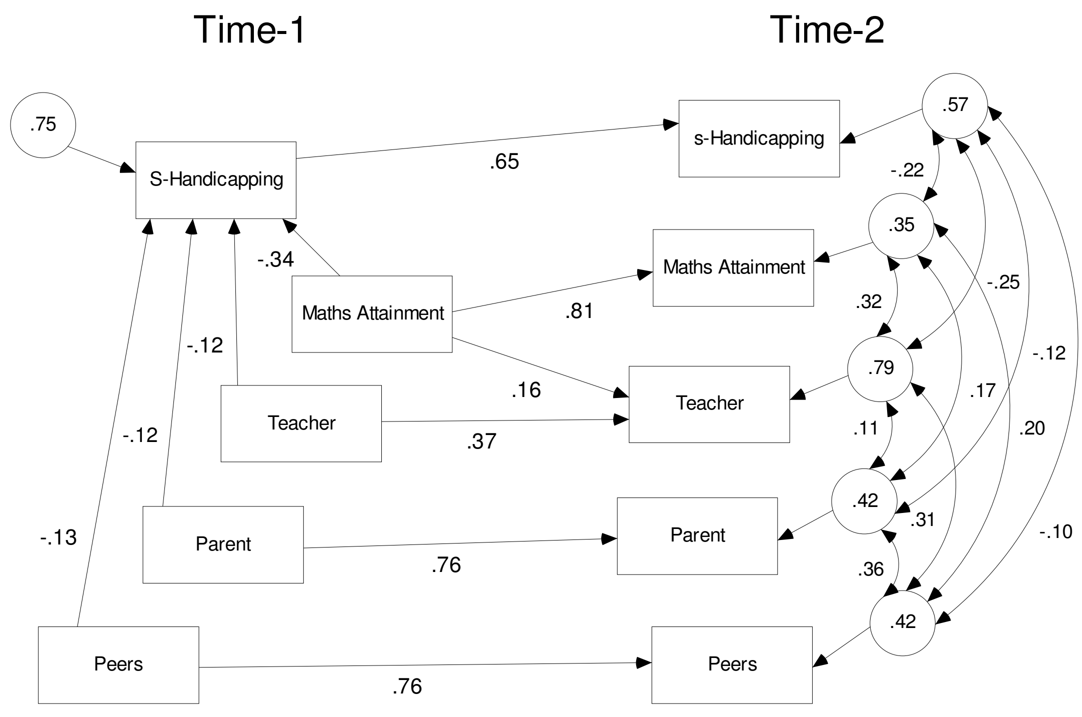


Figure 12i. Final structural equation model for self-handicapping

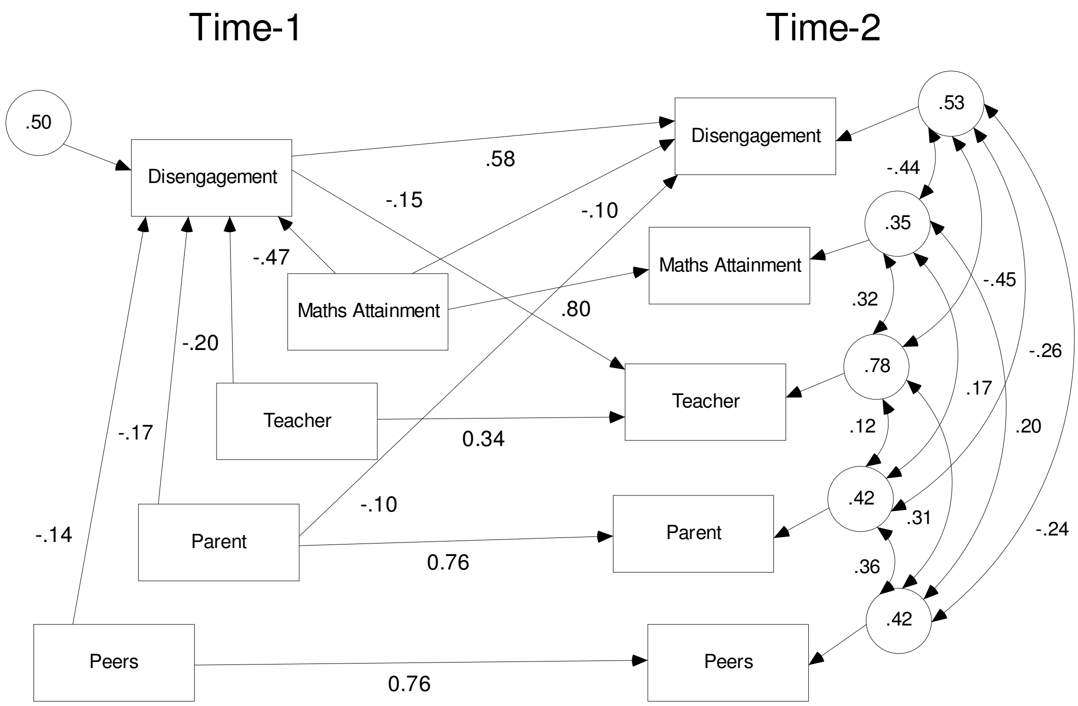


Figure 12j. Final structural equation model for disengagement

8.3b Multiple Group Analyses

After the best fitting models were obtained for each facet of maths motivation, the next task was to address the moderating role of gender in the relationship between motivation and affiliation and their development over time. Multiple group analysis tests if group membership moderates parameters within a model (Kline, 1998). Consequently, the model for each facet of motivation was then put through a group analysis to test if the pattern of structural relationships was the same for males and females. Multigroup path analyses are similar to multigroup tests of measurement invariance where an unconstrained model is compared to a model with equalities held across groups. In this case, the constrained model holds the path coefficients equal across gender. If the fit of the constrained model is significantly worse than the unconstrained model, as indicated by a chi-square difference test, then there is a significant difference between boys and girls in the structural paths (Kline, 1998).

An unconstrained and a constrained model for each facet was formed and the results for the model fit and chi-square difference tests are shown in Table 25. Apart from disengagement, the chi-square difference tests were non-significant for all models, indicating no significant difference in the path coefficients between boys and girls. Details of the constrained gender multigroup models are presented in Appendix N.

Table 25.
Model Fit for Gender Multigroup Models

Model	χ^2	*df*	CFI	TLI	RMSEA	χ^2 diff.
Belief	71.90	36	.99	.97	.062	
Belief Invariance	81.89	47	.99	.98	.053	p > .52
Valuing	80.15	36	.98	.96	.069	
Valuing Invariance	97.92	47	.98	.97	.065	p > .08
Mastery	72.28	36	.99	.97	.062	
Mastery Invariance	84.39	47	.98	.97	.055	p > .35
Plan	57.73	19	.98	.96	.063	
Plan Invariance	96.18	48	.98	.96	.062	p > .10
Persist	62.88	34	.99	.97	.057	
Persist Invariance	77.63	46	.99	.98	.051	p > .25
Anxiety	76.95	42	.98	.97	.057	
Anxiety Invariance	86.63	50	.98	.97	.053	p > .28
U-Control	73.35	40	.99	.97	.057	
U-Control Invariance	84.24	49	.98	.98	.053	p > .27
F-Avoid	80.22	42	.98	.97	.059	
F-Avoid Invariance	91.52	50	.98	.97	.057	p > .18
S-Handicap	76.92	38	.98	.97	.063	
S-Handicap Invariance.	92.78	48	.98	.97	.060	p > .09
Disengage	76.33	34	.98	.96	.069	
A - Disengage Inv.	101.04	46	.98	.97	.068	p < .04
B - Disengage Inv.	84.90	43	.98	.97	.061	p > .47

Note. A – Disengage Inv. = Initial invariance test for disengagement with all paths held equal. B – Disengage Inv. = Final invariance test for disengagement with 3 paths freed across gender.

To identify the source of non-invariance in the disengagement model, post-hoc analyses were performed by relaxing the equality parameters one at time until a non-significant chi-square difference was found. This process identified three paths within the model as significantly differing between boys and girls. As shown in Figure 13, girls' Time 1 disengagement was negatively predicted by peer affiliation, whereas boys' was not. Girls' Time 1 disengagement was also more strongly predicted by teacher affiliation than boys'. Thirdly, girls' Time 2 disengagement was negatively predicted by Time 1 parent affiliation, while this path was non-significant for boys. All other paths in the model were invariant across gender.

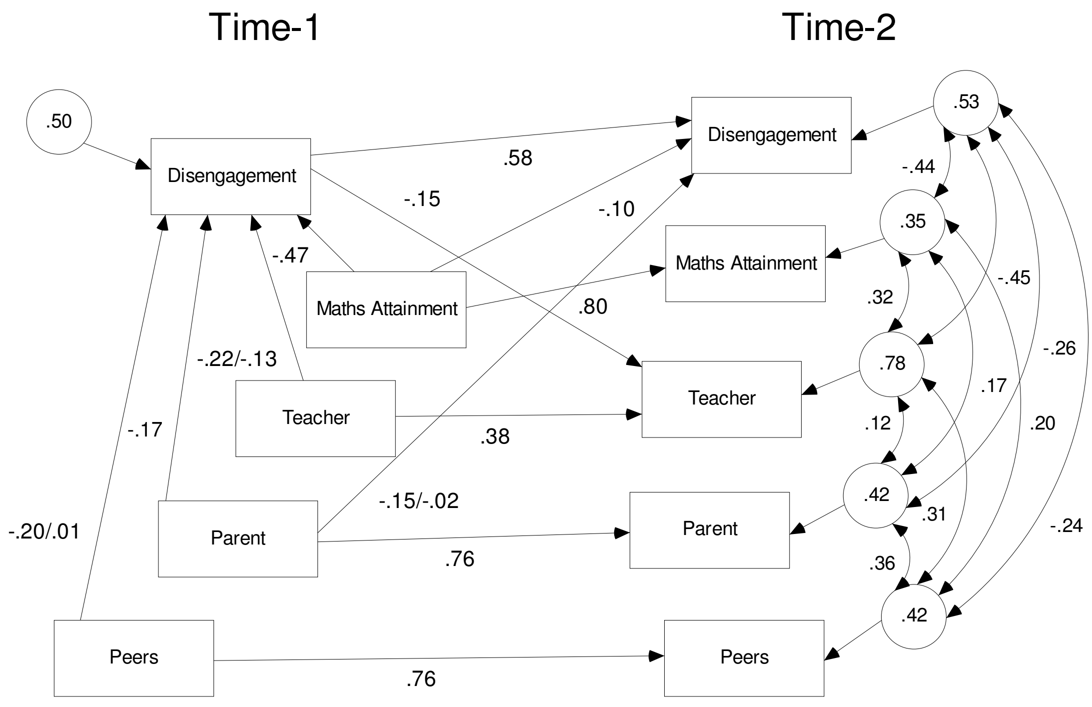


Figure 13. Gender multigroup path analysis for disengagement

Note. girls/boys. Only non-invariant paths have separate coefficients presented for gender.

Chapter 9
Study 2 Discussion

9.1 Outline of Chapter 9

In this chapter the main research questions of Study 2 and the methods used to investigate them are firstly reviewed. The main findings are then summarised and discussed in relation to the literature reviewed in Chapter 5. This includes a discussion of the nature of students' relationships, as well as the development of teacher affiliation. It then evaluates how affiliation and maths attainment relate to adaptive cognitions and behaviours, as well as maladaptive cognitions and behaviours. This is followed by a discussion of how affiliation is relevant to the core theories of academic motivation. The relative influence of different social partners is then addressed, as well as the nature of peer influence and the moderating role of gender. Lastly, the limitations and conclusions of Study 2 are presented.

9.2 The Research Questions and Methods Used

The major of focus of Study 2 was the role of relationship quality in maths motivation during high school. The predictive value of relatedness with parents, peers and friends was investigated in relation to a comprehensive range of adaptive and maladaptive facets of maths motivation. The nature of influence was examined in terms of concurrent and longitudinal associations across a one-year interval. The context of gender was also considered as a potential moderator of the relationship between affiliation and motivation.

Firstly, the model fit and factor structure of affiliation and maths attainment were examined and then measurement invariance was established for boys and girls cross-sectionally and across time. Path analyses were then performed to test a hypothesised model of the effects of relatedness on each motivation construct while controlling for previous maths attainment. Finally, the moderating role of gender in the relationship between affiliation and motivation was tested by performing multiple group path analyses.

9.3 Summary of Findings

The current study found that relatedness with teachers, peers and parents were experienced as distinct relationships, despite being positively correlated with each other. Interestingly, teacher and parent affiliation were only weakly correlated, with peer affiliation showing strong relationships with these two sources of influence. Maths attainment positively correlated with all three sources of affiliation, indicating that students perceiving stronger relationships tend to have greater maths achievement than those with less positive relationships. Nevertheless, maths success was most strongly linked to students' rapport with their teacher.

The measurement structure of the affiliation and maths attainment constructs were equivalent between boys and girls and across time. Much research addressing mean gender differences in experiences of affiliation has failed to test for measurement invariance. This is concerning because it is possible that observed gender differences in affiliation may actually be based on differences in how boys and girls interpret measures of affiliation. However, Study 2 found that girls and boys construed the affiliation and attainment items as intended and that the factor structure was equivalent across gender and time.

Generally, the hypothesised structural model was supported. Time 1 affiliation tended to significantly predict Time 1 maths motivation and strong stability was found for all constructs, with few longitudinal relationships between affiliation and motivation. In fact, disengagement was the only Time 2 construct of motivation to show a path with previous affiliation. In terms of stability, failure avoidance showed the relatively lowest and anxiety the strongest. However, overall the stability of all the motivation constructs was fairly similar. The stability for maths teacher affiliation was lower than for parents and peers, which is consistent with the rotation of teachers between academic years. Although the path coefficients suggested specialised roles for parents, teachers and peers in shaping different facets of motivation, their influence on adaptive cognitions and both types of behaviour did not significantly differ. The finding that peers were the only source of affiliation associated with failure avoidance and uncertain control highlights their potential function in regulating students' fear of failure. However in contrast to expectations, they were not associated with anxiety. Instead, teacher affiliation positively predicted anxiety. Overall, maths attainment was the strongest and most consistent predictor of motivation concurrently and longitudinally.

Some unexpected and interesting findings were the additional paths found between Time 2 teacher affiliation and some Time 1 constructs. The more students were interested in maths and persisted, the more likely they were one-year later to have perceptions of their maths teacher as being friendly and likeable than students who were previously disengaged. Furthermore, the higher students' maths attainment, the more likely they were to have a positive relationship with their maths teacher one-year later. In relation to longitudinal associations with motivation, students with higher attainment had an increased likelihood of developing an adaptive orientation towards maths characterised by self-efficacy, valuing and persistence. They were also less likely to report low perceptions of control and to feel amotivated one-year later.

Unexpectedly, gender was largely unrelated to the relationship between affiliation and maths motivation. Except for disengagement, the impact of having trusting relationships was associated with each facet of motivation in a similar way for boys and girls. The stability of motivation was also equivalent across gender indicating that individuals' ratings of maths attitudes and behaviours tended to be fairly consistent relative to other students across time regardless of their gender.

9.4 Associations amongst Affiliation Factors

The correlational findings demonstrate that students have some degree of consistency in how they perceive their relationships with different social partners, although relationship quality may be more similar between certain relationships than others. The finding that affiliation with each source of influence was positively correlated may reflect an additive role in building students' resilience. Students who reported stronger rapport with one group were more likely to have other relationships characterised by trust, fairness and liking. This tendency to have positive relationships is likely to have a cumulative effect that benefits students' sense of security, self-confidence and identity (Ryan & Powelson, 1991) with positive implications for their exploratory behaviour and responses to challenges (Bowlby, 1979). However, students with lower affiliation were also more likely to experience a degree of consistency amongst their relationships, as a student with a poor relationship with one source of affiliation was more likely to have weaker relationships with others. As a result, a sense of detachment with either peers, parents or a teacher may be a risk indicator for the quality of students' other interpersonal relationships. To some extent this supports the suggestions of attachment theory that individuals tend to develop a consistent style in the way they approach and exist within different interpersonal relationships (Bowlby, 1979).

However despite the positive associations, the strength of correlations were not so strong as to indicate that the quality of relationships with others would always be alike. The strength of these associations suggested that there was room for differences in the degree of affiliation students perceived with each social partner. Although the nature of relationships tended to be similar, if a student's relationship with one source was poor there was still the potential to experience more supportive relationships with others. Furthermore, there was a particularly weak association between maths teacher and parents. This indicates a level of independence between these relationships that may allow for a compensatory function in protecting students' wellbeing (Benner & Minstry, 2007; Furrer & Skinner, 2003; Wentzel, 1998). In this way, negative consequences of low parent affiliation may be counterbalanced by having relationships with teachers that are characterised by more warmth and trust. This might be especially adaptive during adolescence when students branch out from the family unit but are still in need of adult guidance.

9.5 The Development of Teacher Affiliation

A unique feature of the current study was to consider the relationship between affiliation, achievement and maths motivation across time. A positive relationship between maths attainment and teacher affiliation was identified both cross-sectionally and longitudinally. The greater success students experienced in maths, the more likely they were to perceive the relationship with their teacher in a positive light. However, the lower attainment students experienced, the more likely they were to perceive this relationship negatively. This is interesting because students' teachers often change year-to-year, however despite this rotation it appears that the implications of previous competency evaluations continue to influence the student-teacher relationship.

One explanation may be that past experiences shape students' conceptualisation of a 'maths teacher' and their relationship with those in that role. This may represent a self-worth enhancing process for those with high attainment and a self-worth protective process for those with low achievement. For example, students who are disappointed with their achievement may psychologically disassociate themselves from those who judge their competency negatively. This may be because the judgments from those we are detached to are less important than judgments from those with whom we share meaningful relationships. However, students with high attainment have had their worth gratified, rather than challenged. These students may perceive the teacher more positively because their self-worth benefits by valuing the evaluator and thus recognising and accepting their positive feedback.

This trend could also be explained by the social-cognitive model of personality development, which argues that environmental, behavioural and personality factors interact within a system of 'reciprocal determinism' (Bandura, 1997). When adapted to the current context, perceptions of the teacher are an environmental influence, maths attainment is the behavioural outcome and attitudes towards learning are held within personality. Students with greater achievement in maths may tend to be more enthusiastic and engaged than those with lower achievement. As a result, teachers may be perceived as behaving in a warmer and friendlier manner towards 'achieving' and cooperative students. On the other hand, students with lower attainment may tend to be more frustrated or bored in class and so teachers may appear as less positive towards these students. Both the perceptions of the teacher's behaviour and the experience of negative affect may lead the student-teacher relationship to be perceived less positively. The current results show a clear association between greater maths achievement and more positive relationships with teachers, concurrently and in the future. It is likely that the process through which attainment relates to teacher affiliation is a combination of self-worth maintenance and reciprocal determinism.

Another unexpected finding was that teacher affiliation at Time 2 was also predicted by prior ratings of persistence, mastery orientation and disengagement. Students who liked maths and exerted more effort tended to perceive their teacher more positively the following year, whereas students who tended to feel detached from learning were more likely to feel disconnected to their teacher in the future. As with the relationship between attainment and teacher affiliation, this could reflect the long-term implications of reciprocal determinism (Bandura, 1997). This process explains how differences in the nature of student-teacher interactions between an enthusiastic versus a disengaged student may influence the development of teacher affiliation. As a result, although affiliation is hypothesised to facilitate intrinsic motivation (Ryan & Deci, 2000a, 2000b), it appears that this motivational orientation may also be conducive to maintaining positive student-teacher relationships.

The reason why mastery interest, persistence and disengagement were the only motivation constructs directly associated with future teacher affiliation may be the extent to which their operationalisation is observable by others compared to other facets of motivation. Although a student may believe in their ability and consider maths as useful, this may not translate to recognisable enthusiasm and participation like enjoying learning maths would. Similarly, study planning and self-handicapping are more private behaviours that a teacher can not readily observe, whereas a student who is disengaged may be more obvious in their apathetic approach towards learning tasks during class. As a result, the degree of mastery, persistence and disengagement a student displays may influence interactions with their teacher, and thus shape the student's perception of the quality of this relationship. This reciprocal relationship then sets a trend for the nature of student-teacher relationships across time as both parties develop and maintain expectations about each other.

The long term associations interest, persistence, disengagement and attainment shared with teacher affiliation are particularly interesting because it is students with problematic ratings of these factors that need extra support. It is usually the teacher who is given responsibility to address such needs. However, the current results demonstrate that a students' past motivation and performance outcomes may, to some extent impede the likelihood of having positive perceptions of their teacher. Furthermore, the processes linking these factors with Time 2 teacher affiliation reveal how students can develop an orientation towards learning that is fairly consistent across time, whether it is positive or maladaptive.

9.6 The Influence of Affiliation and Attainment on Adaptive Constructs

In relation to the predictive value of affiliation, the results partly supported expectations and previous research. Affiliation was positively associated with adaptive cognitions and behaviours within the same wave of data collection. This supports SDT that a sense of relatedness is conducive to self-determined behaviour characterised by intrinsic interest (Connell & Wellborn, 1991; Ryan & Deci, 2000a), the transmission of learning values (Catalano et al., 2004; Ryan & Deci, 2000b; Ryan & Powelson, 1991) and greater self-regulation (Ryan & Deci, 2000b). As each source of affiliation was influential, the results also lend support to the school belonging framework suggesting that perceiving a general social environment characterised by support is beneficial for learning (Baumeister & Leary, 1995; Goodenow & Grady, 1993). Furthermore, as all the adaptive constructs were uniquely predicted by relatedness with each social group, these relationships appeared to play cumulative, rather than supplementary roles in the development of a positive orientation towards learning maths.

While the current results are consistent with previous research finding that relatedness is relevant to self-regulation, competency and value beliefs, they are in contrast to those reporting a difference in the strength of parent, teacher and peer influence (Chouinard et al., 2007; Furrer & Skinner, 2003; Hardre et al., 2006; Legault et al., 2006; Martin et al., 2007; Martin et al., 2009) or that friends are irrelevant in predicting these constructs (Ryan et al., 1994). The current results support those arguing that security within the peer context is beneficial for students' self-efficacy, values and effortful learning behaviour (Cocks & Watt, 2004; Levy-Tossman et al., 2006; Martin et al., 2007; Nelson & DeBacker, 2008). Importantly, the current study was the first to observe an equivalent degree of influence from these social partners on a range of adaptive facets of maths motivation.

Although adaptive motivation was not longitudinally associated with affiliation, self-efficacy, valuing and persistence at Time 2 were predicted by previous maths attainment. This finding that students with greater prior achievement were more likely to believe in their capabilities, perceive a task as personally relevant and exert effort may be consistent with self-worth theory. This is because past experience tells such students they are likely to achieve and so considering maths as useful and exerting effort poses no threat to their self-worth and may actually contribute to their sense of self. However, it is less clear why prior maths attainment was not longitudinally predictive of mastery orientation or planning. An achievement goal perspective presents mastery orientation as reflecting an intrinsic interest in learning, largely unconcerned with competition (Ames, 1992) and in this sense, evaluative measures of achievement may not have long term implications for students' internally driven mastery goals. Perhaps Time 1 attainment was unrelated to Time 2 planning because previous achievement inconsistently influenced the way different students actively organise their study. Lower achievement may inspire some students to engage in greater organising and planning, whereas success may lead others to believe they do not need to engage in this behaviour.

9.7 The Influence of Affiliation and Attainment on Maladaptive Cognitions

A distinctive feature of the current research was to consider the role of affiliation with a range of social partners in the darker side of motivation. The current results showed that relationships with adults were largely unrelated to building students' resilience to anxiety, perceptions of control or failure avoidance. This is in contrast to those, such as Roeser et al. (1996) who suggest that adults help regulate students' coping resources and evaluative concerns. Interestingly, the more high school students liked their teacher, the greater their tendency to worry about doing well on evaluative tasks. Rather than teacher affiliation being associated with reduced worries about success, it appeared to contribute to a greater concern about doing well. This may be because the interpersonal bond develops a greater willingness to please the teacher or internalisation of the importance of doing well.

The current results highlight friends, rather than parents or teachers as an important resource in developing a sense of control and protecting against a fear of failure. However, as friends showed no significant relationship with maths anxiety, the path analyses only partially support previous research identifying supportive peers as a psychological resource against emotional distress (Mounts et al., 2006; Wentzel, 1998). Importantly, the results are partially consistent with Martin et al.'s (2009) research with the Wheel and the relative influence of parents, teachers and same-sex peers. They found that same-sex peer relations were the strongest correlates of anxiety and failure avoidance, and were equally as influential as adults in uncertain control. The relevance of peers to maladaptive cognitions could be because during adolescence concerns with the judgments of peers rather than adults are central to students' identity and arousing their self-consciousness (Berndt, 1999; Osterman, 2000). Consequently, welcoming classmates may instill a sense of psychological safety and less pre-occupation with others' judgments. Perhaps then affiliation with adults was not so relevant to anxiety-based cognitions because students' self-consciousness is less sen sitive to the evaluative judgments of teachers or parents compared to that of peers.

In relation to anxiety, the current results showed no support for the function of adult or peer relationships as protective resources in maths motivation. This was despite suggestions that these relationships help develop students' coping resources (Osterman, 2000; Roester et al., 1996). However as discussed in Study 1, anxiety is a multifaceted construct. The current measure of anxiety was based on feelings of worry, rather than negative affect or physical symptoms of stress (Wigfield & Meece, 1988). Consequently, the implications of affiliation with adults and peers for negative affect were not addressed. It may be this aspect of anxiety for which supportive relationships play a more pivotal role in developing resilience.

The only maladaptive cognition that was influenced by previous maths attainment was uncertain control. This is consistent with theories of academic motivation as rather than worry or fearing failure, perceptions of control are based on students' beliefs about the causes of success or failure (Weiner, 1979). Perceived control was negatively associated with the feedback students received about their progress. If students receive positive responses (in the form of good grades) they may be more likely to be confident with the strategies they chose and thus confident in their ability to influence future outcomes than if their performance is judged negatively. The current results suggest that to maintain an influence across time, feedback such as grades or test scores are internalised to then contribute to students' future judgments of attribution. In contrast, anxiety develops from low perceptions of control (Bandura, 1997) and so prior achievement is not expected to have a lasting direct influence on experiences of worry. Furthermore, failure avoidance is more strongly based within self-worth and shame processes and so prior achievement may only be indirectly relevant to this concern.

9.8 The Influence of Affiliation and Attainment on Maladaptive Behaviours

Affiliation with parents, teachers and peers were each associated with self-handicapping and disengagement. Self-handicapping is a maladaptive coping strategy and it is characterised by an acceptance of failure and defining one's self-worth according to ability (Covington, 2000). Consequently, Connell and Wellborn's (1991) suggestion that affiliation plays a role in self-worth processes was supported. According to this perspective, if students feel detached from others in their learning environment, their self-esteem is likely to be impeded because they fail to perceive themselves as valuable. As a result, they tend to have poor coping resources and learning challenges are experienced as threats to self-worth. On the other hand, if students feel secure within their social environment, they are more likely to value themselves and develop a stronger sense of identity and perceive less need to use self-handicapping strategies to protect self-worth.

Although the initial analyses showed that disengagement was influenced by all three sources of affiliation, the gender multigroup tests revealed a more complicated association. These revealed that the function of affiliation differed somewhat between girls and boys. Overall, boys' disengagement was primarily influenced by their relationships with adults, whereas girls' disengagement was influenced by relationships with peers and adults. The greater role of affiliation in preventing girls' disengagement is consistent with previous research showing girls tend to have a stronger relational orientation and that it is more relevant to their school adjustment than boys (Altermatt et al., 2002). However, the findings only partially confirm Martin et al. (2007) who found teacher affiliation negatively predicted girls' maladaptive cognitions and also their maladaptive behaviours more strongly than that of boys, with no gender difference in relation to parent affiliation. The current study also extended Martin et al. (2007) by including peers as a source of influence and showing the role of significant others in specific maladaptive facets of the Wheel. However contrary to expectations, the current study only found gender effects for disengagement, rather than also for the anxiety-based cognitions. This is despite previous findings that girls may have a greater sensitivity to negative feedback (Creasey et al., 1997) and willingness to please others (Miller et al., 1996). In summary of the gender effects, the school relational context was particularly relevant in preventing girls' apathy toward learning maths, while positive relationships with adults were more salient than friends in preventing boys' disengagement.

Nevertheless, the current results for disengagement generally support previous research addressing social support and amotivation. They are consistent with suggestions that relationship quality with teachers, parents and peers have implications for students' feelings of apathy (Legault et al., 2006; Martin, et al., 2009). However, the current results also extend previous research by addressing these relationships within maths rather than general academic motivation and considering the moderating role of gender.

The negative association between affiliation and disengagement may stem from a variety of processes. Some of these may include the failure to internalise the learning values of significant others (Ryan & Deci, 2000b; Wigfield & Eccles, 2002), as a consequence of greater perceptions of self-worth threats (Elliot & Thrash, 2004) or because unsupportive relationships have left students feeling helpless in their ability to influence outcomes (Bandura, 1997; Elliot & Thrash, 2004). Nevertheless, the negative relationship between affiliation and disengagement supports suggestions of SDT that amotivation may be the expression of unmet interpersonal needs (Connell & Wellborn, 1990; Legault et al., 2006; Ryan & Deci, 2000a).

Disengagement was also significantly predicted by both prior and current maths achievement, as was uncertain control. When these relationships are considered in combination they are reminiscent of learned helplessness (Seligman, 1975). The current results then demonstrate that helplessness may develop gradually across time or conversely, that academic success has a longitudinal effect in building students' resilience to this self-defeating orientation. From an intervention perspective this is important for understanding student experiences, as perceptions of their maths performance from as long as one year ago can influence a student's current sense of control and apathy towards learning.

9.9 The Moderating Role of Gender

Despite expectations, the current study found little support for a moderating role of gender in the relationship between affiliation and maths motivation, particularly in regard to anxiety-based beliefs. Although gender differences in maths motivation arise, the current results suggest that they do not necessarily stem from differences in the way affiliation functions between boys and girls. With the exception of disengagement, affiliation with significant others influenced boys' and girls' adaptive and maladaptive facets of maths motivation in a similar way. Previous research addressing this gender effect has been somewhat inconsistent. Some have found that affiliation is more relevant for girls' academic motivation (Goodenow, 1993; Martin et al., 2007; Ntoumanis, 2001) and others that it is more relevant for boys' (Fullarton et al., 2003; Furrer & Skinner, 2003). Consequently, more research is needed to clarify the implications that relationships have on maths motivation according to gender. It is possible that the current results are unique to maths rather than general motivation, or that gender is relevant to another feature of interpersonal relationships, such as the degree of competency support or perceived expectations of others.

9.10 Affiliation and the Core Theories of Motivation

Most theories of development and motivation implicate social support as conducive to healthy psychological development. Consequently, the contextual nature of the social environment is relevant to the core theories of academic motivation. Although affiliation may not be explicitly identified within each theory, the relevance of social support to the pivotal theoretical frameworks will now briefly be discussed in relation to the current results.

Affiliation is relevant to need achievement and self-worth theory because the standards by which students define their achievements and their self-worth are partly developed through their social interactions. This theoretical link was supported by the current results, as affiliation was negatively associated with failure avoidance and self-handicapping, which are both self-worth protective strategies. This indicates that learning challenges were less likely to be perceived as self-worth threats and to activate approval and shame processes when a student felt more supported by significant others.

In relation to control, Connell and Wellborn (1991) suggest that relatedness enhances students' coping resources and resilience because experiencing supportive relationships gives students a sense that they are capable and worthy of respect. However, the current results only partially confirmed the relationship between uncertain control and affiliation, as peers were the only significant social partner. Affiliation with adults did not appear to be directly relevant to students' perceptions of control over outcomes. Perhaps other features of relationships with adults, such as helpfulness or competency support are more relevant to attribution and control theory.

According to Self-efficacy theory and EVT, competency beliefs reflect both actual abilities and messages from others that students have internalised. Research has found that students who perceive significant others as believing they are capable of success are likely to develop this belief themselves (Benner & Mistry, 2007; Howard, 2003; Israelashvili, 1997; Trouilloud, Sarrazin, Bressoux, & Bois, 2006; Wigfield &

Eccles, 2000). On the other hand, students who perceive that significant others doubt their ability tend to be less likely to experience a strong sense of self-efficacy. The current results extend the role of significant others in competency beliefs by showing that relationships characterised by warmth, trust and positive expectations can also promote the development of context specific competency beliefs.

Also within EVT, students' expectancies and values are hypothesised to stem from their perceptions of socialisers' expectancies, attitudes and behaviours (Wigfield & Eccles, 2000). The suggestion that the transmission of values is more likely within relationships characterised by affiliation is also very important to EVT. Cocks and Watt (2004) interviewed Year 6 students and found that strong peer relationships were frequently mentioned as have a positive effect on their competence beliefs and intrinsic interest in Maths and English. The current results support and extend such findings by showing that affiliation with each social partner was positively associated with self-efficacy, as well as both types of value beliefs in high school. Consequently, affiliation with significant others is relevant to EVT in the transmission of values and support of competency beliefs.

Finally, in relation to goal theory previous research has found that relationships characterised by affiliation and cooperation tend to promote mastery, rather than performance or avoidance goals (DEST, 2005; Nelson & De Backer, 2008; Patrick et al., 2007; Turner et al., 2002). Relatedness may also have a buffering effect to provide resilience when students may otherwise feel insecure and threatened. For example, Turner et al. (2002) found that although teachers emphasised either mastery or performance goals, only students whose teacher lacked affiliation adopted a negative performance orientation towards learning if their classroom was characterised by performance goals. The current study supports this link between affiliation, goal theory and adaptive behaviour because perceiving warm and caring relationships was associated with a stronger adaptive goal orientation and greater self-regulation.

9.11 The Relative Strength of Influence from Different Social Partners

A key research question the current study addressed was the relative influence of different social partners in orientations towards learning maths. The current results are in contrast to expectations that teacher affiliation would be most influential (Goodenow, 1993a ; Martin et al., 2009; Wentzel, 1994, 1997, 1998) or that the relevance of different relationships would vary between competency beliefs, values or self-regulation (Chouinard et al., 2007; Connell & Wellborn, 1991; Hardre et al., 2006; Legault et al., 2006; Steinberg et al., 1992). Instead, each source of affiliation was equally relevant in supporting adaptive engagement and preventing self-handicapping. Although parents and friends are salient to students' personal life and their sense of identity, the quality of these relationships were no more relevant to these features of maths motivation than student-teacher relationships. However, feeling a sense of belonging amongst peers was most relevant in preventing low control and a fear of failure. These results have important practical implications as they provide guidance for interventions that target students' social environment and relationships. Although students receive a variety of messages from many social partners (Bouchey & Harter, 2005), the current results indicate which particular relationships may need addressing depending on the nature of a students' motivational difficulties.

9.12 The Nature of Peer Influence

Another main concern study 2 addressed was the relevance of peers in maths motivation and the nature of this relationship. Although few studies have addressed their role through affiliation, the current results do challenge prior literature suggesting that closeness with peers is irrelevant to academic outcomes or inevitably leads to antisocial behaviour. In contrast, peer relationships appeared to be central to adolescents' approach towards learning, as those who lacked quality friendships were more likely to report negative attitudes and behaviours towards maths. Furthermore, not only were peers relevant, the current study found that they were as important as adults. As Legault et al. (2006) suggest, if friends are central to students' interpersonal life, then it follows that peer influence through relatedness would be relevant to their school functioning. If peers contribute to students' sense of self and identity, then their support should be relevant in contexts such as the learning environment, where adaptive cognitions and coping resources are needed to exert effort. The adaptive function of peer affiliation is good news because it provides students with an additional resource from which to counterbalance potential influences from negative relationships with parents or teachers (Furrer & Skinner, 2003; Mounts & Steinberg, 1995; Wentzel, 1998). It also gives educators a further indicator by which to identify students at risk of under-achieving or withdrawing from maths.

9.13 Differences between Study 2 and Previous Research

Although most predictions of the current study were confirmed, a number of others based on previous research were challenged. These mainly concern the relative influence of teachers, parents and peers in academic motivation, as some research suggests that the relevance of different social partners differs according to the facet of motivation. Consequently, a question arises as to why the current results differed.

Most previous research has assessed general academic motivation, included a subset of motivation constructs, been cross-sectional, overlooked the peer group and, or has not accounted for maths attainment. For example, of the key studies reviewed, Legault et al. (2006) and Furrer and Skinner (2003) tested general academic motivation, as did Martin and his colleagues (2007, 2009). Although Chouinard et al. (2007) addressed maths motivation specifically, only support from parents and teachers was examined. Furthermore and possibly most importantly, none of these studies accounted for maths attainment when examining the predictive value of teacher affiliation. Previous performance is strongly predictive of motivation (Klassen, 2004) and is also positively correlated with teacher-student relationships, suggesting previous attainment moderates the relationship between teacher affiliation and motivation. When a moderating variable is not included within a model, path coefficients may be over-estimated (Baron & Kenny, 1986). Consequently, research failing to account for this relationship may be reporting an inflated predictive value of teacher relatedness. In summary, differences between the current and previous results appear to stem from differences in research design and methodology.

9.14 Limitations of Study 2

Despite the strengths and valuable contributions of Study 2 there were some limitations in relation to the final sample and potentially relevant social context variables that were not included in the current model. These will now be discussed.

Similar to Study 1, the first limitation relates to the longitudinal nature of Study 2 spanning across two-academic years. The strength of this design was that it extended previous research on affiliation and motivation that tends to be cross-sectional or examine associations within the same academic year. While this allowed an assessment of how these constructs interact and develop across time, it may have inadvertently led to a biased sample. As discussed in section 5.9, the current study included only students who were present and adequately completed questionnaires at both data collection periods. This is likely to have unintentionally excluded very unmotivated students with poor attendance and, or attention spans. This may have contributed towards inconsistencies with previous research based on a single period of data collection, particularly in regard to gender effects. For example, Lopez et al. (1997) suggest that because maths is a male-stereotyped domain, social support is particularly important for girls. In this sense, perhaps gender differences in the function of affiliation are more prominent amongst highly disengaged students because girls in this group need extra encouragement to challenge societal stereotypes. This effect may have been overlooked with the current sample. Consequently, future research needs to examine the longitudinal interactions between affiliation and motivation with students from a range of levels of engagement and achievement.

Secondly, the interpersonal process of affiliation was the main focus of Study 2. However, it is acknowledged that other features of interpersonal experiences are also relevant to students' academic motivation. Within the context of the classroom, teaching quality would be an important factor also influencing students' orientation towards learning. For example, although a student may feel comfortable with and trust their teacher, the teacher's ability to communicate knowledge would also be relevant to shaping the student's motivation. Perhaps students are more likely to trust and feel secure with those who do a better 'job' at teaching. Alternatively, perhaps the degree of affiliation moderates the role of teaching quality in motivation. Nevertheless, it is likely that aspects of teaching quality interact with the relationships amongst teacher affiliation, motivation and attainment. However, teaching quality is a very broad term and there is little consensus on how it can be measured succinctly (Cochran-Smith, 2003). It can refer to a teacher's ability to design interesting lesson plans, give clear explanations, demonstrate enthusiasm or convey a deep knowledge of the subject matter (Cochran-Smith, 2003). Some have even described teaching quality as involving a caring attitude (Cochran-Smith, 2003; Berliner, 2005). Consequently, given the vague definition of teaching quality, affiliation could be considered as a component. However, the practical constraints of the current project did not permit a deeper exploration of this variable. This is an avenue of research that also needs to be explored in more detail. Different facets of teaching quality could be tested for their relative influence in shaping maths motivation and how they interact with affiliation.

A remaining question from Study 2 is the development of maladaptive cognitions. These three constructs showed little associations with affiliation, despite supportive relationships theorised as enhancing students' inner coping resources. Other relational processes that may be more relevant to anxiety-based beliefs should be explored. This leads to the third limitation of Study 2 being the range of social influence variables it addressed. Study 2 focused on the psychological need for relatedness because of its theoretical relevance to a sense of belonging and adaptive human functioning, as well as the particular salience of this need during adolescence. However, other types of influence are also relevant in the development of students' attitudes and behaviours toward learning. SDT suggests that competency and autonomy support are two important factors for adaptive engagement. EVT highlights the role of significant others' expectancies, whereas social-cognitive theory emphasises vicarious learning and direct influence as processes through which influence occurs. It is possible that that certain facets of motivation are more sensitive to different types of influence. Certain social partners may also be more relevant to motivation through different avenues of influence. For example, the current study found no significant direct path between teacher affiliation and uncertain control. However, as the main assessors of student work it seems unlikely that teachers are irrelevant to this construct. Teachers may have an indirect influence through other facets of motivation that are related to uncertain control. It is also possible that other features of relationships and social interactions are more relevant to perceptions of control than teacher affiliation. To delineate these social processes research could examine the relative role different types of influence have in maths motivation. This could also be done in relation to a variety of social partners to identify in detail the potential unique roles that parents, teacher and peers play in shaping maths motivation.

9.15 Summary of Study 2 and Conclusion

Study 2 found that maths attainment and affiliation with teachers, parents, and peers were uniquely associated with the development of specific facets of maths motivation. Overall, secure relationships with parents, teachers and peers each played a significant role in shaping adaptive constructs and maladaptive behaviours, with their relative influence being fairly equal. However, affiliation with adults was not relevant in preventing the development of maladaptive cognitions including anxiety, failure avoidance and uncertain control. Instead, quality peer relationships appeared useful in regulating some of these concerns. Furthermore, affiliation was primarily associated with concurrent motivation. Although the current study found the influence of affiliation does not reach across academic years, it did find that previous performance and motivation can have long-term associations with student-teacher relationships.

The current study is noteworthy because it was the first to examine the relationship between affiliation and a comprehensive model of maths motivation across time. Also, previous studies have only addressed affiliation cross-sectionally, with none having examined the development of affiliation within the motivational context. The current findings support suggestions that attitudes and behaviours towards learning develop within the social environment (Goodenow & Grady, 1993) and that perceiving secure interpersonal relationships is conducive to adaptive motivation (Ryan & Powelson, 1991; Ryan & Deci, 2000a). These results help clarify the function of different relationships during high school for students' orientation towards learning maths. It enhances knowledge of how students' resilience can be encouraged and in what ways poor coping strategies that lead to maths underachievement or withdrawal can be avoided. This is useful for parents, educators and researchers wanting to understand how relationships with significant others may encourage or impede the development of maths motivation at a construct specific level.

Chapter 10
Summary and Conclusions

10.1 Goals of the Thesis

The main goal of this thesis was to provide a comprehensive exploration of the maths motivation of Australian high school students, and to do so particularly within the rural context. The first study aimed to explore the nature of maths motivation and to clarify the nature and extent of developmental and gender trends. The main questions of Study 1 were 1) Can a multifaceted general model of academic motivation be applied to maths and what is its factor structure? 2) What is the nature of associations amongst a comprehensive range of motivation constructs and do the core theories of academic motivation account for these relationships? 3) Does the maths motivation of Australian students become more maladaptive during high school and where do gender differences in maths motivation lie? The second study aimed to examine the social antecedents of maths motivation by testing to what extent affiliation with parents, teachers and peers are associated with the development of maths motivation. It asked 1) What are the predictors for each facet of motivation? 2) What is the relative predictive value of relatedness with specific social partners? 3) Does the role of affiliation in maths motivation function differently for boys and girls?

10.2 The Research Process

These goals and research questions were addressed through a two-year longitudinal study where students provided a detailed picture of their maths motivation, affiliation with significant others and maths attainment in the second semester of each school year. The Student Motivation and Engagement Wheel was applied as a multifaceted model of academic motivation and the role of affiliation with multiple relevant social partners was explored. Firstly, Study 1 explored the model fit and factor structure of the MES-HS within mathematics. These analyses considered if maths motivation could be captured best by the complex model presented by Martin (2007b, 2009) or by alternative models put forward in this thesis. Then the measurement invariance of the MES-HS was tested across time and gender to ensure these groups interpreted the scale in a similar way. Next, the correlations between the motivational facets were examined to understand their complex associations with each other. The stability of each individual construct across the one-year interval was also tested. Finally Study 1 addressed changes in mean ratings of maths motivation across the two academic years, testing for gender and cohort effects.

The second study began with assessing the model fit and factor structure of the affiliation and maths attainment scales. The measurement invariance of these measures across time and gender was also examined. It then tested how affiliation and motivation develop and interact concurrently and longitudinally while taking maths attainment into account. Lastly, Study 2 assessed the moderating role of gender in the relationship between affiliation and motivation.

10.3 A Review of the Main Findings

The project achieved its aims and the research questions were answered with a number of interesting findings. Firstly, although the Student Motivation and Engagement Wheel is a general framework of academic motivation, overall it and its measure, the MES-HS were clearly shown to be applicable to maths. However, whether a 10 or 11 factor model is most suitable is open to more research. The theoretical analysis of the findings also found that none of the single theoretical approaches considered in this thesis adequately conceptualised the complex interrelations amongst all the facets of maths motivation. As there were many ways that the components of motivation related to each other, to comprehensively explain this web of associations a combination of the core theoretical frameworks was needed. This finding suggests that those who feel perplexed by a student's behaviour towards maths would benefit from an awareness of each of these frameworks and how they relate to and complement each other. This would offer a more complete understanding of why a student may or may not have a particular orientation towards learning maths.

Another main finding was that the adaptive motivation of Australian rural high school students decreased across grades 7 to 10, while disengagement increased. However, in general students did not appear to experience an increase in stress or self-worth protective concerns and behaviours. Generally, the rates of change were also similar for each cohort, indicating that no grade was particularly at risk. The results demonstrate that it is important for educators and parents to promote maths throughout high school, particularly its utility value. A primary gender difference was observed, namely that girls compared to boys reported stronger maladaptive cognitions stemming from control, fearing failure and worry concerns. Those interested in understanding boys and girls' participation in maths may benefit from addressing issues of pleasing others, shame and control. While the current study replicated some previous gender and developmental trends it should be kept in mind that most of these effect sizes were weak by Cohen's standards. This means that although mean gender and developmental differences may arise and these differences can be seen as important, dramatic conclusions about vast changes or mean differences are not warranted.

The primary outcome from Study 2 was that secure relationships with parents, teachers and peers each played a role in shaping adaptive constructs and maladaptive behaviours. Furthermore, these social partners tended to share a similar degree of influence which was weak to moderate in strength. However, affiliation with peers as opposed to adults was most relevant to regulating concerns with failure avoidance and uncertain control. This is useful for interventions as targeting different interpersonal relationships may assist in improving specific aspects of a student's maths motivation. This finding also provides teachers, counselors, parents and students with an insight into the academic risks associated with feeling disconnected from the social environment.

10.4 Limitations and Directions for Future research

The limitations of Study 1 and Study 2 have already been discussed in detail in sections 5.9 and 9.14, respectively. These primarily addressed the students possibly left out in the final sample, length of the study and the range of social context variables that were examined.

The final sample probably included a greater proportion of students with relatively better attendance, literacy and concentration rates compared to the total student population. It would be valuable for future research to follow both students who regularly attend class and complete work, as well as those who are more inconsistent in their attendance and work completion. This kind of multi-group longitudinal design would gain a more accurate picture of the nature of motivation, how it develops (particularly the maladaptive facets), gender differences, as well as the function of affiliation in these processes for all students. Therefore more research is needed to replicate the current findings in relation to gender and developmental differences in a similar population and also explore their existence in at risk populations.

Both studies were also limited in that they did not address the final two grades of high school and consisted of only two time-points. Although there was an intention to track students across Grades 10 to 11, due to the demands of the participating schools' timetables and students' workload, this was not practical. Instead the project focused on students from grades 7 to 10. The multi-cohort-multi-occasion design allowed a longitudinal study covering the junior and middle grades. However a longer study would provide a more comprehensive analysis allowing for longer trends to be examined, including nonlinear ones.

Although anxiety regulation is seen as important to successfully learning maths (Baloğlu & Koçak, 2006), the findings from both Study 1 and Study 2 suggest that the current measure of maths anxiety may need revising. Maths worry showed both positive and negative associations with adaptive facets of motivation and was largely unrelated to affiliation. As discussed in section 2.2f, Wigfield and Meece (1988) have shown maths anxiety to comprise of a worry and an affective factor. It is possible that the affective facet may show different associations compared to the cognitive component with affiliation and other motivation constructs, as well as developmental and gender trends. Consequently, future research could include a measure of affective maths anxiety as it is important that both components of maths anxiety and their implications are understood.

Finally, the current project was partly inspired by the need for maths-skilled individuals and the declining rates of participation in maths-related study and employment. However, it was first necessary to understand the nature of motivation and how it develops in high school because the foundation for long-term maths motivation is laid down during these earlier years. Now that a clearer picture of maths motivation and its associations with affiliation has been obtained, research can build on this to address the next question, namely the value of these constructs in predicting maths participation. Future research can now build on the insights gained from the current project to ascertain which of the multiple motivation and affiliation constructs are most useful in predicting students' high school maths enrolments, as well as their post-high school maths-related educational and employment decisions.

10.5 Strengths of the Research

The key strength of this thesis is that it extends research in the field of motivation and maths education by comprehensively exploring the multifaceted nature of maths motivation, its development during high school and the social antecedents relevant during adolescence. In doing so, a gap in the knowledge regarding the motivational experiences of rural Australian high school students has also been addressed. The current project differed from previous research with the Student Motivation and Engagement Wheel model by applying it specifically to mathematics and examining alternative models with a sophisticated approach to ordinal data analysis. Previous research has not tested if females and males conceptualise maths the same way or if maths motivation measurement scales are interpreted consistently across different time-points. Through Confirmatory Factor Analysis and tests of invariance the current research found measurement invariance between boys and girls and also across time. It also extended previous research on the trajectory of maths motivation by addressing a range of adaptive and maladaptive motivation constructs, as well as the relative influence of multiple relationships. A particular distinctive contribution was to include a measure of peer relationships, as well as relationships with teacher and parents. Confirmatory Factor Analysis and Repeated Measures Analyses of Variance allowed a thorough analysis of maths motivation, revealing in which facets developmental and gender differences can be observed. The path analyses provided a picture of how each construct develops across time and is associated with the quality of the relationships students share with significant others.

10.6 Final Conclusion

A main theoretical contribution of the current research is to demonstrate that a multifaceted general model of academic motivation is applicable to the mathematics context. However, it proposes a re-evaluation of the distinctiveness of planning and study management factors as measured by the MES-HS. Furthermore, the current study demonstrates that interpersonal relationships are relevant to maths motivation at the construct specific level. The results extend understanding of the relationship social support shares with both adverse and adaptive motivational tendencies. This suggests that a more comprehensive approach can be developed that incorporates a range of theories of academic motivation with theories of affiliation and belonging.

The knowledge gained from this thesis has practical implications for enhancing student wellbeing in terms of positive learning experiences, academic attainment and supportive relationships. The exploration of the complex web of associations extends knowledge of how students' academic resilience can be encouraged and in what ways poor coping strategies that lead to maths underachievement or withdrawal can be avoided. The findings can also provide educators, parents and counselors with awareness that during high school, ratings of adaptive cognitions are vulnerable to declines and that girls may experience more maladaptive cognitions than boys. This has practical implications, as all facets of the Wheel can be applied to create an individualized strategy to help a student by identifying their specific strengths and weaknesses. Having this broad perspective enables more avenues of intervention because, as Martin (2001, 2002b) describes, each facet of motivation can be targeted by specific intervention strategies. The current results also assist in developing an understanding of how the social context may promote or undermine different aspects of a student's maths motivation which opens more avenues to develop additional strategies to bolster student motivation and engagement.

This thesis was based on a belief that both motivation and interpersonal relationships are important factors for promoting maths participation. Although the results showed a steady decline in adaptive maths motivation, the extent of these changes was not dramatic and did not emphasise a particular cohort. Nevertheless, the steady downward trend suggests that high school is an appropriate period during which to focus on maths motivation. Furthermore, another key finding was that girls reported stronger maladaptive cognitions than boys throughout high school. These findings suggest that declining participation in maths may be related to declining adaptive attitudes and behaviours towards maths, and that the under-representation of girls in maths orientated fields may stem from gender differences in maladaptive anxiety-based beliefs. Applying the knowledge gained from this thesis has the potential to address national concerns regarding teacher recruitment, as well as the demand for maths-orientated education and maths specialists. While the findings have direct relevance for addressing concerns about mathematics motivation and engagement during high school, they may also have positive flow on effects that eventually support the continuing prosperity of Australia's communities, businesses and many industries that rely on maths-skilled individuals.

Reference List

Ablard, K. E., & Lipschultz, R. E. (1998). Self-regulated learning in high-achieving students: Relations to advanced reasoning, achievement goals and gender. *Journal of Educational Psychology, 90*, 94-101.

Abramson, L. Y., Seligman, M. E., & Teasdale, J. D. (1978). Learned helplessness in humans: Critique and reformulation. *Abnormal Psychology, 87*, 49-74.

Ainley, J., Kos, J., & Nicholas, M. (2008). *Participation in Science, Mathematics and Technology in Australian Education* (No. ACER Research Monograph No 63). Camberwell: The Australian Council for Educational Research.

Allen, J. P., Weissberg, R. P., & Hawkins, J. A. (1989). The relation between values and social competence in early adolescence. *Developmental Psychology, 25*, 458-464.

Altermatt, E. R., Pomerantz, E. M., Ruble, D. N., Frey, K. S., & Greulich, F. K. (2002). Predicting changes in children's self-perceptions of academic competence: A naturalistic examination of evaluative discourse among classmates. *Developmental Psychology, 38*, 903-917.

Altermatt, E. R., & Pomerantz, E. M. (2003). The development of competence-related and motivational beliefs: An investigation of similarity and influence among friends. *Journal of Educational Psychology, 95*, 111-123.

Ames, A., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*, 260-267.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*, 261-271.

Anderman, E. H. (2003). Academic and social perception as predictors of change in middle school students' sense of belonging. *The Journal of Experimental Education, 72*, 5-22.

Anderman, E. M., & Maehr, M. L. (1994). Motivation and schooling in the middle grades. *Review of Educational Research, 64*, 287-309.

Anderman, E. M., & Midgley, C. (1997). Changes in achievement goal orientations, perceived academic competence and grades across the transition to middle-level schools. *Contemporary Educational Psychology, 22*, 269-298.

Anderman, L. H. (2004). Introduction: Student motivation across subject-area domains. *The Journal of Educational Research, 97*(6), 283-285.

Anderman, L. H., & Anderman, E. M. (1999). Social predictors of changes in students' achievement goal orientations. *Contemporary Educational Psychology, 25*, 21-37.

Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the student engagement instrument. *Journal of School Psychology, 44*, 427-445.

Archambault, I., Janosz, M., Fallu, J., & Pagani, L. (2008). Student engagement and its relationship with early high school dropout. *Journal of Adolescence, In press*, 1-20.

Armsden, G. C., & Greenberg, M. T. (1987). The inventory of parent and peer attachment: Individual differences and their relationship to psychological well-being in adolescence. *Journal of Youth and Adolescence, 16*, 427-454.

Atkinson, J. W. (1957). Motivation al determinants of risk-taking behavior. *Psychological Review, 64*, 359-372.Australian Academy of Science. (2006). *Mathematics and Statistics: Critical Skills for Australia's Future, The National Strategic Review of Mathematical Sciences Research in Australia.*

Australian Bureau of Statistics. (2004). *Survey of Education and Work (No. 6227.0.* Canberra: Commonwealth of Australia.

Avery, R. R., & Ryan, R. M. (1987). Object relations and ego development: Comparison and correlates in middle childhood. *Journal of Personality 56*, 547-569.

Baloğu, M., & Koçak, R. (2006). A multivariate investigation of the differences in mathematics anxiety. *Personality and Individual Differences, 40*, 1325-1335.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bandura, A., & Schunk, D. H. (1981). Cultivating competency, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social*

Psychology, 41(3), 586-598.

Barrett, P. (2007). Structural equation modelling: Adjudging model fit. *Personality and Individual Differences, 42*, 815-824.

Barrington, F. (2006). *Participation in Year 12 mathematics across Australia 1995-2004*. Melbourne: University of Melbourne, on behalf of the International Centre of Excellence for Education in Mathematics.

Bates, S. L. (2004). Socioracial group differences in family and peer influences on adolescents' academic achievement

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*, 497-529.

Benner, A. D., & Mistry, R. S. (2007). Congruence of mother and teacher educational expectations and low-income youth's academic competence. *Journal of Educational Psychology, 99*, 140-153.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*, 238-246.

Berliner, D. C. (2005). The near impossibility of testing for teacher quality. *Journal of Teacher Education, 56(3),* 205-213.

Berndt, T. J. (1979). Developmental changes in conformity to peers and parents. *Developmental Psychology, 15*, 608-616.

Berndt, T. J. (1999). Friends' influence on students' adjustment to school. *Educational Psychologist, 34*(1), 15-28.

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology, 25*, 441-448.

Bigelow, B. J., & Zhou, R. M. (2001). Relational scaffolding of school motivation: Developmental continuities in students' and parents' ratings of the importance of school goals. *The Journal of Genetic Psychology, 162*, 75.

Bleeker, M. M., & Jacobs, J. E. (2004). Achievement in math and science: Do mothers' beliefs matter 12 years later? *Journal of Educational Psychology, 96*, 97-109.

Bleeker, M. M., & Jacobs, J. E. (2004). Achievement in math and science: Do mothers' beliefs matter 12 years later? *Journal of Educational Psychology, 96*, 97-109.

Bong, M. (1996). Problems in academic motivation research and advantages and disadvantages of their solutions. *Contemporary Educational Psychology, 21*, 149-165.

Bong, M. (2001). Between- and within-domain relations of academic motivation among middle and high school students: Self-efficacy, task-value, and achievement goals. *Journal of Educational Psychology, 93*, 23-34.

Bong, M. (2008). Effects of parent-child relationships and classroom goal structures on motivation, help-seeking avoidance and cheating. *Journal of Experimental Education, 76*, 191-217.

Bouchey, H. A., & Harter, S. (2005). Reflected appraisals, academic self-perceptions, and math/science performance during early adolescence. *Journal of Educational Psychology, 97*, 673-686.

Bowlby, J. (1979). *The making and breaking of affectionate bonds*. New York: Routledge.

Brown, B. B., Clasen, D. R., & Eicher, S. A. (1986). Perceptions of Peer Pressure, Peer Conformity Dispositions, and Self-Reported Behaviour Among Adolescents. *Developmental Psychology, 22*, 521-530.

Brown, G. (2009). Review of Education in Mathematics, Data Science and Quantitative Disciplines. Canberra: Group of Eight.

Brown, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. Scott Lang (Eds.), *Testing Structural Models* (pp. 136-162). Newbury Park, CA: Sage Publications.

Buhs, E. S., Ladd, G. W., & Herald, S. L. (2006). Peer exclusion and victimization: Processes that mediate the relation between peer group rejection and children's classroom engagement and achievement. *Journal of Educational Psychology, 98*, 1-13.

Byrne, B. M., Shavelson, R. J., & Muthen, B. (1989). The issue of partial measurement invariance. *Psychological Bulletin, 105*(3), 456-466.

Byrnes, J. P., & Miller, D. C. (2007). The relative importance of predictors of math and science achievement: An opportunity-propensity analysis. *Contemporary Educational Psychology, 32*, 599-629.

Carr, M., Borkowski, J. G., & Maxwell, S. E. (1991). Motivational components of underachievement. *Developmental Psychology, 27*(`), 108-118.

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and*

Social Psychology, 79(4), 644-655.

Catalano, R. F., Haggerty, K. P., Oesterle, S., Flemming, C. B., & Hawkins, D. (2004). The importance of bonding to school for healthy development: Findings from the social development research group. *Journal of School Health, 74*, 252-261.

Cauce, A. M., Hannan, K., & Sargeant, M. (1992). Life stress, social support, and locus of control during early adolescence: Interactive effects. *American Journal of Community Psychology, 20*, 787-798.

Centre of Population Studies. (2004). *CoPS Briefing Handbook December 2004.* Melbourne: Monash University.

Chapell, M., S., Blanding, Z. B., Silverstien, M. E., Takahashi, M., Newman, B., Gubi, A., et al. (2005). Test anxiety and academic performance in undergraduate and graduate students. *Journal of Educational Psychology, 97*, 268-274.

Cheng, S. (1997). Psychological determinants of idolatry in adolescents. *Adolescence, 32*, 687-692.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling, 9*, 233-255.

Chouinard, R., Karsenti, T., & Roy, N. (2007). Relations among competence beliefs, utility values, achievement goals, and effort in mathematics. *British Journal of Educational Psychology, 77*, 501-517.

Chouinard, R., & Roy, N. (2008). Changes in high-school students' competence beliefs, utility value and achievement goals in mathematics. *British Journal of Educational Psychology, 78*, 31-50.

Cochran-Smith, M. (2003). Teaching quality matters. *Journal of Teacher Education, 54(2),* 95-98.

Cocks, R., & Watt, H. M. (2004). Relationships among perceived competence, intrinsic value and mastery goal orientation in English and maths. *The Australian Educational Researcher, 31*(2), 81-112.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2 ed.). New Jersey: Lawrence Erlbaum.

Cole, D. A. (1991). Change in self-perceived competence as a function of peer and teacher evaluation. *Developmental Psychology, 27*, 682-688.

Collins, C., Kenway, J., & McLeod, J. (2000). *Factors influencing the educational performance of males and females in school and their initial destinations after* *leaving school*. Canberra: Department of Education, Training and Youth Affairs.

Committee for the Review of Teaching and Teaching Education. (2002). *Australia's Teachers: Australia's Future. Advancing Innovation, Science, Technology and Mathematics (Main Report).* Canberra: Commonwealth of Australia.

Connell, J. P. (1985). A new multidimensional measure of children's perceptions of control. *Child Development, 56*(4), 1018-1041.

Connell, J. P., & Wellborn, J. G. (1991). Competence, autonomy and relatedness: A motivational analysis of self-system processes. In J. E. Jacobs (Ed.), *Developmental perspective on motivation* (pp. 57-97). Lincoln: University of Nebraska Press.

Covington, M. V. (1992). *Making the Grade: A Self-worth Perspective on Motivation and School Reform*. New York: Cambridge University Press.

Covington, M. V. (2000). Goal theory, motivation and school achievement: An integrative review. *Annual Review of Psychology, 51*, 171-200.

Creasey, G., Ottlinger, K., De Vico, K., Murray, T., Harvey, A., & Hesson-McInnis, M. (1997). Children's affective responses, cognitive appraisals, and coping strategies in response to the negative affect of parents and peers. *Journal of Experimental Child Psychology, 37*, 39-56.

Crocker, J., & Wolfe, C. T. (2001). Contingencies of self-worth. *Psychological Review, 108*, 593-623.

D'Ailly, H. (2004). The role of choice in children's learning: A distinctive cultural and gender difference in efficacy, interest, and effort. *Canadian Journal of Behavioural Science, 36*(1), 17-29.

De Fraine, B., Van Damme, J., & Onghena, P. (2007). A longitudinal analysis of gender differences in academic self-concept and language achievement: A multivariate latent growth approach. *Contemporary Educational Psychology, 32*, 132-150.

Dekkers, J., & Malone, J. (2000). Mathematics enrolments in Australian upper secondary schools (1980-1999): Trends and implications. *Australian Senior Mathematics Journal, 14*(2), 49-57.

Department of Education, Science and Training. (2005) *Schooling Issues Digest: Student Motivation and Engagement.* Canberra: Australian Government.

Department of Education, Science and Training. (2006) *Audit of Science, Engineering and*

Technology Skills Summary Report. Canberra: Australian Government.

Deppe, R. K., & Harackiewicz, J. M. (1996). Self-handicapping and intrinsic motivation: Buffering intrinsic motivation from the threat of failure. *Journal of Personality and Social Psychology, 70*(4), 868-876.

Diperna, J. C. (2006). Academic enablers and student achievement: Implications for assessment and intervention services in the schools. *Psychology in the Schools, 43*, 7-17.

Dobson, I. R. (2007). *Sustaining Science: University Science in the Twenty-First Century*. Melbourne: Australian Council of Deans of Science.

Dowson, M., & McInerney, D. M. (2003). What do students say about their motivational goals?: Towards a more complex and dynamic perspective on student motivation. *Contemporary Educational Psychology, 28*, 91-113.

Duda, J. L., & Nicholls, J. G. (1992). Dimensions of achievement motivation in schoolwork and sport. *Journal of Educational Psychology, 84*(3), 290-299.

Dumenci, L., & Achenbach, T., M. (2008). Effects of estimation methods on making trait-level inferences from ordered categorical items for assessing psychopathology. *Psychological Assessment, 20*(1), 55-62.

Dumenci, L., Erol, N., Achenbach, T., M., & Simsek, Z. (2004). Measurement structure of the Turkish translation of the child behavior checklist using confirmatory factor analytic approaches to validation of syndromal constructs. *Journal of Abnormal Child Psychology, 32*(3), 335-340.

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology*, 382-393.

Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist, 41*, 1040-1048.

Dweck, C. S., & Elliott, E. S. (1983). Achievement motivation. In P. Mussen & E. M. Hetherington (Eds.), *Handbook of Child Psychology*. New York: Wiley.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95*, 256-273.

Eccles, J. S. (1999). The development of children ages 6 to 14. *The Future of Children, 9*, 30-44.

Eccles, J. S., Adler, T., & Meece, J. (1984). Sex differences in achievement: A test of alternate theories. *Journal of Personality and Social Psychology, 46*, 26-43.

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., et al. (1983). Expectancies, values and academic behaviours. In J. T. Spence (Ed.), *Achievement and Achievement Motives* (pp. 75-146). San Francisco: Freeman.

Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., et al. (1993). Development during adolescence: The impact of stage-environment fit on young adolescents' experiences in schools and in families. *American Psychologist, 48*, 90-101.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin, 21*(3), 215-225.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values and goals. *Annual Review of Psychology, 53*, 109-132.

Elliot, A. J., & Harackiewicz, J. M. (1996). Approach and avoidance achievement goals and intrinsic motivation: A mediational analysis. *Journal of Personality and Social Psychology, 70*, 461-475.

Elliot, A. J., & Thrash, T. M. (2004). The intergenerational transmission of fear of failure. *Personality and Social Psychology Bulletin, 30*, 957-971.

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology, 54*, 5-12.

Feather, N. T. (1985). Attitudes, values and attributions: Explanations of unemployment. *Journal of Personality and Social Psychology, 48*, 876-889.

Feldaufer, H., Midgley, C., & Eccles, J. S. (1988). Student, teacher, and observer perceptions of the classroom environment before and after the tansition to junior high school. *Journal of Early Adolescence, 8*(2), 133-156.

Fennema, E., & Sherman, B. F. (1978). Sex-related differences in mathematics achievement and related factors: A further study. *Journal for Research in Mathematics Education, 9*, 189-203.

Fennema, E., & Sherman, J. (1976). Fennema-Sherman mathematics attitude scales: Instruments designed to measure attitudes toward the learing of mathematics by females and males. *Catalogue of Selected Documents in Psychology, 6*, 31-32.

Field, T., Diego, M., & Sanders, C. (2002). Adolescents' parent and peer relationships.

Adolescence, 37, 121-130.

Finn, J. (1989). Withdrawing from school. *Review of Educational Research, 59*, 117-142.

Flora, D. B., & Curran, P. J. (2004). An empirical evaluation of alternative methods of estimation for confirmatory factor analysis with ordinal data. *Psychological Methods, 9*(4), 466-491.

Floyd, H., & South, D. (1972). Dilemma of youth: The choice of parents or peers as a frame of reference for behaviour. *Journal of Marriage and the Family, 34*, 627-634.

Forgasz, H. J. (1995). Gender and the relationship between affective beliefs and perceptions of Grade 7 mathematics classroom learning environments. *Educational Studies in Mathematics, 28*(3), 219-239.

Forgasz, H. J., & Leder, G. C. (2001). The Victorian certificate of education - A gendered affair? *Australian Educational Researcher, 28*(2), 53-66.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*, 59-109.

Fredricks, J. A., & Eccles, J. S. (2002). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental Psychology, 38*, 519-533.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Girls and mathematics: A 'hopeless' issue? A control-value approach to gender differences in emotion toward mathematics. *European Journal of Psychology of Education, 22*, 497-514.

Friedel, J. M., Cortina, K. S., Turner, J. C., & Midgley, C. (2007). Achievement goals, efficacy beliefs and coping strategies in mathematics: The role of perceived parent and teacher goal emphasis. *Contemporary Educational Psychology, 32*, 434-458.

Fullarton, S., & Ainley, J. (2000). *Subject choice by students in year 12 in Australian secondary schools* (LSAY Research Report No. 15). Melbourne: ACER.

Fullarton, S., Walker, M., Ainley, J., & Hillman, K. (2003). *Patterns of Participation in Year 12* (LSAY Research report No. 33). Melbourne: ACER.

Furrer, C., & Skinner, E. (2003). Sense of relatedness as a factor in children's academic engagement and performance. *Journal of Educational Psychology, 95*, 148-162.

Gallagher, A. M., & De Lisi, R. (1994). Gender differences in scholastic aptitude test-

Mathematics problem solving among high-ability students. *Journal of Educational Psychology, 86*(2), 204-211.

Garber, J., Weiss, B., & Shanley, N. (1993). Cognitions, depressive symptoms, and development in adolescents. *Journal of Abnormal Child Psychology, 102*(1), 47-57.

Garner, R. (1990). When children and adults do not use learning strategies. *Review of Educational Research, 60*, 517-530.

Geen, R. G., Beatty, W. W., & Arkin, R. M. (1984). *Human Motivation: Physiological, Behavioural, and Social Approaches*. U.S.A.: Allyn and Bacon.

Georgiou, S. N. (1999). Achievement attributions of sixth grade children and their parents. *Educational Psychology, 19*, 399-412.

Gest, S. G., Domitrovich, C. E., & Welsh, J. A. (2005). Peer academic reputation in elementary school: Associations with changes in self-concept and academic skills. *Journal of Educational Psychology, 97*(3), 337-346.

Glanville, J. L., & Wildhagen, T. (2007). The measurement of school engagement: Assessing dimensionality and measurement invariance across race and ethnicity. *Educational and Psychological Measurement, 67*, 1019-1041.

Goffin, R., D. (2007). Assessing the adequacy of structural equation models: Golden rules and editorial policies. *Personality and Individual Differences, 42*(5), 831-839.

Goodenow, C. (1992). Strengthening the links between educational psychology and the study of social contexts. *Educational Psychologist, 27*, 177-196.

Goodenow, C. (1993). The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools, 30*, 79-90.

Goodenow, C., & Grady, K. E. (1993). The relationship of school belonging and friends' values to academic motivation among urban adolescent students. *Journal of Experimental Education, 62*, 30-71.

Gordon, D. (1998). The relationships among academic self-concept, academic achievement, and persistence with self-attribution, study habits, and perceived school environment. *Dissertation Abstracts International Section A: Humanities and Social Sciences, 58*, 12-A.

Gottfried, A. E., Fleming, J. S., & Gottfried, A. W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. *Journal of Educational Psychology, 93*(2), 3-13.

Green, J., Martin, A. J., & Marsh, H. W. (2007). Motivation and engagement in English, mathematics and science high school subjects: Toward an understanding of multidimensional domain specificity. *Learning and Individual Differences, 17*, 269-279.

Greene, B. A., DeBaker, T. K., Ravindran, B., & Krows, A. J. (1999). Goals, values and beliefs as predictors of achievement and effort in high school mathematics classes. *Sex Roles, 40*, 421-458.

Guay, F., Marsh, H. W., & Boivin, M. (2003). Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology, 95*, 124-136.

Guay, F., Marsh, H. W., Dowson, M., & Larose, S. (2005). *Assessing Academic Motivation among Elementary School Children: The Elementary School Motivation Scale.* Paper presented at the Australian Association for Research in Education, Parramatta, N.S.W.

Guttmannova, K., Szanyi, J. M., & Cali, P. W. (2008). Internalizing and externalizing behavior problem scores: Cross-ethnic and longitudinal measurement invariance of the behavior problem index. *Educational and Psychological Measurement, 68*(4), 676-694.

Hackett, G. (1985). Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology, 32*, 47-56.

Hardre, P. L., & Reeve, J. (2003). A motivational model of rural students' intentions to persist in, versus drop out of, high school. *Journal of Educational Psychology, 95*, 347-356.

Hardre, P. L., Chen, C., Huang, S., Chiang, C., Jen, F., & Warden, L. (2006). Factors affecting high school students' academic motivatino in Taiwan. *Asia Pacific Journal of Education, 26*, 189-207.

Harris, K., Jensz, F., & Baldwin, G. (2005). *Who's Teaching Science? Meeting the demand for qualified science teachers in Australian Secondary Schools*. Melbourne: Centre for the Study of Higher Education, University of Melbourne.

Harter, S. (1990). Causes, correlates and the functional role of global self-worth: A lifesspan perspective. In R. J. Sternberg & J. Kolligian (Eds.), *Competence Considered* (pp. 69-97). New Haven, CT: Yale University Press.

Hill, L. G., & Werner, N. E. (2006). Affiliative motivation, school attachment, and aggression in school. *Psychology in the Schools, 43*, 231-246.

Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3*(4), 424-453.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55.

Hughes, J. N., & Zhang, D. (2006). Effects of the structure of classmates' perceptions of peers' academic abilities on children's perceived cognitive competence, peer acceptance, and engagement. *Contemporary Educational Psychology, In Press*.

Hunsley, J. (1987). Cognitive processes in mathematics anxiety and test anxiety: The role appraisals, internal dialogue, and attributions. *Journal of Educational Psychology, 79*, 388-392.

Jacobs, J., Lanza, S., Osgood, W., Eccles, J. S., & Wentzel, K. R. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73*, 509-527.

Kasser, T., & Ryan, R. M. (1996). Further examining the American dream: Differential correlates of intrinsic and extrinsic goals. *Personality and Social Psychology Bulletin, 22*, 280-287.

Katz, I. (1967). The socialisation of academic motivation in minority group children. In D. Levine (Ed.), *Nebraska Symposium on Motivation* (pp. 133-191). Lincoln: University of Nebraska Press.

Kenney-Benson, G. A., Patrick, H., Pomerantz, E. M., & Ryan, A. M. (2006). Sex differences in math performance: The role of children's approach to schoolwork. *Developmental Psychology, 42*, 11-26.

Klassen, R. M. (2004). A cross-cultural investigation of the efficacy beliefs of south Asian immigrant and Anglo Canadian nonimmigrant early adolescents. *Journal of Educational Psychology, 96*(4), 731-742.

Klem, A. M., & Connell, J. P. (2004). Relationships matter: Linking teacher support to student engagement and achievement. *Journal of School Health, 74*, 262-273.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. NY: Guilford Press.

Knesting, K., & Waldron, N. (2006). Willing to play the game: How at-risk students persist in school. *Psychology in the Schools, 43*.

Lau, S., & Nie, Y. (2008). Interplay between personal goals and classroom goal structures in predicting student outcomes: A multilevel analysis of person-context interactions. *Journal of Educational Psychology, 100*(1), 15-29.

Legault, L., Green-Demers, I., & Pelletier, L. (2006). Why do high school students lack motivation in the classroom? Toward an understanding of academic amotivation and the role of social support. *Journal of Educational Psychology, 98*, 567-582.

Lepper, M. R., Iyengar, S. S., & Corpus, J. H. (2005). Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates. *Journal of Educational Psychology, 97*(2), 184-196.

Levesque, C., Zuehlke, A. N., Stanek, L. R., & Ryan, R. M. (2004). Autonomy and competence in German and American university students: A comparative study based on self-determination theory. *Journal of Educational Psychology, 96*(1), 68-84.

Levy-Tossman, I., Kaplan, A., & Assor, A. (2007). Academic goal orientations, multiple goal profiles, and friendship intimacy among early adolescents. *Contemporary Educational Psychology, 32*, 231-252.

Llabre, M. M., & Suarez, E. (1985). Predicting math anxiety and course performance in college men and women. *Journal of Counseling Psychology, 32*, 283-287.

Lopez, F. G., Brown, S. D., Lent, R. W., & Gore, P. A. (1997). Role of Social-Cognitive Expectations in High School Students' Mathematics-Related Interest and Performance. *Journal of Counseling Psychology, 44*(1), 44-52.

Ludowyke, J., & Scanlon, J. (1997). *Improving the School Performance of Boys*. Melbourne: Victorian Association of State Secondary Principals.

Lynch, M., & Cicchetti, D. (1997). Children's relationships with adults and peers: An examination of elementary and junior high school students. *Journal of School Psychology, 35*, 81-99.

Lyons, T., Cooksey, R., Panizzon, D., Parnell, A., & Pegg, J. (2006). *Science, ICT and Mathematics Education in Rural and Regional Australia: The SiMERR National*

Survey: National Centre of Science, ICT and Mathematics Education for Rural and Regional Australia.

Ma, X., & Cartwright, F. (2003). A longitudinal analysis of gender differences in affective outcomes in mathematics during middle and high school. *School Effectiveness and School Improvement, 14*(4), 413-439.

Ma, X., & Xu, J. (2004). The causal ordering of mathematics anxiety and mathematics achievement: A longitudinal panel analysis. *Journal of Adolescence, 27*, 165-179.

MacCallum, R. C., Roznowski, M., & Necowitz, L. B. (1992). Model modifications in covariance structure analysis: The problem of capitalization on chance. *Psychological Bulletin, 111*, 490-504.

MacIver, D. J., Stipek, D. J., & Daniels, D. H. (1991). Explaining within-semester changes in student effort in junior high school and senior high school courses. *Journal of Educational Psychology, 83*, 201-211.

Maehr, M. (2001). Goal theory is not dead - not yet, anyway: A reflection on the Special Issue. *Educational Psychology Review, 13*, 177-185.

Maehr, M. I., & Nicholls, J. B. (1980). Culture and achievement motivation: A second look. In N. Warren (Ed.), *Studies in cross-cultural psychology* (Vol. 3, pp. 221-267). New York: Academic Press.

Maehr, M. L., & Meyer, H. A. (1997). Understanding motivation and schooling: Where we've been, where we are, and where we need to go. *Educational Psychology Review, 9*(4), 371-409.

Markland, D. (2007). The golden rule is that there are no golden rules: A commentary on Paul Barrett's recommendations for reporting model fit in structural equation modelling. *Personality and Individual Differences, 42*, 851-858.

Marsh, H. W. (1989). Age and sex effects in multiple dimensions of self-concept: Preadolescence to early adulthood. *Journal of Educational Psychology, 81*, 417-430.

Marsh, H. W. (1990). The structure of the academic self-concept: The Marsh/Shavelson model. *Journal of Educational Psychology, 82*, 623-636.

Marsh, H. W., Balla, J. R., & Hau, K. (1996). An evaluation of incremental fit indices: A clarification of mathematical and empirical processes. In G. A. Marcoulides & R. E. Schumacker (Eds.), *Advanced structural Equation Modeling Techniques*.

Hillsdale, NJ: Erlbaum.

Marsh, H. W., Balla, J. R., & McDonald, R. P. (1988). Goodness-of-fit in confirmatory factor analysis: The effect of sample size. *Psychological Bulletin, 103*(3), 391-410.

Marsh, H. W., Byrne, B. M., & Shavelson, R. J. (1988). A multifaceted academic self-concept: Its hierarchical structure and its relation to academic achievement. *Journal of Educational Psychology, 3*, 366-380.

Marsh, H. W., Hau, K., Balla, J. R., & Grayson, D. (1998). Is more ever too much? The number of indicators per factor in confirmatory factor analysis. *Multivariate Behavioural Research, 33*(2), 181-220.

Marsh, H. W., Hau, K., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling, 11*, 320-341.

Marsh, H. W., Hau, K.-T., & Grayson, D. (2005). Goodness of fit evaluation in structural equation models. In A. Maydeu-Olivares & J. McCardle (Eds.), *A festschrift to Roderick P. McDonald* (pp. 275-340). Mahwah, NJ: Erlbaum.

Marsh, H. W., Roche, L. A., Pajares, F., & Milller, D. (1997). Item-specific efficacy judgements in mathematical problem solving: The downside of standing too close to trees in a forest. *Contemporary Educational Psychology, 22*, 363-377.

Martin, A. J. (2001). The student motivation scale: a tool for measuring and enhancing motivation. *Australian Journal of Guidance and Counselling, 11*, 1-20.

Martin, A. J. (2002a). The lethal cocktail: Low self-belief, low control, and high fear of failure. *Australian Journal of Guidance and Counselling, 12*, 74-85.

Martin, A. J. (2002b). Motivation and academic resilience: Developing a model for student enhancement. *Australian Journal of Education, 46,* 34-49.

Martin, A. J. (2003a). The student motivation scale: Further testing of an instrument that measures school students' motivation. *Australian Journal of Education, 47*, 88-106.

Martin, A. J. (2003b). Boys and motivation: Contrasts and comparisons with girls' approaches to schoolwork. *The Australian Educational Researcher, 30*, 43-65.

Martin, A. J. (2003c). *How to motivation your child for school and beyond*. Sydney, Australia: Bantam.

Martin, A. J. (2004). School motivation of boys and girls: Differences of degree, differences of kind or both? *Australian Journal of Psychology, 56*, 133-146.

Martin, A. J. (2007a). *The Motivation and Engagement Scale*. Sydney: Lifelong Achievement Group.

Martin, A. J. (2007b). Examining a multidimensional model of student motivation and engagement using a construct validation approach. *British Journal of Educational Psychology, 77*, 413-440.

Martin, A. J. (2009). Motivation and engagement across the academic life span: A developmental construct validity study of elementary school, high school, and university/College students. *Educational and Psychological Measurement, 69*, 794-824.

Martin, A. J., & Marsh, H. W. (2003). Fear of failure: Friend or foe? *Australian Psychologist, 38*, 31-38.

Martin, A. J., & Marsh, H. W. (2005). Motivating boys and motivating girls: Does teacher gender really make a difference? *Australian Journal of Education, 49,* 320-334.

Martin, A. J., Marsh, H. W., & Debus, R. L. (2001). Self-handicapping and defensive pessimism: Exploring a model of predictors and outcomes from a self-protection perspective. *Journal of Educational Psychology, 93*, 87-102.

Martin, A. J., Marsh, H. W., & Debus, R. L. (2003). Self-handicapping and defensive pessimism: A model of self-protection from a longitudinal perspective. *Contemporary Educational Psychology, 28*, 1-36.

Martin, A. J., Marsh, H. W., McInerney, D. M., & Green, J. (2009). Nonacademic outcomes: Scoping the relative salience of teachers, parents, same-sex peers, and opposite-sex peers. *Teachers College Record*(Marsh).

Martin, A. J., Marsh, H. W., McInerney, D. M., Green, J., & Dowson, M. (2007). Getting along with teacher and parents: The yields of good relationships for students' achievement motivation and self-esteem. *Australian Journal of Guidance and Counselling, 12*(2), 109-125.

Martin, M. O., Mullis, I., Gonzalez, E., & Chrostowski, S. (2004). *TIMSS 2003 International Science Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Maslow, A. (1962). *Towards a psychology of being*. Princeton, NJ: D. Van Nostrand.

Mason, L. (2003). High school students' beliefs about maths, mathematical problem solving, and their achievement in maths: A cross-sectional study. *Educational Psychology, 23*, 73-85.

McIntosh, C. (2007). Rethinking fit assessment in structural equation modelling: A commentary and elaboration on Battett (2007). *Personality and Individual Differences, 42*, 589-867.

McPhan, G., Morony, W., Pegg, J., Cooksey, R., & Lynch, T. (2008). *Maths? Why Not?* Canberra: Department of Education, Employment and Work Place Relations.

Meade, A. W., Johnson, E. C., & Braddy, P. W. (2008). Power and sensitivity of alternative fit indices in tests of measurement invariance. *Journal of Applied Psychology, 9*(3), 568-592.

Meade, A. W., & Lautenschlager, G. J. (2004). A monte-carlo study of confirmatory factor analytic tests of measurement equivalence/invariance. *Structural Equation Modeling, 11*(1), 60-70.

Meece, J. L., Blumenfeld, P. C., & Hoyle, R. H. (1988). Students' goal orientations and cognitive engagement in classroom activities. *Journal of Educational Psychology, 80*, 514-523.

Meece, J. L., Eccles, J. S., Kaczala, C. M., Goff, S. B., & Futterman, R. (1982). Sex differences in math achievement: Toward a model of academic choice. *Psychological Bulletin, 91*, 324-348.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology, 82*, 60-70.

Middleton, M. J., & Midgley, C. (1997). Avoiding the demonstration of lack of ability: An underexplored aspect of goal theory. *Journal of Educational Psychology, 89*, 710-718.

Midgley, C., Arunkumar, R., & Urdan, T. (1996). "If I don't do well tomorrow, there's a reason": Predictors of adolescents' use of academic self-handicapping strategies. *Journal of Educational Psychology, 88*(3), 423-434.

Midgley, C., Feldaufer, H., & Eccles, J. S. (1989). Student/teacher relations and attitudes toward mathematics before and after the transition to junior high school. *Child Development, 60*, 981-922.

Midgley, C., & Urdan, T. (2001). Academic self-handicapping and achievement goals: A further examination. *Contemporary Educational Psychology, 26*, 61-75.

Miles, J., & Shevlin, M. (2007). A time and a place for incremental fit indices. *Personality and Individual Differences, 42*, 869-874.

Miller, R. B., Behren, J. T., & Greene, B. A. (1993). Goals and perceived ability: Impact on student valuing, selg-regulation, and persistence. *Contemporary Educational Psychology, 18*, 2-14.

Miller, R. B., Greene, B. A., Montalvo, G., P., Ravindran, B., & Nichols, J. D. (1996). Engagement in academic work: The role of learning goals, future consequences, pleasing others and perceived ability. *Contemporary Educational Psychology, 21*(388-422).

Millsap, R. E., & Yun-Tein, J. (2004). Assessing factorial invariance in ordered-categorical measures. *Multivariate Behavioural Research, 39*(3), 479-515.

Ministerial Council on Education, Employment, Training & Youth Affairs. (2004). *Demand and Supply of Primary and Secondary School Teachers in Australia*. Melbourne: MCEETYA.

Miserandino, M. (1996). Children who do well in school: Individual differences in perceived competence and autonomy in above-average children. *Journal of Educational Psychology, 2*, 203-214.

Moore, S., & Boldero, J. (1991). Pyschosocial development and friendship functions in adolescence. *Sex Roles, 25*(9/10), 521-536.

Mounts, N. S., & Steinberg, L. (1995). An ecological analysis of peer influence on adolescent grade point average and drug use. *Developmental Psychology, 31*, 915-922.

Mounts, N. S., Valentiner, D., Anderson, K., & Boswell, M. (2006). Shyness, sociability, and parents support for the college transition: Relation to adolescents' adjustment. *Journal of Youth and Adolescence, 35*(1), 71-80.

Mulaik, S. (2007). There is a place for approximate fit in structural equation modelling. *Personality and Individual Differences, 42*, 883-891.

Murdock, T. B. (1999). The social context of risk: Status and motivational predictors of alienation in middle school. *Journal of Educational Psychology, 91*, 62-75.

Murphy, P. K., & Alexander, P. A. (2000). A motivated exploration of motivation terminology *Contemporary Educational Psychology, 25*, 3-53.

Muthén, L. K., & Muthén, B. O. (2007). *Mplus User's Guide.* (Fifth ed.). Los Angeles, CA: Muthén & Muthén.

National Numeracy Review Report. (2008). Canberra: Commonwealth of Australia.

Neslon, R. M., & DeBaker, T. K. (2008). Achievement motivation in adolescents: The role of peer climate and best friends. *The Journal of Experimental Education, 76*, 170-189.

Nicholls, J. B. (1984). Achievement motivation: Concepts of ability, subjective experience, task choice, and performance. *Psychological Bulletin, 91*, 328-346.

Nichols, S. L. (2008). An exploration of students' belongingness beliefs in one middle school. *The Journal of Experimental Education, 76*, 145-169.

Ntoumanis, N. (2001). A self-determined approach to the understanding of motivation in physical education. *British Journal of Educational Psychology, 71*, 225-242.

O'Connor, E., & McCartney, K. (2007). Examining teacher-child relationships and achievement as part of an ecological model of development. *American Educational Research Journal, 44*(2), 340-369.

Onwuegbuzie, A. J. (2004). Academic procrastination and statistics anxiety. *Assessment and Evaluation in Higher Education, 24*(1), 3-19.

Osterman. (2000). Students' need for belonging in the school community *Review of Educational Research, 70*(3), 323-367.

Otis, N., Grouzet, F. M., & Pelletier, L. G. (2005). Latent motivational change in an academic setting: A 3-year longitudinal study. *Journal of Educational Psychology, 97*, 170-183.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66*, 543-578.

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of Educational Psychology, 2*, 193-203.

Patrick, B. C., Skinner, E. A., & Connell, J. P. (1993). What motivates children's behaviour and emotion? Joint effects of perceived control and autonomy in the academic domain. *Journal of Personality and Social Psychology, 65*, 781-791.

Patrick, H., Kaplan, A., & Ryan, A. M. (2007). Early adolescents' perceptions of the classroom social environment, motivational beliefs, and engagement. *Journal of Educational Psychology, 99*, 83-98.

Patrick, H., Mantzicopoulos, P., Samarapungavan, A., & French, B. F. (2008). Patterns of young children's motivation for science and teacher-child relationships. *Journal of Experimental Education, 76*(2), 121-144.

Pekrun, R., Elliot, A. J., & Maier, M. A. (2006). Achievement goals and discrete achievement emotions: A theoretical model and prospective test. *Journal of Educational Psychology, 98*, 583-597.

Perl, T. H. (1982). Discriminating factors and sex differences in electing mathematics. *Journal for Research in Mathematics Education, 13*, 66-74.

Perry, R. P., Hladkyi, S., Pekrun, R. H., & Pelletier, S. T. (2001). Academic Control and Action Control in the Achievement of College Students: A Longitudinal Study. *Journal of Educational Psychology, 93*(4), 776-789.

Pintrich, P. R., & De Groot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*, 33-40.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95*, 667-686.

Pintrich, P. R., & Schunk, D. H. (1996). *Motivation in education: Theory, research, and applications*. Englewood Cliffs, NJ: Merrill/Prentice Hall.

Pokay, P., & Blumenfeld, P. C. (1990). Predicting achievement early and late in the semester: The role of motivation and use of learning strategies. *Journal of Educational Psychology, 82*, 41-50.

Pomerantz, E. M., Altermatt, E. R., & Saxon, J. L. (2002). Making the grade but feeling distressed: Gender differences in academic performance and internal distress. *Journal of Educational Psychology, 9*, 396-404.

Pomerantz, E. M., & Ruble, D. N. (1998). The role of maternal control in the development of sex differences in child self-evaluative factors. *Child Development, 69*(2), 458-478.

Rankin, J. L., Lane, D. J., Gibbons, F. X., & Gerrard, M. (2004). Adolescent self-consciousness: Longitudinal age changes and gender differences in two cohorts. *Journal of Research On Adolescence, 14*(1), 1-21.

Rennie, L., & Goodrum, D. (2007). *Australian School Science Education National Action Plan 2008-2012*. Canberra: Department of Education, Science and Training.

Roeser, R. W., Midgley, C., & Urdan, T. C. (1996). Perceptions of the school psychological environment and early adolescents' psychological and behavioural functioning in school: The mediating role of goals and belonging. *Journal of Educational Psychology, 88*, 408-422.

Rowe, K. J., & Rowe, K. S. (2002). *What matters most: Evidence-based findings of key factors affecting the educational experiences and outcomes for girls and boys throughout their primary and secondary schooling*: Supplementary submission to House of Representatives Standing Committee on Education and Training: Inquiry Into the Education of Boys.

Ruble, D., N., Greulich, F., Pomerantz, E. M., & Gochberg, B. (1993). The role of gender-related processes in the development of sex differences in self-evaluation and depression. *Journal of Affective Disorders, 29*, 97-128.

Rudolph, K. D., Lambert, S. F., Clark, A. G., & Kurlakowsky, K. D. (2001). Negotiating the transition to middle school: The role of self-regulatory processes. *Child Development, 72*(3), 929-946.

Ryan, A. M. (2000). Peer groups as a context for the socialization of adolescents' motivation, engagement, and achievement in school. *Educational Psychologist, 35*(2), 101-111.

Ryan, R. M., & Deci, E. L. (2000a). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54-67.

Ryan, R. M., & Deci, E. L. (2000b). Self-determination theory and the facilitation of intrinsic motivation, social development and well-being. *American Psychologist, 55*(1), 68-78.

Ryan, R. M., & Powelson, C. L. (1991). Autonomy and relatedness as fundamental to motivation and education. *Journal of Experimental Education, 60*, 49-66.

Ryan, R. M., Stiller, J. D., & Lynch, J. H. (1994). Representations of relationships to teachers, parents and friends as predictors of academic motivation and self-esteem. *Journal of Adolescence, 14*(2), 226-249.

Schermelleh-Engel, K., Moosbrugger, H., & Muller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online, 8*(2), 23-74.

Schraw, G., Olafson, L., & Wadkins, T. (2007). Doing the things we do: A grounded theory of academic procrastination. *Journal of Educational Psychology, 99*, 12-

25.

Schunk, D. H. (2000). Coming to terms with motivation constructs. *Contemporary Educational Psychology, 25*, 116-119.

Schunk, D. H., Pintrich, P. R., & Meece, J. (2007). *Motivation in Education: Theory, Research, and Applications*. Upper Saddle River, NJ: Merrill-Prentice Hall.

Seligman, M. E. (1975). *Helplessness: On Depression, Development, and Death*. San Francisco: Freeman.

Shell, D. F., & Husman, J. (2008). Control, motivation, affect, and strategic self-regulation in the college classroom: A multidimensional phenomenon. *Journal of Educational Psychology, 100*(2), 443-459.

Simpson, S. M., Licht, B. G., Wagner, R. K., & Stader, S. R. (1996). Organisation of children's academic ability-related self-perceptions. *Journal of Educational Psychology, 88*, 387-396.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research, 95*, 323-332.

Skaalvik, E. M. (1990). Gender differences in general academic self-esteem and in success expectations on defined academic problems. *Journal of Educational Psychology, 82*, 593-598.

Skaalvik, S., & SKaalvik, E. M. (2004). Gender differences in math and verbal self-concept, performance expectations, and motivation. *Sex Roles, 50*(3/4), 241-252.

Skinner, E. A. (1996). A guide to constructs of control. *Journal of Personality and Social Psychology, 71*, 549-570.

Skinner, E. A., Wellborn, J. G., & Connell, J. P. (1990). What it takes to do well in school and whether I've got it: A process model of perceived control and children's engagement and achievement in school. *Journal of Educational Psychology, 82*, 22-32.

Smiley, P. A., & Dweck, C. S. (1994). Individual differences in achievement goals among young children. *Child Development, 65*, 1723-1743.

Smith, L. (2004). Changes in student motivation over the final year of high school. *Journal of Educational Enquiry, 5*, 64-85.

Speering, W., & Rennie, L. (1996). Students' perceptions about science: The impact of transition from primary to secondary school. *Research in Science Education 26*(3), 283-298.

Stader, S. R., & Licht, B. G. (1992). Effects of questionnaire administration condition on children's achievement-related beliefs. *Journal of Educational Psychology, 84*, 28-34.

Steinberg, L., Dornbusch, S. M., & Brown, B. B. (1992). Ethnic differences in adolescent achievement: An ecological perspective. *American Psychologist, 47*, 723-729.

Stevens, T., Olivarez, A., & Hamman, D. (2006). The role of cognition, motivation, and emotion in explaining the mathematics achievement gap between Hispanic and white students. *Hispanic Journal of Behavioural Sciences, 28*, 161-186.

Stipek, D. J., & Daniels, D H. (1998). Declining perceptions of competence: A consequence of changes in the child or in the educational environment? *Journal of Educational Psychology, 80*, 352-356.

Stipek, D. J., & Gralinski, H. (1991). Gender differences in children's achievement-related beliefs and emotional responses to success and failure in mathematics. *Journal of Experimental Psychology, 83*, 361-371.

Stipek, D. J., & MacIver, D. (1989). Developmental change in children's assessment of intellectual competence. *Child Development, 60*, 521-538.

Syngollitou, E., &, & Daskalou, V. (2004). Developmental changes of self-concept and affective factors in adolescence.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using Multivariate Statistics*. Boston: Allyn & Bacon.

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin, 103*(2), 193-210.

Tedesco, L. A., & Gaier, E. L. (1988). Friendship bonds in adolescence. *Adolescence, 23*, 127-136.

Thompson, T. (1994). Self-worth protection: Review and implications for the classroom. *Educational Review, 46*, 259-274.

Thompson, T., & Richardson, A. (2001). Self-handicapping status, claimed self-handicaps and reduced practice effort following success and failure feedback. *British Journal of Educational Psychology, 71*, 151-170.

Thomson, S., Cresswell. J., & De Bortoli, L. (2004). *Facing the Future: A Focus on Mathematical Literacy Among Australian 15-year-old students in PISA*.

Camberwell, VIC: ACER.

Thomson, S., & Flemming, C. B. (2004). *Summing it up: Mathematics achievement in Australian schools in TIMSS 2002* (TIMSS Australia Monograph No. 6). Melbourne: ACER.

Thomson, S., Wernert, N., Underwood, C., & Nicholas, M. (2008). *Highlights from TIMSS 2007 from Australia's perspective: Highlights from the full report, Taking a closer look at mathematics and science in Australia*. Melbourne: ACER.

Tice, D. M., & Baumeister, R. F. (1990). Self-esteem, self-handicapping, and self-presentation: The strategy of inadequate practice. *Journal of Personality, 58*, 443-464.

Turner, J. C., Midgley, C., Meyer, D. K., Gheen, M., Andermann, E. M., Kang, Y., & Patrick, H. (2002). The classroom environment and students' reports of avoidance strategies in mathematics: A multimethod study. *Journal of Educational Psychology, 94*, 8-106.

Tytler, R. (2007). *Re-imagining Science Education: Engaging students in science for Australia's future*. Camberwell: Australian Council for Educational Research.

Urberg, K. A., Degirmencioglu, S. D., Tolson, J. M., & Halliday-Scher, K. (1995). The structure of adolescent peer networks. *Developmental Psychology, 31*, 540-547.

Urdan, T. (2004). Predictors of academic self-handicapping and achievement: Examining achievement goals, classroom goal structures and culture. *Journal of Educational Psychology, 96*, 251-264.

Urdan, T., & Schoenfelder, E. (2006). Classroom effects on student motivation: Goal structures, social relationships, and competence beliefs. *Journal of School Psychology, 44*, 331-349.

Urdan, T., Midgley, C., & Anderman, E. M. (1998). The role of classroom goal structure in students' use of self-handicapping strategies. *American Educational Research Journal, 35*, 101-122.

Watt, H. M. (2004). Development of adolescents' self-perceptions, values and task perceptions according to gender and domain in 7th- through 11th-grade Australian students. *Child Development, 75*, 1556-1574.

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational Psychology, 71*(1), 3-25.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92*(4), 548-573.

Weiner, B. (1990). The history of motivation research in education. *Journal of Educational Psychology, 82*(616-622).

Wentzel, K. R. (1994). Relations of social goal pursuit to social acceptance, classroom behavior, and perceived social support. *Journal of Educational Psychology, 86*(2), 173-182.

Wentzel, K. R. (1997). Student motivation in middle school: The role of perceived pedagogical caring. *Journal of Experimental Psychology, 89*, 411-419.

Wentzel, K. R. (1998). Social relationships and motivation in middle school: The role of parents, teachers, and peers. *Journal of Educational Psychology, 90*, 202-209.

Wentzel, K. R. (1999). Social-motivational processes and interpersonal relationships: Implications for understanding motivation at school. *Journal of Educational Psychology, 91*, 76-97.

Wigfield, A. (1994). Expectancy-value theory of achievement motivation: A developmental perspective. *Educational Psychology Review, 6*(1).

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12*, 265-310.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68-81.

Wigfield, A., Eccles, J. S., Mac Iver, D. J., Reuman, D. A., & Midgley, C. (1991). Transitions during early adolescence: Changes in children's domains-specific self-perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology, 27*, 652-656.

Wigfield, A., & Guthrie, J. T. (1997). Relations of children's motivation for reading to the amount and breadth of their reading. *Journal of Educational Psychology, 89*, 420-432.

Wigfield, A., Harold, R. D., Freedman-Doan, C., Eccles, J. S., Yoon, K. S., Arbreton, A. J., et al. (1997). Change in children's competency beliefs and subjective task values across the elementary school years: A 3-year study. *Journal of Educational Psychology, 89*, 451-469.

Wigfield, A., & Meece, J. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*, 210-216.

Wolters, C. A. (2004). Advancing achievement goal theory: Using goal structures and goal orientations to predict students' motivation, cognition and achievement. *Journal of Educational Psychology, 96*, 236-250.

Wolters, C. A., & Pintrich, P. R. (1998). Contextual differences in student motivation and self-regulated learning in mathematics, English and social studies classrooms. *Instructional Science, 26*, 27-47.

Wolters, C. A., Yu, S. L., & Pintrich, P. R. (1996). The relation between goal orientation and students' motivational beliefs and self-regulated learning. *Learning and Individual Differences, 8*(3), 211-238.

Wu, C., Chen, L. H., & Tsai, Y. (2009). Longitudinal invariance analysis of the satisfaction with life scale. *Personality and Individual Differences, 46*, 396-401.

Yu, C. Y. (2002). *Evaluating cutoff criteria of model fit indices for latent variable models with binary and continuous outcomes. Doctoral Dissertation.* University of California, Los Angeles.

Yuan, K., & Bentler, P. M. (2004). On chi-square difference and *z* tests in mean and covariance structure analysis when the base model is misspecified. *Educational and Psychological Measurement, 64*(5), 737--757.

Zimmerman, B. J. (1986). Development of self-regulated learning: Which are the key subprocesses? . *Contemporary Educational Psychology, 16*, 307-313.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology, 81*, 329-339.

Zimmerman, B. J. (1994). Dimensions of academic self regulation: A conceptual framework for education. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 3-21). Hillsdale, NJ: Lawrence Erlbaum Associates.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary Educational Psychology, 25*, 82-91.

Zimmerman, B. J., & Martinez-Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex and giftedness to self-efficacy and strategy use. *Journal of Educational Psychology, 82*(1), 51-59.

Appendices

Appendix A - Adapted MES-HS Item Listings

Self Belief

SB13 - If I try hard, I believe I can do my maths work well

SB23 - If I don't give up, I believe I can do difficult maths work

SB33 - If I have enough time, I believe I can do well in my maths work

SB40 - If I work hard enough, I believe I can get on top of my maths work

Valuing

V4 - I'm able to use some of the things I learn in maths in other parts of my life

V14 - Learning maths is important

V34 - What I learn in maths will be useful one day

V41 - It's important to understand what I'm taught in maths

Mastery Orientation

MF2 - I feel very please with myself when I really understand what I'm taught in maths

MF7 - I feel very please with myself when I do well in maths by working hard

MF25 - I feel very pleased with myself when what I learn in maths gives me a better idea of how something works

MF26 - I feel very pleased with myself when I learn new things in maths.

Planning

Pl21 - I get it clear in my head what I'm going to do when I sit down to study maths

Pl27 - Before I start a maths assignment, I plan out how I am going to do it

Pl30 - I try to plan things out before I start working on my math homework or assignments

Pl39 - I usually stick to a maths study timetable or study plan

Study Management

SM3 - When I study maths, I usually study in places where I can concentrate

SM17 - When I study maths, I usually organise my study area to help me study best

SM32 - When I study maths, I usually try to find a place where I can study well

SM44 - When I study maths, I usually study at times when I can concentrate best

Persistence

P1 - If I can't understand my maths work at first, I keep going over it until I do

P9 - If my maths homework is difficult, I keep working at it trying to figure it out

P28 - When I'm taught something in maths that doesn't make sense, I spend time to try understand it

P36 I'll keep working at difficult maths work until I think I've work it out

Anxiety

A10 - When maths exams and assignments are coming up, I worry a lot

A19 - I worry about failing maths exams and assignments

A37 - When I do maths tests or exams I don't feel very good

A43 - In terms of my maths work, I'd call myself a worrier

Failure Avoidance

FA11 - Often the main reason I work at maths is because I don't want people to think that I'm dumb

FA20 - Often the main reason I work at maths is because I don't want people to think bad things about me

FA31 - Often the main reason I work at maths is because I don't want to disappoint my parents

FA38 - Often the main reason I work at maths is because I don't want my teacher to think less of me

Uncertain Control

UC6 - When I don't do so well at maths I'm often unsure how to avoid that happening again

UC12 - When I get a good mark in maths I'm often not sure how I'm going to get that mark again

UC16 - When I get a bad mark in maths I'm often unsure how I'm going to avoid getting that mark again

UC18 - I'm often unsure how I can avoid doing poorly at maths

Self-Handicapping

SH5 - Sometimes I don't try hard at maths assignments so I have an excuse if I don't do so well

SH24 - I sometimes don't study very hard before maths exams so I have an excuse if I don't do so well

SH35 - I sometimes do things other than study the night before a maths exam so I have an excuse if I don't do so well

SH42 - I sometimes put assignments and study off until the last moment so I have an excuse if I don't do so well

Disengagement

D8 - Each week I'm trying less and less in maths

D15 - I don't really care about maths anymore

D22 - I've pretty much given up being involve in things in maths

D29 - I've pretty much given up being interested in school

Appendix B - Ethics Committee Approval

Appendix B(I) - New South Wales Department of Education and Training

PLANNING AND INNOVATION

NEW SOUTH WALES
DEPARTMENT
OF EDUCATION
AND TRAINING

Early Childhood and Primary Education
Secondary Education
Technical and Further Education
Vocational Education and Training
Higher Education
Adult and Community Education

Ms Stephanie Plenty
50 Gruner St
Weston ACT 2611

Dear Ms Plenty

SERAP Number: **06.288**

I refer to your application to conduct a research project in NSW government schools entitled *The complex nature of mathematics motivation and the influence of friends*. I am pleased to inform you that your application has been approved. You may now contact the Principals of the nominated schools to seek their participation.

This approval will remain valid until 19 July 2007

This approval covers the following researchers and research assistants to enter schools for the purposes of this research:

Names	**Approval expires**
Stephanie Plenty	29 May 2007

You should include a copy of this letter with the documents you send to schools.

I draw your attention to the following requirements for all researchers in NSW government schools:

- School Principals have the right to withdraw the school from the study at any time. The approval of the Principal for the specific method of gathering information for the school must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school's convenience.
- Any proposal to publish the outcomes of the study should be discussed with the Research Approvals Officer before publication proceeds.

When your study is completed please forward your report marked to General Manager, Planning and Innovation, Department of Education and Training, GPO Box 33, Sydney, NSW 2001.

Yours sincerely

Dr Christine Ewan
General Manager, Planning and Innovation
18 July 06

• Level 6, 35 Bridge Street • GPO Box 33 • Sydney NSW 2001 Australia •
• *telephone* 02 61 2 9561 8744 • *facsimile* 02 61 2 9561 8941 • www.det.nsw.edu.au •

PLANNING AND INNOVATION

NEW SOUTH WALES
DEPARTMENT
OF EDUCATION
AND TRAINING

Early Childhood and Primary Education
Secondary Education
Technical and Further Education
Vocational Education and Training
Higher Education
Adult and Community Education

Ms Stephanie Plenty
50 Gruner St
Weston ACT 2611

Dear Ms Plenty SERAP Number **05.288**

I refer to your application for extension of your research project in NSW government schools entitled *The complex nature of mathematics motivation and the influence of friends*. I am pleased to inform you that your application has been approved.

This approval will remain valid until 14/06/2008.

The following researchers or research assistants have fulfilled the Working with Children screening requirements to interact with or observe children for the purposes of this research for the period indicated:

Name	**Approval expires**
Stephanie May Plenty	04/06/2008

When your study is completed please forward your report marked to the General Manager, Planning and Innovation, Department of Education and Training, GPO Box 33, Sydney, NSW 2001.

Yours sincerely

Brian Davies

Dr Brian Davies
Manager, Research and Analysis
17 June 07

• Level 6, 35 Bridge Street • GPO Box 33 • Sydney NSW 2001 Australia •
• *telephone* 02 61 2 9561 8744 • *facsimile* 02 61 2 9561 8941 • www.det.nsw.edu.au •

PLANNING AND INNOVATION

NEW SOUTH WALES DEPARTMENT OF EDUCATION AND TRAINING

Ms Stephanie Plenty
50 Gruner Street
WESTON ACT 2611

Dear Ms Plenty SERAP number 05.288

I refer to your application for extension of your research project in NSW government schools entitled *Changes in Mathematics Motivation During High School*. I am pleased to inform you that your application has been approved.

This approval will remain valid until 31 November 2008.

The following researchers or research assistants have fulfilled the Working with Children screening requirements to interact with or observe children for the purposes of this research for the period indicated:

Name	Approval expires
Stephanie May Plenty	10 July 2009

When your study is completed please forward your report marked to the General Manager, Planning and Innovation, Department of Education and Training, GPO Box 33, Sydney, NSW 2001.

Yours sincerely

Brian Davies

Dr Brian Davies
Manager, Research and Evaluation
29 July 08

Appendix B (II) - Australian National University Human Research Ethics Committee

THE AUSTRALIAN NATIONAL UNIVERSITY

RESEARCH OFFICE

Ms Yolanda Shave
Secretary, Human Research Ethics Committee

CANBERRA ACT 0200 AUSTRALIA
TELEPHONE:(02) 6125 7945
FACSIMILE: (02) 6125 4807
EMAIL: Yolanda.Shave@anu.edu.au

15 September 2006

Ms Stephanie Plenty
50 Gruner Street
WESTON ACT 2611

Dear Ms Plenty,

Protocol 2005/90
Mathematics Motivation: Its Complex Nature and Influence of Friends
Variation: Addition of questions to questionnaire

I am pleased to advise that the above variation to the above protocol, as described in your email to me of 12 September 2006, has been approved by the Chair of the Human Research Ethics Committee Prof Lawrence Cram on 14 September 2006. The approval of the variation will routinely be reported to the Committee at its next meeting.

Please do not hesitate to contact me if you have any queries.

Yours sincerely

JRadcliffe
per

Yolanda Shave
Secretary Human Research Ethics Committee

Appendix C - Information and Consent Forms

Appendix C (I) - Principal Information Form

Title of study: Changes in Mathematics Motivation During High School

Dear XXXX,

I am postgraduate student from the Faculty of Psychology at the Australian National University and am currently completing a PhD thesis about academic motivation in adolescence. In particular, I am researching the influence significant others have on students' motivation for academic achievement. I will be assessing students' general experiences of school as well as their values, beliefs and behaviours relating specifically to maths.

I would like to survey students from grades 7-11 about their values and beliefs regarding school and learning. Students from each mathematics class from grades 7-11 would be invited to participate. Participation involves completing a questionnaire during normal lesson time, which takes approximately 40 minutes. Participation is voluntary and students are free to withdraw at any time.

Information obtained from the questionnaire will be used in my PhD thesis, and potentially published as a journal article. However individual responses and names will be suppressed as data will be collated and only expressed in terms of averages and general trends. All questionnaires and consent forms will be treated as confidential as far as the law allows and securely stored in locked filing cabinets at the ANU. No names will be documented on the computer file used for analysing the data. No teacher, parent or student will have access to individual responses so that students can feel free to express what they really think.

This study has received approval from the ANU Human Research Ethics Committee.

If you are interested in participating in this study, or have any queries, please contact me on;

Stephanie Plenty on 0422 136737 or stephplenty@hotmail.com.

If you have any ethical concerns about the study please contact the ANU Human Research Ethics Committee;

Human.Ethics.Officer@anu.edu.au or Tel: 6215 7945

Yours sincerely,

Stephanie Plenty

Appendix C (II) - Teacher Information and Consent Form

Title of study: Changes in Mathematics Motivation During High School

Dear XXXX,

I am postgraduate student from the Faculty of Psychology at the Australian National University and am currently completing a PhD thesis about academic motivation in adolescence. In particular, I am researching the influence significant others have on students' motivation for academic achievement. I will be assessing students' general experiences of school as well as their values, beliefs and behaviours relating specifically to maths.

I would like to survey students from grades 7-11 about their values and beliefs regarding school and learning. Students from each mathematics class from grades 7-11 would be invited to participate. Participation involves completing a questionnaire during normal lesson time, which takes approximately 40 minutes. Participation is voluntary and students are free to withdraw at any time.

Information obtained from the questionnaire will be used in my PhD thesis, and potentially published as a journal article. However individual responses and names will be suppressed as data will be collated and only expressed in terms of averages and general trends. All questionnaires and consent forms will be treated as confidential as far as the law allows and securely stored in locked filing cabinets at the ANU. No names will be documented on the computer file used for analysing the data. No teacher, parent or student will have access to individual responses so that students can feel free to express what they really think.

This study has received approval from the ANU Human Research Ethics Committee.

If you are interested in participating in this study, or have any queries, please contact me on;

Stephanie Plenty on 0422 136737 or stephplenty@hotmail.com.

If you have any ethical concerns about the study please contact the ANU Human Research Ethics Committee;

Human.Ethics.Officer@anu.edu.au or Tel: 6215 7945

Yours sincerely,

Stephanie Plenty

Appendix C (III) - Parent Information and Consent Form

Parents/Guardians, please read now!!

Study Title: Changes in Mathematics Motivation During High School

I am a postgraduate student from the School of Psychology at the Australian National University researching academic motivation. **Over the next three years I will be asking students' to describe their experiences with school and their motivation to do maths in particular**. This research will help educators support motivation and learning in the classroom. I will be assessing students' general experiences of school, as well as their values, beliefs and involvement relating to maths.

On **XXX** I will invite students from grades 7-11 to be surveyed. Participation involves completing a questionnaire, which takes approximately 40 minutes. **Participation is voluntary** and students are free to withdraw at any time. Alternative work will be made available to students who choose not to take part.

Information obtained from the questionnaire will be used in my PhD thesis, and potentially published as a journal article. The school will receive a summary of the nature and trends of students' academic motivation. However no student will be named and only summary results will be presented. All information will be treated as strictly **confidential** as far as the law allows and kept securely locked at the ANU.

The ANU Human Research Ethics Committee and the NSW Department of Education and Training have cleared this study. Participation in greatly appreciated and the school will benefit most by having as many students as possible involved. **Please complete and return the attached consent form for your child's participation before XXXX**

If you have any queries, please contact me on; Stephanie.Plenty@anu.edu.au or Tel: 6215 5585

If you have any ethical concerns about the study please contact the ANU Human Research Ethics Committee; Human.Ethics.Officer@anu.edu.au or Tel: 6215 7945

Yours sincerely,

Stephanie Plenty

Parent/Guardian Statement of Informed Consent (please return)

Study Title: Changes in Mathematics Motivation During High School

Parent/Guardian to complete

I, ………………………………………………, do / do not consent to my child,
(Full Name)

……………………………………………… participating in the above study.
(Full Name)

- I understand that my child's participation is voluntary and that they may withdraw from the study at any time. Participants do not have to provide any reason and will not be penalised in any way if they do not wish to continue.

- I understand the purpose of this study as explained to me by the information sheet.

- I understand that my child will in no way be identifiable in any published work resulting from this research.

- I understand that any concerns regarding the ethics of this research can be raised with the ANU Human Ethics Officer.

Signature: …………………………………………. Date: ………........

Appendix C (IV) - Student Information and Consent Form

Information for Students

Study Title: Changes in Mathematics Motivation During High School

- The aim of this study is to understand processes involved in academic achievement motivation during high school. It looks at your general experiences of school as well as your views of different subjects and maths in particular.

- There are no known psychological risks from participating in this study. Procedures and questions are similar to those used in previous research.

- **Participation in the study is voluntary** and you are free to withdraw from the study at any time and for any reason. You are not required to explain your reasons to the researcher, teacher or classmates. This year's study is part of a longer project and you may be invited to participate in a follow up in a year's time. However, you are under no obligation to commit to future studies.

- If you wish to withdraw from the study at any time after completing and handing in the questionnaire, please contact me either by my mobile or email provided below. Names will be recorded with questionnaires, so I will be able to identify yours for removal. No parent, teacher or students will have access to your answers.

- All data collected will be only available to the researchers and will not be released to any other individual so far as the law allows. It will be stored in a secure location at the ANU.

- The data collected will be used in a PhD thesis and may be published. However, any publication would only report averages of the data set and no participant will be identifiable from that data.

- This study has been approved by the ANU Human Research Ethics Committee and NSW Department of Education and Training.

If you have any further queries, please feel free to contact;

Stephanie Plenty on 6125 5585 or stephanie.plenty@anu.edu.au.

If you have any concerns about how the study was conducted please contact the ANU Human Research Ethics Committee;

Tel: 02 6125 7945 or Email: Human.Ethics.Officer@anu.edu.au

Statement of Informed Consent

Study Title: Changes in Mathematics Motivation During High School

Student to complete

I, ……………………………………, consent to participating in the above study.
(Full Name)

- I understand that my participation is voluntary and that I may withdraw from the study at any time. I do not have to provide any reason and will not be penalised in any way if I do not wish to continue.
- I understand the purpose of this study as explained to me by the researcher and information sheet.
- I understand that I will in no way be identifiable in any published work resulting from this research.
- I understand that any concerns regarding the ethics of this research can be raised with the ANU Human Ethics Officer.

Signature: …………………………….……………….. Date: ……………..

Appendix C (V) - Notice in School Newsletters

Notice To Parents/Guardians To Go In School Newsletter

Changes in Mathematics Motivation During High School

XXXX High School is participating in a study about academic motivation during adolescence. Stephanie Plenty, a postgraduate student from the School of Psychology at the Australian National University, is conducting the research as part of her PhD. The research involves students from grades 7-11 completing a questionnaire, taking approximately 40 minutes. The questionnaire will ask students to indicate their value and competency beliefs towards maths and how social interactions with friends may influence their motivation.

Participation in greatly appreciated and the school will benefit most by having as many students as possible involved. However guardian consent is required before students are invited to participate. Students will receive information and consent forms to take home. Please complete and return consent forms for your child's participation **XXXX.**

If you have any enquiries or comments, please feel free to contact her or the school.

Email: Stephanie.Plenty@anu.edu.au Tel : (02) 6125 5585

Appendix D – Questionnaire

Study Title: Changes in Mathematics Motivation During High School

Stephanie Plenty

The Australian National University

Please write your age, grade, sex and initials.

Age ………. Grade …….. Sex: M F Initials ………..

Read each statement carefully. Each sentence starts with “My school is a place where…” Circle the number which corresponds to your feelings about your school.
Make sure you answer ALL statements.

1	2	3	4	5
Certainly false	Probably false	Uncertain	Probably true	Certainly true

<u>“My school is a place where…..”</u>

1.	…..I find it easy to get to know other people.	1	2	3	4	5
2.	…..other students are very friendly.	1	2	3	4	5
3.	…..mixing with other people helps me understand myself.	1	2	3	4	5
4.	…..I learn to get along with other people.	1	2	3	4	5
5.	…..I feel worried.	1	2	3	4	5
6.	…..I feel proud of myself.	1	2	3	4	5
7.	…..other students accept me as I am.	1	2	3	4	5
8.	.....I get along well with other students in the class.	1	2	3	4	5

Please read each sentence put a circle around one number from 1 to 6 for each of your answers. Please make sure you answer every question.

1	2	3	4	5	6
False	Mostly false	More false then true	More true than false	Mostly true	True

9.	MATHEMATICS is one of my best subjects.	1	2	3	4	5	6
10.	I get along well with my parents.	1	2	3	4	5	6
11.	I get good marks in MATHEMATICS.	1	2	3	4	5	6
12.	My parents treat me fairly.	1	2	3	4	5	6
13.	I have always done well in MATHEMATICS.	1	2	3	4	5	6
14.	My parents understand me.	1	2	3	4	5	6
15.	I do badly in tests of MATHEMATICS.	1	2	3	4	5	6
16.	I do not like my parents very much.	1	2	3	4	5	6

1	2	3	4	5	6	7
Disagree strongly	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Agree strongly

Not shown due to copyright

Not shown due to copyright

Not shown due to copyright

Not shown due to copyright

Circle the answer that most accurately describes your **maths teacher** and your relationship with them.

1	2	3	4	5
Strongly disagree	Disagree	Uncertain	Agree	Strongly agree

1.	I like my maths teacher	1	2	3	4	5
2.	My maths teacher shows no interest in me	1	2	3	4	5
3.	My maths teacher is friendly	1	2	3	4	5
4.	My maths teacher treats me unfairly	1	2	3	4	5
5.	I get along well with my maths teacher	1	2	3	4	5
6.	I'd prefer another maths teacher	1	2	3	4	5

Background Information

1. **Name: ....**

2. What language(s) do you speak at home?

   ……………………………………………………………………………….

3. What is the highest level of <u>education</u> your parents have completed? Please use the codes from 1 to 6 below:

   a) Mother: ……………………. b) Father: ……………………..

   1 = Primary School (grades 1-6)
   2 = High School (grades 7-10)
   3 = High School (grades 11-12)
   4 = CIT, TAFE etc (any education after year 12, other than university study)
   5 = University Degree (Bachelors degrees, including honours degrees)
   6 = Post-graduate Degree (eg Masters, PhD)

YOU HAVE FINISHED THE SURVEY!
THANK YOU FOR YOUR CONTRIBUTION.

PLEASE CHECK THAT YOU HAVE ANSWERED EVERY QUESTION ON EVERY PAGE.

Appendix E - Descriptive Statistics for MES-HS Items

Table 24.

Descriptive Statistics for MES-HS Items at Time 1

MES-HS Item	Mean	SD	Skewness	Kurtosis
1	5.01	1.58	-.66	-.36
2	5.71	1.44	-1.29	1.52
3	4.89	1.78	-.69	-.41
4	5.21	1.59	-.85	.14
5	3.06	1.79	.58	-.63
6	3.63	1.76	.05	-.93
7	5.78	1.42	-1.25	1.14
8	2.55	1.70	1.06	.21
9	4.83	1.69	-.55	-.48
10	4.02	2.00	-.01	-1.22
11	3.03	1.90	.59	-.80
12	3.74	1.91	.14	-1.13
13	5.74	1.43	-1.28	1.27
14	5.70	1.48	-1.30	1.35
15	2.67	1.81	.94	-.18
16	3.54	1.86	.22	-.96
17	3.62	1.89	.19	-1.02
18	3.26	1.76	.36	-.83
19	4.41	2.01	-.31	-1.12
20	2.90	1.78	.64	-.63
21	4.18	1.71	-.18	-.71
22	2.64	1.69	.89	-.06
23	5.22	1.63	-.82	.02
24	2.94	1.77	.66	-.56
25	5.42	1.47	-.90	.47
26	5.34	1.48	-.80	.30
27	3.51	1.77	.26	-.86
28	4.79	1.75	-.57	-.54
29	2.78	1.81	.82	-.35
30	3.8.	1.83	.09	-.95
31	4.10	2.03	-.13	-1.23
32	4.36	1.87	-.33	-.94
33	5.45	1.48	-.91	.34
34	5.63	1.51	-1.08	.51
35	2.95	1.72	.60	-.63
36	4.94	1.57	-.57	-.24
37	3.84	1.84	.07	-.95
38	2.98	1.76	.51	-.72
39	2.76	1.66	.73	-.26
40	5.35	1.67	-.10	.30
41	5.58	1.50	-1.18	1.09
42	3.12	1.87	.56	-.76
43	3.35	1.86	.34	-.92
44	4.53	1.82	-.46	-.75

Table 25.

Descriptive Statistics for MES-HS Items at Time 2

MES-HS Item	Mean	SD	Skewness	Kurtosis
1	5.02	1.48	-.73	.11
2	5.71	1.40	-1.29	1.43
3	4.73	1.73	-.58	-.50
4	4.93	1.64	-.72	-.16
5	3.01	1.72	.58	-.59
6	3.66	1.68	.06	-.78
7	5.68	1.32	-.08	1.08
8	2.68	1.65	.92	.14
9	4.72	1.63	-.49	-.54
10	4.17	1.97	-.09	-1.19
11	2.94	1.83	.59	-.81
12	3.69	1.85	.14	-1.10
13	5.66	1.33	-1.16	1.39
14	5.64	1.42	-1.12	.99
15	5.61	1.42	-1.12	.99
16	3.40	1.83	.30	-.96
17	3.56	1.85	.21	-.99
18	3.19	1.69	.34	-.83
19	4.50	1.96	-.35	-1.10
20	2.78	1.71	.68	-.57
21	4.14	1.67	-.09	-.62
22	2.75	1.76	.93	-.03
23	5.22	1.54	-.78	.16
24	2.84	1.66	.67	-.37
25	5.37	1.41	-.94	.83
26	5.38	1.4	-.93	.64
27	3.50	1.68	.21	-.73
28	4.78	1.59	-.58	-.34
29	2.91	1.85	.70	-.64
30	3.74	1.72	.07	-.86
31	3.89	2.02	-.01	-1.27
32	4.09	1.76	-.14	-.92
33	5.31	1.51	-.98	.49
34	5.21	1.62	-.74	-.17
35	2.93	1.64	.56	-.48
36	4.80	1.55	-.55	-.23
37	3.94	1.8	.03	-.99
38	2.85	1.70	.65	-.52
39	2.70	1.62	.77	-.20
40	5.27	1.53	-.87	.22
41	5.49	1.43	-.96	.64
42	3.45	1.85	.31	-.82
43	3.39	1.85	.33	-.93
44	4.23	1.74	-.20	-.82

Appendix F - Factor Loadings for 11-Factor Model

Table 26.

Time 1 Factor Loadings for 11 Factor Model

Item	SE	VS	MO	PL	SM	P	A	FA	UC	SH	D	Resid.
SE13	.75	0	0	0	0	0	0	0	0	0	0	44
SE23	.77	0	0	0	0	0	0	0	0	0	0	41
SE33	.76	0	0	0	0	0	0	0	0	0	0	42
SE40	.84	0	0	0	0	0	0	0	0	0	0	29
V4	0	.66	0	0	0	0	0	0	0	0	0	56
V14	0	.74	0	0	0	0	0	0	0	0	0	45
V34	0	.79	0	0	0	0	0	0	0	0	0	37
V41	0	.854	0	0	0	0	0	0	0	0	0	30
MF2	0	0	.78	0	0	0	0	0	0	0	0	39
MF7	0	0	.83	0	0	0	0	0	0	0	0	31
MF25	0	0	.87	0	0	0	0	0	0	0	0	24
MF26	0	0	.85	0	0	0	0	0	0	0	0	29
Pl21	0	0	0	.79	0	0	0	0	0	0	0	38
Pl27	0	0	0	.78	0	0	0	0	0	0	0	40
Pl30	0	0	0	.79	0	0	0	0	0	0	0	38
Pl39	0	0	0	.47	0	0	0	0	0	0	0	78
M3	0	0	0	0	.71	0	0	0	0	0	0	50
M17	0	0	0	0	.71	0	0	0	0	0	0	49
M32	0	0	0	0	.85	0	0	0	0	0	0	28
M44	0	0	0	0	.75	0	0	0	0	0	0	44
P1	0	0	0	0	0	.67	0	0	0	0	0	55
P9	0	0	0	0	0	.79	0	0	0	0	0	37
P28	0	0	0	0	0	.74	0	0	0	0	0	46
P36	0	0	0	0	0	.80	0	0	0	0	0	35
A10	0	0	0	0	0	0	.70	0	0	0	0	51
A19	0	0	0	0	0	0	.70	0	0	0	0	51
A37	0	0	0	0	0	0	.81	0	0	0	0	34
A43	0	0	0	0	0	0	.68	0	0	0	0	54
FA11	0	0	0	0	0	0	0	.80	0	0	0	36
FA20	0	0	0	0	0	0	0	.88	0	0	0	22
FA31	0	0	0	0	0	0	0	.69	0	0	0	53
FA38	0	0	0	0	0	0	0	.66	0	0	0	56
UC6	0	0	0	0	0	0	0	0	.74	0	0	46
UC12	0	0	0	0	0	0	0	0	.77	0	0	40
UC16	0	0	0	0	0	0	0	0	.74	0	0	46
UC18	0	0	0	0	0	0	0	0	.81	0	0	34

Table 26.
(Continued)

Item	SE	VS	MO	PL	SM	P	A	FA	UC	SH	D	Resid.
SH5	0	0	0	0	0	0	0	0	0	.70	0	51
SH24	0	0	0	0	0	0	0	0	0	.76	0	42
SH35	0	0	0	0	0	0	0	0	0	.75	0	44
SH42	0	0	0	0	0	0	0	0	0	.74	0	46
SH8	0	0	0	0	0	0	0	0	0	0	.80	36
SH15	0	0	0	0	0	0	0	0	0	0	.82	33
SH22	0	0	0	0	0	0	0	0	0	0	.84	29
SH29	0	0	0	0	0	0	0	0	0	0	.85	28

Note. SE = self-efficacy, VS = valuing of school, MO = Mastery Orientation, PL = planning, SM = study management, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. All p <.001.

Table 27.
Time 2 Factor Loadings for 11 Factor Model

Item	SE	VS	MO	PL	SM	P	A	FA	UC	SH	D	Resid.
SE13	.78	0	0	0	0	0	0	0	0	0	0	.39
SE23	.78	0	0	0	0	0	0	0	0	0	0	.39
SE33	.82	0	0	0	0	0	0	0	0	0	0	.33
SE40	.82	0	0	0	0	0	0	0	0	0	0	.33
V4	0	.66	0	0	0	0	0	0	0	0	0	.56
V14	0	.82	0	0	0	0	0	0	0	0	0	.33
V34	0	.72	0	0	0	0	0	0	0	0	0	.49
V41	0	.85	0	0	0	0	0	0	0	0	0	.28
MF2	0	0	.75	0	0	0	0	0	0	0	0	.44
MF7	0	0	.80	0	0	0	0	0	0	0	0	.36
MF25	0	0	.83	0	0	0	0	0	0	0	0	.31
MF26	0	0	.85	0	0	0	0	0	0	0	0	.28
Pl21	0	0	0	.87	0	0	0	0	0	0	0	.24
Pl27	0	0	0	.76	0	0	0	0	0	0	0	.42
Pl30	0	0	0	.80	0	0	0	0	0	0	0	.37
Pl39	0	0	0	.34	0	0	0	0	0	0	0	.88
M3	0	0	0	0	.80	0	0	0	0	0	0	.37
M17	0	0	0	0	.71	0	0	0	0	0	0	.50
M32	0	0	0	0	.89	0	0	0	0	0	0	.38
M44	0	0	0	0	.71	0	0	0	0	0	0	.50
P1	0	0	0	0	0	.75	0	0	0	0	0	.44
P9	0	0	0	0	0	.84	0	0	0	0	0	.30
P28	0	0	0	0	0	.81	0	0	0	0	0	.35
P36	0	0	0	0	0	84	0	0	0	0	0	.30

Table 27.
(Continued)

Item	SE	VS	MO	PL	SM	P	A	FA	UC	SH	D	Resid.
A10	0	0	0	0	0	0	.70	0	0	0	0	.51
A19	0	0	0	0	0	0	.78	0	0	0	0	.40
A37	0	0	0	0	0	0	.73	0	0	0	0	.47
A43	0	0	0	0	0	0	.72	0	0	0	0	.49
FA11	0	0	0	0	0	0	0	.86	0	0	0	.26
FA20	0	0	0	0	0	0	0	.87	0	0	0	.24
FA31	0	0	0	0	0	0	0	.71	0	0	0	.50
FA38	0	0	0	0	0	0	0	.74	0	0	0	.45
UC6	0	0	0	0	0	0	0	0	.62	0	0	.62
UC12	0	0	0	0	0	0	0	0	.82	0	0	.34
UC16	0	0	0	0	0	0	0	0	.83	0	0	.32
UC18	0	0	0	0	0	0	0	0	.78	0	0	.39
SH5	0	0	0	0	0	0	0	0	0	.72	0	.48
SH24	0	0	0	0	0	0	0	0	0	.81	0	.35
SH35	0	0	0	0	0	0	0	0	0	.82	0	.33
SH42	0	0	0	0	0	0	0	0	0	.63	0	.60
SH8	0	0	0	0	0	0	0	0	0	0	.79	.37
SH15	0	0	0	0	0	0	0	0	0	0	.84	.30
SH22	0	0	0	0	0	0	0	0	0	0	.80	.37
SH29	0	0	0	0	0	0	0	0	0	0	.88	.30

Note. SE = self-efficacy, VS = valuing of school, MO = Mastery Orientation, PL = planning, SM = study management, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. All p <.001

Appendix G - 11-Factor Model Construct Correlations

Table 28.

Time 1 Factor Correlations for 11-Factor Model with Items Removed

	SE	VS	MO	PL	SM	P	A	FA	UC	SH
SE	-									
VS	.84	-								
MO	.90	.86	-							
PLN	.51	.47	.51	-						
SM	.62	.62	.62	.92	-					
P	.88	.76	.80	.77	.79	-				
A	-.07	.12	.20	.15	.29	-.01	-			
FA	-.21	-.13	-.05	.16	.18	-.15	.69	-		
UC	-.50	-.30	-.24	-.14	-.11	-.42	.69	.72	-	
SH	-.53	-.43	-.42	-.39	-.44	-.52	.27	.50	.63	-
D	-.77	-.81	-.69	-.48	-.55	-.78	.25	.40	.62	.71

Note. SE = self-efficacy, VS = valuing of school, MO = task orientation, PL = planning, SM = study management, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. Values above .09, p < .05.

Table 29.

Time 2 Factor Correlations for 11-Factor Model with Items Removed

	SE	VS	MO	PL	SM	P	A	FA	UC	SH
SE	-									
VS	.88	-								
MO	.86	.81	-							
PLN	.43	.50	.50	-						
SM	.50	.57	.55	.94	-					
P	.83	.79	.75	.64	.66	-				
A	.03	.07	.28	.35	.29	.07	-			
FA	-.31	-.26	-.16	.10	.01	-.23	.65	-		
UC	-.41	-.23	-.13	.03	-.02	-.35	.71	.67	-	
SH	-.47	-.39	-.38	-.23	-.30	-.54	.25	.54	.57	-
D	-.77	-.80	-.66	-.42	-.50	-.81	.16	.50	.60	.67

Note. SE = self-efficacy, VS = valuing of school, MO = task orientation, PL = planning, SM = study management, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. Values above .09, p < .05.

Appendix H - 11-Factor Model Tests of Model Fit and Measurement Invariance

Table 30.

Fit of Time 1 Male-Female Multigroup CFA for 11-Factor Model

Model	χ^2	*df*	CFI	TLI	RMSEA	χ^2 diff
Null						
A-Males	158.47	66	.94	.96	.083	-
A-Females	254.54	83	.95	.98	.081	-
A-Both Genders	393.70	145	.95	.97	.081	-
A-Invariance	375.34	156	.96	.98	.074	P = .88

Note. Invariance = Both threshold and factor loadings constrained equal across gender.

Table 31.

Fit of Time 2 Male-Female Multigroup CFA for 11-Factor Model

Model	χ^2	*df*	CFI	TLI	RMSEA	$\chi2$ diff
A-Males	178.13	66	.93	.96	.091	
A-Females	258.16	83	.95	.98	.082	-
A-Both Genders	418.52	146	.94	.97	.085	-
A-Invariance	425.52	162	.95	.98	.079	P = .02
B-Invariance	420.96	161	.95	.98	.079	P= .08
C-Males	166.03	66	.93	.96	.086	-
C-Females	249.87	84	.95	.98	.079	-
C-Both Genders	394.68	146	.95	.97	.081	-
C-Invariance	398.81	162	.95	.98	.075	P = .06
D-Invariance	394.18	161	.95	.98	.075	P = .22

Note. A = Original invariance model; B = Freeing items 25 and 26 between gender; C = Model fit with item A-43 cross-loading on self-sabotage; D = Model fit with item A-43 cross-loading on self-sabotage and parameters freed for items 25 and 26; Invariance = Both threshold and factor loadings constrained equal across gender.

Table 32.

Fit of 11-Factor MES-HS Across Time and Sex

Model	χ^2	df	CFI	TLI	RMSEA	χ^2 diff
Both Waves	549.03	187	.94	.97	.061	
Invariance	546.37	197	.94	.98	.058	P=.14
Male	194.71	97	.94	.96	07	
Male Invariance	190.42	100	.94	.96	.067	P=.82
Female	344.38	127	.94	.97	.074	
Female Invariance	342.89	133	.94	.97	.071	P= .08

Note. Invariance = Both threshold and factor loadings constrained equal across time.

Appendix I - Higher-Order Structure of the MES-HS with 11-Factor lower-order Structure

Table 33.

Fit of the Time 1 Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
11-Factor A	902.69	115	86	94	.11
11-Factor B	812.58	106	87	94	.11

Note. 11-Factor A = Second-order model with all items. 11-Factor B = Second order model with 4 items removed.

Table 34.

Fit of the Time 2 Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
11-Factor A	1042.24	105	82	92	.13
11-Factor B	910.64	97	84	93	.13

Note. 11-Factor A = Second-order model with all items. 11-Factor B = Second order model with 4 items removed.

Table 35.

Fit of the Time 1 Post-Hoc Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
11-Factor C	1397.87	102	77	88	.16
11-Factor D	1212.27	98	80	90	.15
11-Factor E	892.31	104	.86	.93	.12
11-Factor F	1585.91	100	73	87	.17

Note. 11-Factor C = 2-Factor model with all adaptive constructs vs. maladaptive constructs; 11-Factor D = 2-Factor model with all adaptive constructs and disengagement vs. maladaptive constructs; 11-Factor E = 3-Factor model with adaptive constructs vs. impeding cognitions vs. maladaptive behaviours; 11-Factor F = 1-Factor model with all 11 constructs.

Table 36.

Fit of the Time 2 Post-Hoc Second-Order Factor Structure

Model	χ^2	df	CFI	TLI	RMSEA
11-Factor C	959.16	86	82	92	.14
11-Factor D	1119.70	87	80	90	.15
11-Factor E	955.51	95	83	92	.13
11-Factor F	1507.77	94	72	88	.17

Note. 11-Factor C = 2-Factor model with all adaptive constructs vs. maladaptive constructs; 11-Factor D = 2-Factor model with all adaptive constructs and disengagement vs. maladaptive constructs; 11-Factor E = 3-Factor model with adaptive constructs vs. impeding cognitions vs. maladaptive behaviours; 11-Factor F = 1-Factor model with all 11 constructs.

Appendix J - Final Model Factor Loadings by Gender

Table 37.

Time 1 Multi-group Factor Loadings for 10-Factor Model (Male / Female)

Item	SE	VS	MO	PL	P	A	FA	UC	SH	D	Resid.
SE13	.75/.77	0	0	0	0	0	0	0	0	0	44/42
SE23	.79/.74	0	0	0	0	0	0	0	0	0	37/57
SE33	.76/.76	0	0	0	0	0	0	0	0	0	42/46
SE40	.85/.83	0	0	0	0	0	0	0	0	0	29/36
V4	0	.64/.69	0	0	0	0	0	0	0	0	59/51
V14	0	.76/.72	0	0	0	0	0	0	0	0	43/61
V34	0	.79/.80	0	0	0	0	0	0	0	0	37/40
V41	0	.86/80	0	0	0	0	0	0	0	0	26/48
MF2	0	0	.81/.73	0	0	0	0	0	0	0	35/46
MF7	0	0	.84/.82	0	0	0	0	0	0	0	30/27
MF25	0	0	.90/.83	0	0	0	0	0	0	0	20/28
MF26	0	0	.86/.82	0	0	0	0	0	0	0	25/28
Pl27	0	0	0	.71/.70	0	0	0	0	0	0	49/43
Pl30	0	0	0	.78/.70	0	0	0	0	0	0	40/52
M17	0	0	0	.80/.75	0	0	0	0	0	0	37/42
M32	0	0	0	.90/.74	0	0	0	0	0	0	18/55
M44	0	0	0	.78/.72	0	0	0	0	0	0	40/48
P1	0	0	0	0	.73/.57	0	0	0	0	0	47/86
P9	0	0	0	0	.84/.70	0	0	0	0	0	29/55
P28	0	0	0	0	.78/.67	0	0	0	0	0	39/58
P36	0	0	0	0	.82/.78	0	0	0	0	0	33/33
A10	0	0	0	0	0	.72/.66	0	0	0	0	48/60
A19	0	0	0	0	0	.83/.68	0	0	0	0	31/75
A43	0	0	0	0	0	.68/.70	0	0	0	0	54/44
FA11	0	0	0	0	0	0	.81/.79	0	0	0	34/41
FA20	0	0	0	0	0	0	.92/.83	0	0	0	16/37
FA31	0	0	0	0	0	0	.69/.62	0	0	0	52/76
FA38	0	0	0	0	0	0	.66/.64	0	0	0	57/61
UC6	0	0	0	0	0	0	0	.78/.65	0	0	39/54
UC12	0	0	0	0	0	0	0	.78/.73	0	0	39/34
UC16	0	0	0	0	0	0	0	.76/.68	0	0	43/43
UC18	0	0	0	0	0	0	0	.83/.79	0	0	32/26
SH5	0	0	0	0	0	0	0	0	.70/.70	0	51/44
SH24	0	0	0	0	0	0	0	0	.78/.74	0	40/43
SH35	0	0	0	0	0	0	0	0	.82/.65	0	34/80
SH42	0	0	0	0	0	0	0	0	.75/.70	0	43/52
D8	0	0	0	0	0	0	0	0	0	.84/.73	34/65
D15	0	0	0	0	0	0	0	0	0	.82/.83	33/31
D22	0	0	0	0	0	0	0	0	0	.87/.81	25/42
D29	0	0	0	0	0	0	0	0	0	.85/.84	27/31

Note. Females first, N = 315, Males second, N = 204. SE = self-efficacy, VS = valuing of school, MO = mastery orientation, PL = planning, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. All p <.001.

Table 38.

Time 2 Multi-group Factor Loadings for 10-Factor Model (Male / Female)

Item	SE	VS	MO	PL	P	A	FA	UC	SH	D	Resid.
SE13	79/76	0	0	0	0	0	0	0	0	0	37/41
SE23	80/77	0	0	0	0	0	0	0	0	0	36/40
SE33	86/76	0	0	0	0	0	0	0	0	0	27/48
SE40	85/78	0	0	0	0	0	0	0	0	0	28/41
V4	0	67/65	0	0	0	0	0	0	0	0	56/64
V14	0	81/83	0	0	0	0	0	0	0	0	35/30
V34	0	72/73	0	0	0	0	0	0	0	0	48/49
V41	0	88/81	0	0	0	0	0	0	0	0	22/45
MF2	0	0	77/70	0	0	0	0	0	0	0	40/40
MF7	0	0	80/81	0	0	0	0	0	0	0	35/22
MF25	0	0	87/76	0	0	0	0	0	0	0	24/43
MF26	0	0	90/77	0	0	0	0	0	0	0	20/41
Pl27	0	0	0	70/76	0	0	0	0	0	0	52/40
Pl30	0	0	0	80/70	0	0	0	0	0	0	36/77
M17	0	0	0	83/77	0	0	0	0	0	0	32/51
M32	0	0	0	81/82	0	0	0	0	0	0	35/35
M44	0	0	0	72/74	0	0	0	0	0	0	48/49
P1	0	0	0	0	80/67	0	0	0	0	0	35/56
P9	0	0	0	0	84/82	0	0	0	0	0	29/24
P28	0	0	0	0	88/68	0	0	0	0	0	23/63
P36	0	0	0	0	87/78	0	0	0	0	0	24/34
A10	0	0	0	0	0	74/66	0	0	0	0	45/61
A19	0	0	0	0	0	87/85	0	0	0	0	25/26
A43	0	0	0	0	0	60/60	0	0	0	0	57/45
FA11	0	0	0	0	0	0	86/87	0	0	0	26/29
FA20	0	0	0	0	0	0	86/89	0	0	0	26/25
FA31	0	0	0	0	0	0	68/82	0	0	0	54/55
FA38	0	0	0	0	0	0	73/77	0	0	0	47/45
UC6	0	0	0	0	0	0	0	66/55	0	0	57/82
UC12	0	0	0	0	0	0	0	84/75	0	0	30/46
UC16	0	0	0	0	0	0	0	86/77	0	0	26/41
UC18	0	0	0	0	0	0	0	83/69	0	0	31/61
SH5	0	0	0	0	0	0	0	0	70/77	0	51/38
SH24	0	0	0	0	0	0	0	0	81/79	0	35/45
SH35	0	0	0	0	0	0	0	0	84/79	0	29/47
SH42	0	0	0	0	0	0	0	0	70/52	0	51/1.49
D8	0	0	0	0	0	0	0	0	0	80/77	35/40
D15	0	0	0	0	0	0	0	0	0	85/82	29/32
D22	0	0	0	0	0	0	0	0	0	82/76	33/45
D29	0	0	0	0	0	0	0	0	0	91/84	18/30

Note. Females first, N = 315, Males second, N = 204. SE = self-efficacy, VS = valuing of school, MO = mastery orientation, PL = planning, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. All p <.001.

Appendix K - 10-Factor Model Correlations by Gender

Table 39.

Time 1 10-Factor Model Correlations between Motivation Factors (female/male)

	SE	VS	MO	PLN	P	A	FA	UC	SH
SE	-								
VS	.85/.80	-							
MO	.88/.91	.86/.83	-						
PLN	.63/.54	.65/.45	.61/.55	-					
P	.88/.87	.79/.70	.78/.82	.82/.75	-				
A	-.06/-.12	.13/.06	.24/.06	.20/.26	-.02/-.04	-			
FA	-.19/-.22	-.11/-.16	-.02/-.12	.11/.24	-.18/-.12	.71/.64	-		
UC	-.50/-.53	-.29/-.31	-.19/-.37	-.18/-.08	-.44/-.42	.67/.66	.73/.68	-	
SH	-.54/-.50	-.45/-.36	-.41/-.43	-.44/-.43	-.55/-.50	.30/.17	.52/.41	.68/.54	-
D	-.78/-.72	-.81/-.78	-.68/-.71	-.62/-.45	-.81/-.74	.25/.22	.41/.40	.63/.59	.72/.65

Note. Girls = 315, Boys = 204. SE = self-efficacy, VS = valuing, MO = mastery orientation, PLN = planning, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. Values above .09, p < .05.

Table 40.

Time 2 10-Factor Model Correlations between Motivation Factors (female/male)

	SE	VS	MO	PLN	P	A	FA	UC	SH
SE	-								
VS	.87/.86	-							
MO	.85/.87	.81/.80	-						
PLN	.52/.44	.60/.47	.56/.50	-					
P	.82/.84	.78/.79	.73/.77	.72/.59	-				
A	.07/-.04	.11/.01	.32/.17	.27/.34	.04/.06	-			
FA	-.30/-.31	-.27/-.24	-.16/-.21	-.05/.13	-.28/-.19	.63/.65	-		
UC	-.39/-.46	-.20/-.27	-.11/-.24	-.07/.05	-.38/-.37	.68/.68	.65/.68	-	
SH	-.47/-.46	-.39/-.36	-.38/-.41	-.37/-.18	-.59/-.49	.20/.30	.47/.62	.54/.61	-
D	-.77/-.74	-.80/-.76	-.66/-.67	-.59/-.32	-.86/-.74	.12/.20	.48/.52	.44/.48	.64/.70

Note. Girls = 315, Boys = 204. SE = self-efficacy, VS = valuing, MO = mastery orientation, PLN = planning, P = persistence, A = anxiety, FA = failure avoidance, UC = uncertain control, SH = self-handicapping, D = disengagement. Values above .09, p < .05.

Appendix L - Affiliation and Maths Attainment Item Listings

Maths Teacher Affiliation
MT1 – I like my maths teacher
MT2 – My maths teacher shows no interest in me
MT3 – My maths teacher is friendly
MT4 – My maths teacher treats me unfairly
MT5 – I get along well with my maths teacher
MT6– I'd prefer another maths teacher

Peer Affiliation
Pe1 – I find it easy to get to know other people
Pe2 – Other students are very friendly
Pe3 – Mixing with other people helps me understand myself
Pe4 – I learn to get along with other people
Pe5 – Other students accept me as I am
Pe6 – I get well with other students in my class

Parent Affiliation
Pa1 – I get along well with my parents
Pa2 – My parents treat me fairly
Pa3 – My parents understand me
Pa4– I do not like my parents very much

Maths Attainment
MA1 – Mathematics is one of my best subjects
MA2 – I get good marks in mathematics
MA3 – I have always done well in mathematics
MA4 – I do badly in tests of mathematics

Appendix M - Affiliation and Maths Attainment Factor Loadings by Gender

Table 39.

Time 1 Multi-group Factor Loadings for Affiliation and Maths Attainment (Male / Female)

Item	Peers	Parents	MT	MA
Pe2	.68/.64	0	0	0
Pe4	.76/.67	0	0	0
Pe5	.81/.71	0	0	0
Pe6	.75/.70	0	0	0
Pa1	0	.89/.85	0	0
Pa2	0	.86/.88	0	0
Pa3	0	.93.89	0	0
Pa4	0	.88/.78	0	0
MT1	0	0	.93/.85	0
MT3	0	0	.91/.88	0
MT5	0	0	.93/.89	0
MT6	0	0	.86/.78	0
MA1	0	0	0	.90/.89
MA2	0	0	0	.93/.95
MA3	0	0	0	.85/.86
MA4	0	0	0	.78/.74

Note. Peers = Peer Affiliation; Parents = Parent Affiliation; MT = Maths Teacher Affiliation; MA = Maths Attainment.

Table 40.

Time 2 Multi-group Factor Loadings for Affiliation and Maths Attainment (Male /Female)

Item	Peers	Parents	MT	MA
Pe2	.69/.62	0	0	0
Pe4	.72/.72	0	0	0
Pe5	.72/.70	0	0	0
Pe6	.79/.80	0	0	0
Pa1	0	.92/.88	0	0
Pa2	0	.87/.90	0	0
Pa3	0	.84.88	0	0
Pa4	0	.81/.73	0	0
MT1	0	0	.96/.88	0
MT3	0	0	.88/.78	0
MT5	0	0	.90/.87	0
MT6	0	0	.87/.78	0
MA1	0	0	0	.92/.88
MA2	0	0	0	.88/.92
MA3	0	0	0	.87/83
MA4	0	0	0	.80/76

Note. Peers = Peer Affiliation; Parents = Parent Affiliation; MT = Maths Teacher Affiliation; MA = Maths Attainment.

Appendix N - Gender Multigroup Path Analyses for Maths Motivation and Affiliation

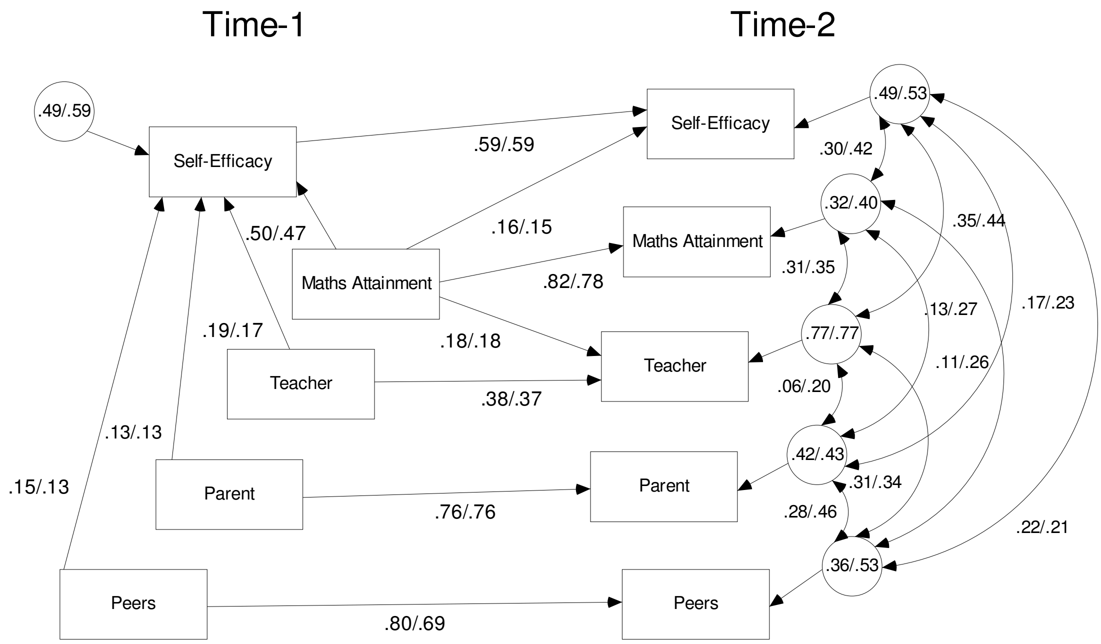


Figure 14a. Gender Multigroup Path Analysis for Self-Efficacy (girls/boys).

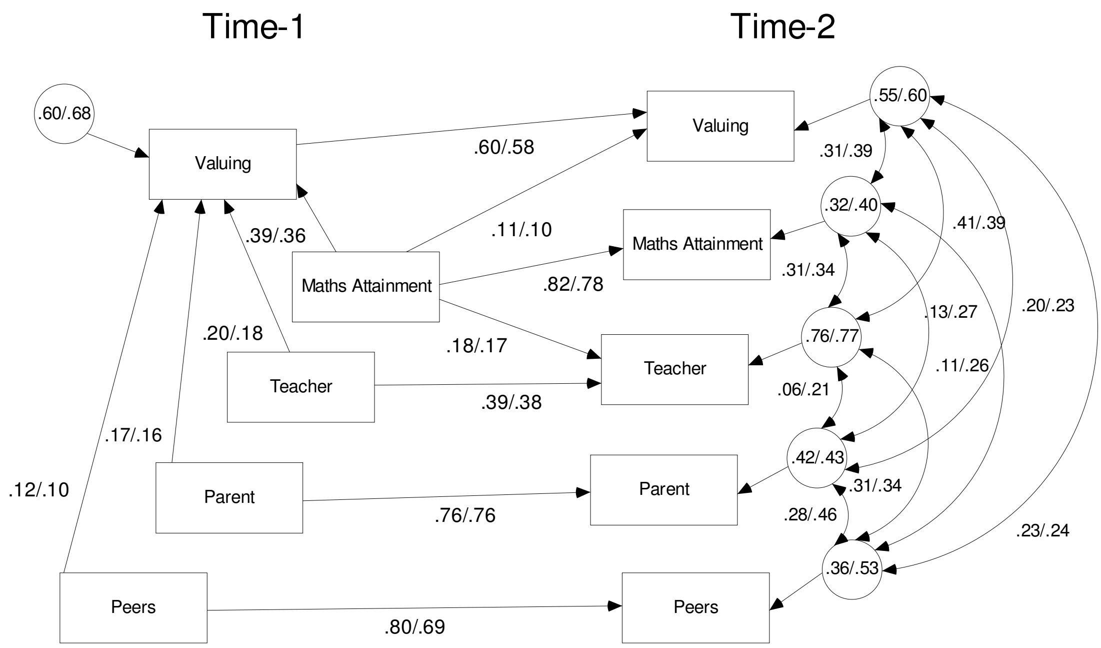


Figure 14b. Gender Multigroup Path Analysis for Valuing (girls/boys).

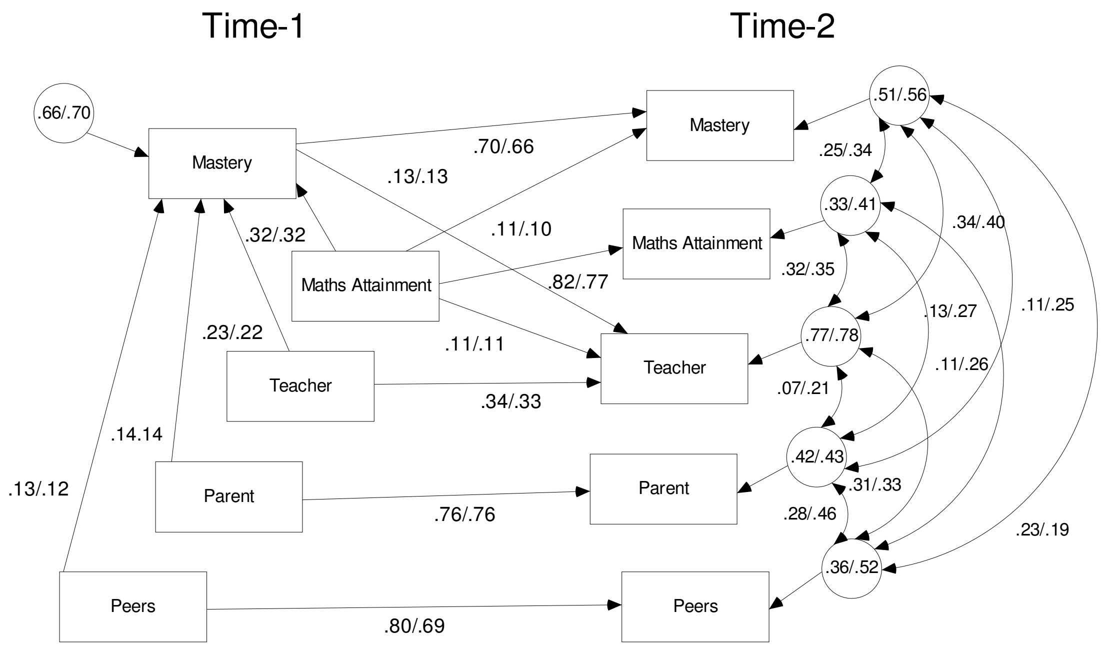


Figure 14c. Gender Multigroup Path Analysis for Mastery (girls/boys).

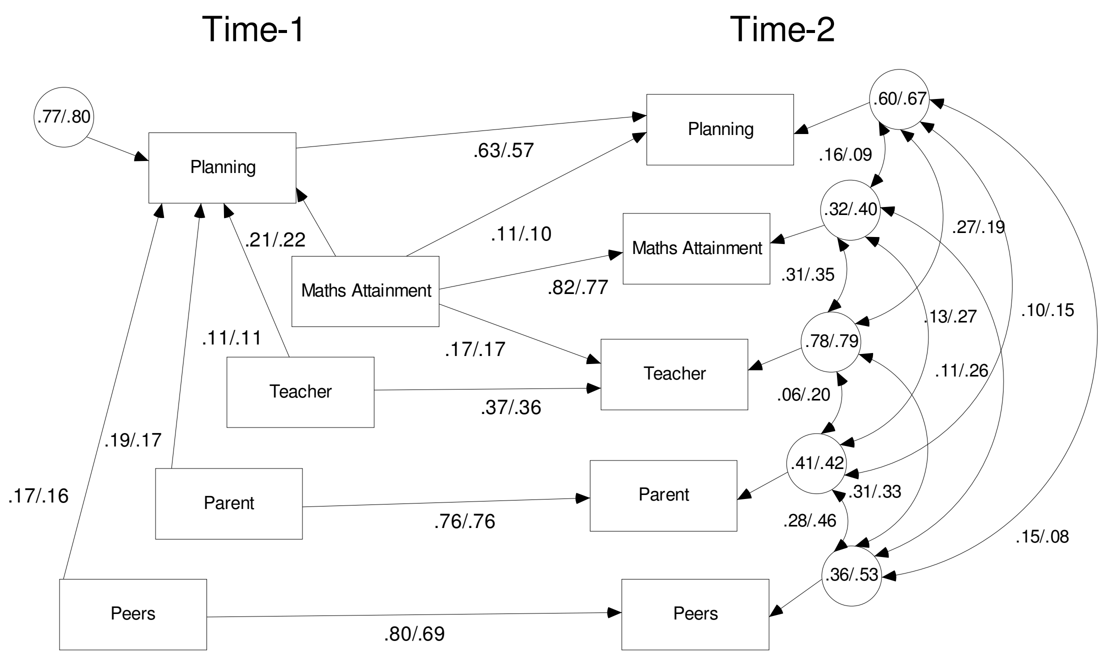


Figure 14d; Gender Multigroup Path Analysis for Planning (girls/boys).

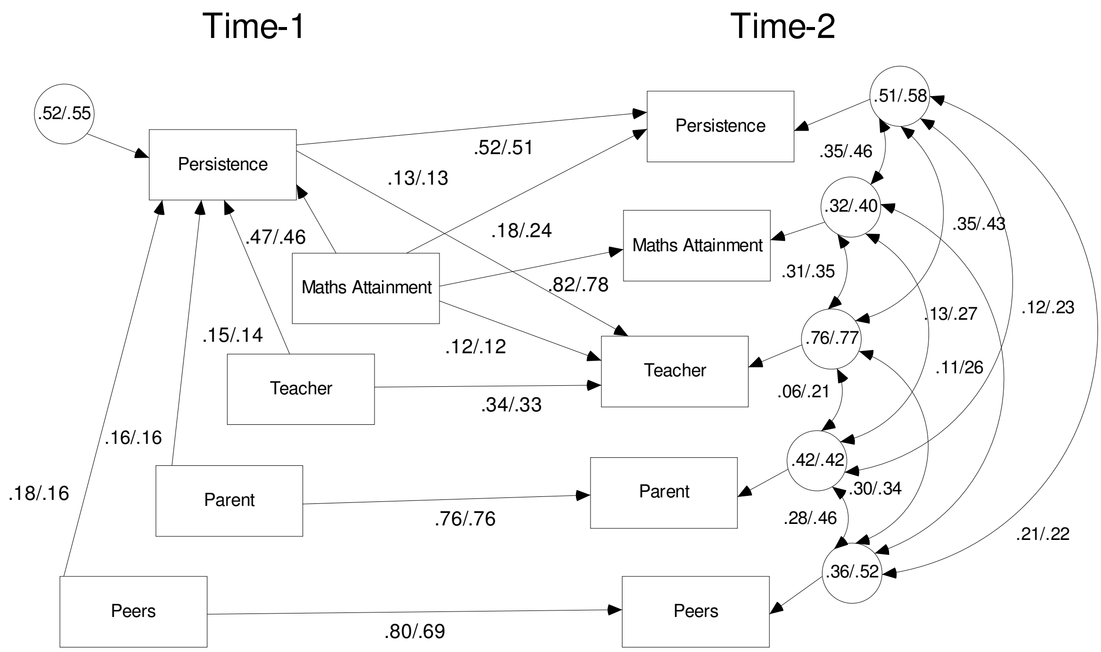


Figure 14e; Gender Multigroup Path Analysis for Persistence (girls/boys).

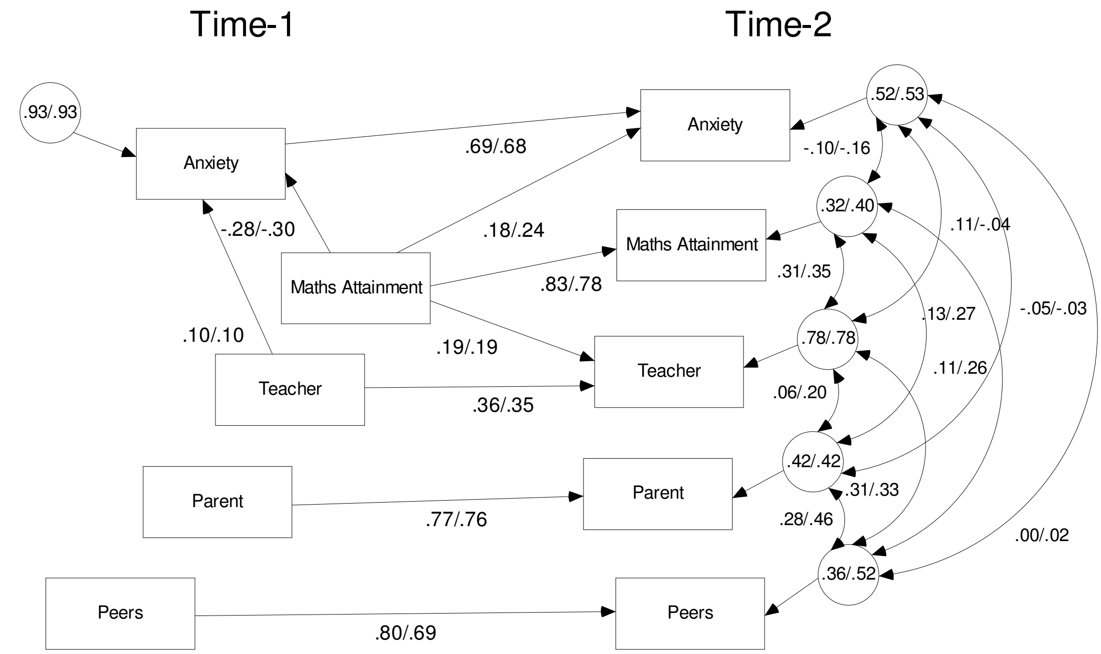


Figure 14f; Gender Multigroup Path Analysis for Anxiety (girls/boys).

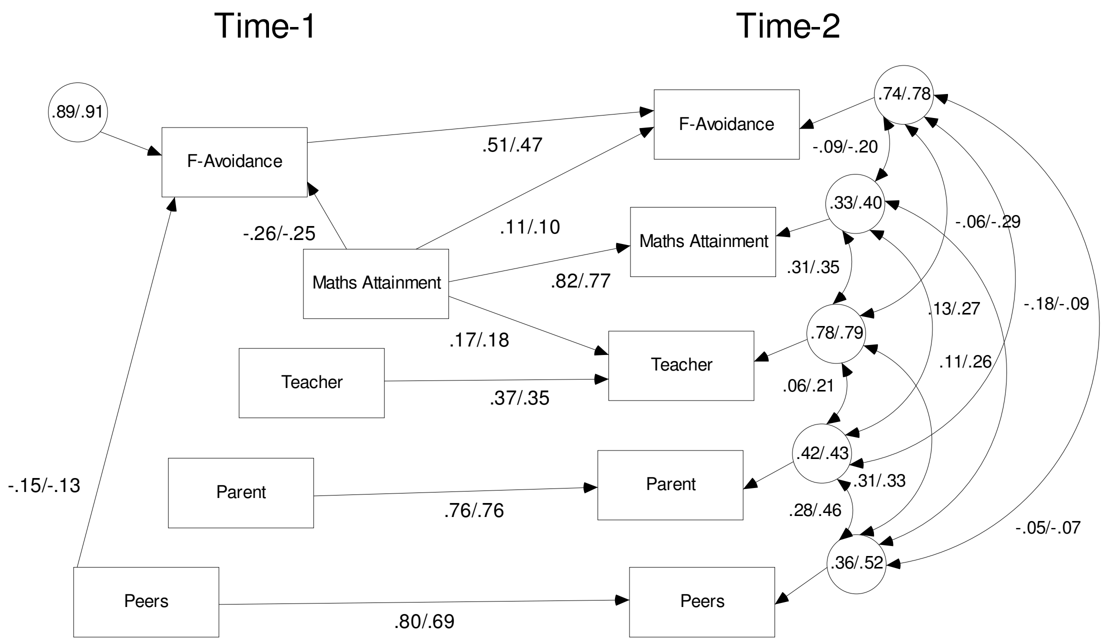


Figure 14g; Gender Multigroup Path Analysis for Failure Avoidance (girls/boys).

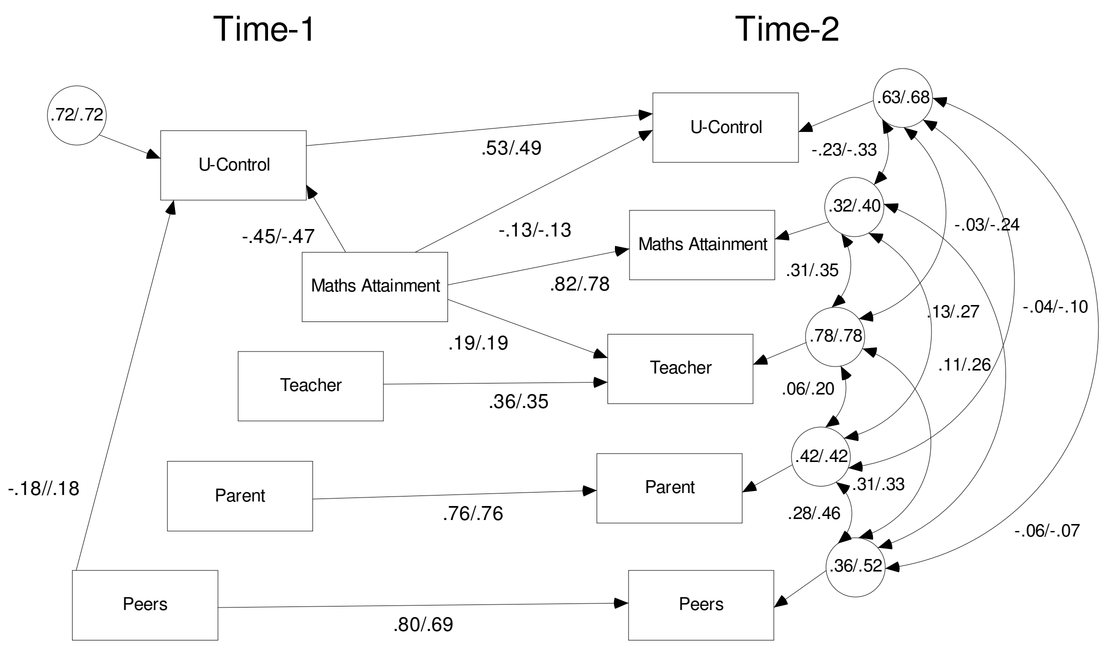


Figure 14h; Gender Multigroup Path Analysis for Uncertain Control (girls/boys).

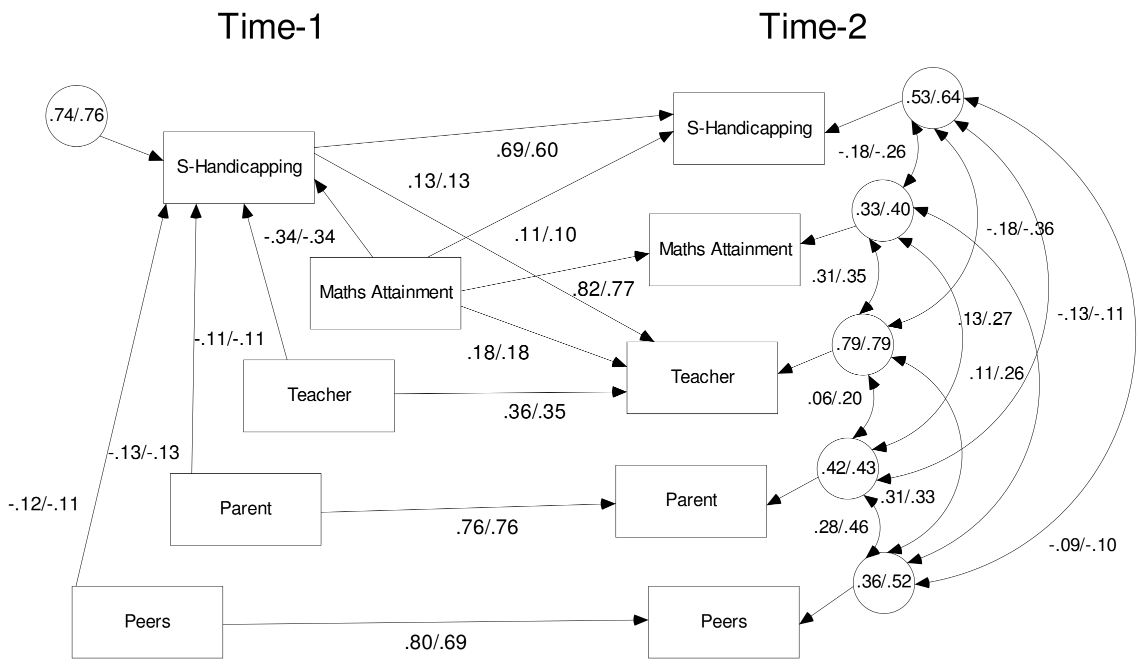


Figure 14i; Gender Multigroup Path Analysis for Self-Handicapping (girls/boys).

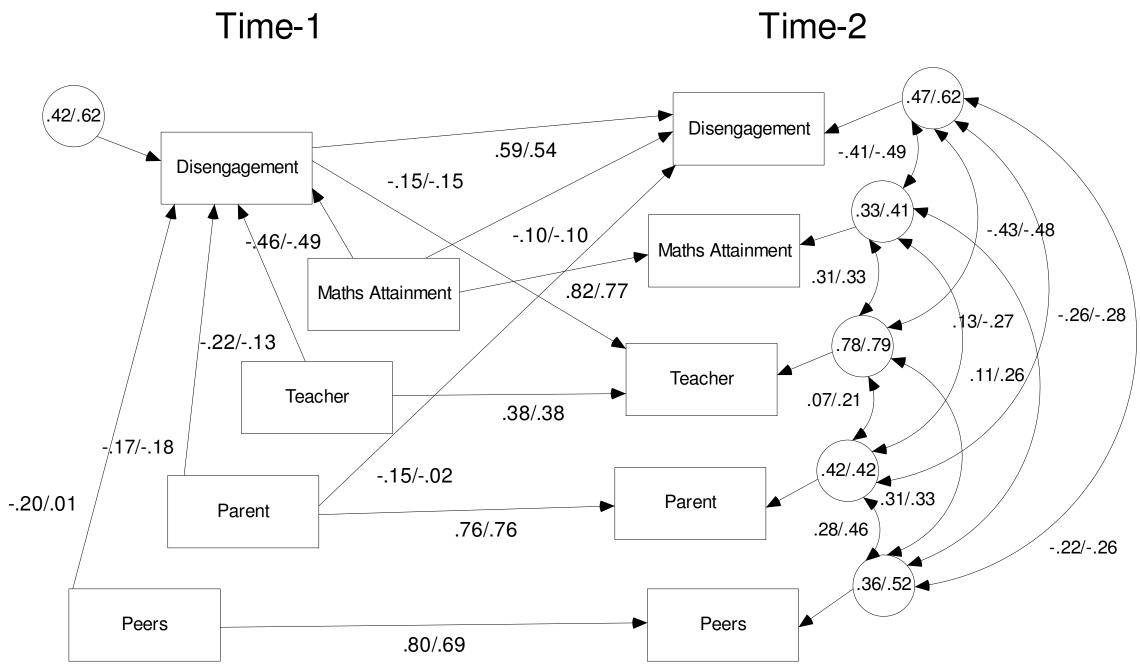


Figure 14j. Gender Multigroup Path Analysis for Disengagement (girls/boys).